HOW COMPETITIVE PERFORMANCE DATA CAN INFORM THE TRAINING PROCESS? AN ACTION-RESEARCH STUDY BASED ON THE CONSTRAINT-LED APPROACH

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Abstract:

By implementing an insider action-research (AR) design throughout a competitive volleyball season, this study sought to examine qualitatively how competitive data, extracted from match analysis, may support the development of a coaching intervention based on the principles of the constraint-led approach. Twelve elite players, one head coach and one assistant coach participated in two AR cycles, each one involving the processes of planning, monitoring, reflecting, and fact-finding. The first author, who was also the assistant coach and the *insider*-researcher, collected data over 20 weeks using interviews, training videotaped records, and field notes. Data were analysed using thematic analysis, and inductive procedures were adopted to deepen an understanding of how a constraint-led coaching intervention evolved over the season. The results highlighted competitive data as a relevant tool for supporting the underlying pedagogical process in the design of representative learning tasks via constraints manipulation. Grounded on competitive data, the learning designs progressed from an initial point where constraints manipulation was scarce, non-representative, and without stimulating players' problem-solving abilities, to an endpoint where tasks were conceived based on the next opposition's features (i.e., task representativeness) and focused on the development of functional and co-adaptative skills. In conclusion, the competitive data supported the development of a coaching practice based on the constraint-led approach. Methodologically, the insider AR-design offered contextualized insights into how the pedagogical coaching intervention evolved over the season. Thus, we highlight the importance of sampling the most relevant information from competition, through match analysis reports, so that coaches can design representative and contextualized learning tasks ongoingly aligned with players' needs.

Key words: *ecological dynamics, sports pedagogy, qualitative analysis, volleyball*

Introduction

Over the last few years, an ecological dynamics framework has been adopted to extend the comprehension of how players and the environment interact to shape collective sports performance in competition (Davids, Araújo, Seifert, & Orth, 2015). From this ecological perspective, the degrees of freedom (e.g., players) that comprise a system (e.g., team), are embedded at different levels of analysis, interacting as the function of task-individual-environment constraints (Davids & Araújo, 2005). Here, constraints are defined as boundaries that influence the emergence of movements/behaviours (Newell, 1986), providing opportunities for players to *act in* and *interact with* the environment (i.e., affordances; Gibson, 1979)).

The role of the interacting constraints has mostly been addressed by the constraint-led approach (CLA) (Davids, Button, & Bennett, 2008). Adopting a *player-environment* scale of analysis, the CLA has emphasised the constraints manipulation as a valuable way to facilitate the action-perception coupling that supports the players' perceptual attunement to specific game-related affordances (Gibson, 1979; Woods, McKeown, O'Sullivan, Robertson, & Davids, 2020a). In this regard, recent systematic reviews have highlighted the task as the most frequently manipulated constraint by sports practitioners (i.e., coaches, teachers, etc.) (Ramos, Coutinho, Davids, & Mesquita, 2020a), reinforcing the need for them to act as *designers of learning* (Woods, et al., 2020a). Such an idea presupposes

that coaches can identify which key informational constraints must be manipulated so that representative action opportunities could emerge during the performance of learning tasks, driving consequently the exploration of effective solutions by players.

To ease such pedagogical procedure, sports practitioners should support the sampling of constraints through sources of competitive data that enable them to identify the most critical information demanded by competition (Woods, McKeown, Shuttleworth, Davids, & Robertson, 2019). To date, the CLA principles have been used and assessed within a training context, but neglected in a competitive context (Ramos, et al., 2020b). More studies focused on the analysis of collective behaviours in competition are therefore needed. Indeed, the competitive environment entails unique features, providing valid and reliable information about the technical and tactical behaviours of competitors (Eccles, Ward, & Woodman, 2009). In this regard, the match analysis (MA) (i.e., notational analysis) depicts a valuable competitive data source that, by considering the critical events of competition (e.g., identifying the frequency of a specific opponent's action), truthfully informs sports performance (Van Maarseveen, Oudejans, & Savelsbergh, 2017). Accordingly, data from MA support the design of representative learning tasks, that is, the manipulation of task constraints manipulated correspond to the critical information of the competitive environment (Pinder, Davids, Araújo, & Renshaw, 2011). Moreover, MA enables players to be attuned to the perceptual-motor relationships demanded by competition (Travassos, Duarte, Vilar, Davids, & Araújo, 2012). Still, and perhaps the most important, the MA can explain or support *why* and *how* a set of task constraints may be manipulated during practice, reinforcing a *process-oriented* approach (Ramos, et al., 2021a).

Although the CLA emphasizes the importance of task representativeness, the competitive information given by MA is frequently neglected during the design of representative learning tasks in training sessions. In fact, typically the studies do not consider—or not report—which are the tactical or technical issues that such intervention claimed to resolve (e.g., Oppici, Panchuk, Serpiello, & Farrow, 2018). Thus, notwithstanding its undeniable contribution, most of the investigations on CLA scope end up losing its practical meaning for sports practitioners (e.g., coaches, teachers, performance analysts). For this reason, it seems pertinent to explore, and demonstrate, how task constraints might enrich the *pedagogical process*. In this respect, despite some investigations have started to explore qualitatively the influence of CLA principles on sports performance (e.g., Ramos, Davids, Coutinho, & Mesquita, 2022), usually investigations focused on CLA follow positivist paradigm and a quantitative approach (Ramos, et al., 2020b), limiting the comprehension of how such intervention scaffolds the performance preparation for competition. Thereby, qualitative studies are currently required to provide renewed context-dependent insights into the real and deep impact of a pedagogical intervention based on CLA principles.

In addition to the abovementioned, it is also common that CLA investigations adopt cross-sectional designs conducted during brief parts of training sessions (e.g., the last 15 minutes of the session; Coutinho, et al., 2020), becoming unrepresentative of the whole pedagogical intervention performed for the coach. Furthermore, such investigations typically apply intervention protocols measuring the differences between the initial and final performance stages (i.e., adopting an 'end-product' perspective). Doing so, the deep and contextualized comprehension of the hows and whys of the training process (e.g., design, pedagogical intervention, feedback, etc.), learning development and performance enhancement is also neglected. In this sense, it is also urgent that using a qualitative approach the investigations examine, monitor, and evaluate longitudinally the *coaching practice* so that the performance outcomes can be interpreted and comprehended in-depth rather than superficially explained.

Given their cyclical and interventionist nature, action-research (AR) designs (Lewin, 1946) are likely to be extremely helpful in this respect. In fact, by affording ongoing and contextualized feedback about the over-time intentional changes of the coaching pedagogical intervention according to players and/or team needs, the AR designs can broadly contribute to bridging the knowledge gap between training and competition, with the MA data mediating this interplay. Commonly, the AR design is used to evaluate the pedagogical intervention of teachers within the Physical Education context (e.g., Gray, Wright, Sievwright, & Robertson, 2019), and despite recently Ramos et al. (2022a) have conducted an insider AR, within the context of youth volleyball training, the implementation of this research design in sports training context remains scarce. Furthermore, a lack of AR designs at sport high performance levels persist, in which the interplay between training and competition is mainly guided to achieve outcomes, to support coaching for competitive performance (Ramos, et al., 2021b).

Through an insider AR conducted over a competitive volleyball season, this study sought to examine qualitatively how competitive data, retrieved from match analysis, might support the development of a pedagogical coaching intervention based on the CLA principles.

Methods

Context and participants

The study sample comprised the head coach and one assistant coach of an elite senior female volleyball team consisting of twelve players. Purpose and convenience sampling criteria were used to select the head coach (Patton, 2015). The head coach, who volunteered to participate in the study, was identified as an information-rich case due to his extensive experience in volleyball coaching (25 years of experience). He is a successful high-level volleyball coach holding the highest level of coaching certification (level III). The first author assumed the dual role of assistant coach and *insider* researcher. As the assistant coach, she worked mainly as a scout, thereby providing—via match-analysis reports—vital competitive data to the head coach about the technical and tactical status of the team, as well as the main features of the next opponent that should be addressed over the training week. As the researcher, she completed a degree in sports sciences and a master's course on research in social sciences, where the action-research design was explored in detail. As the coach, she has six years of competitive experience and holds the national level III coaching certification. This study was conducted throughout a competitive season, lasting 20 weeks. Per week, players performed five training sessions on average (a total of 9 hours) and participated in one official match. Globally, 96 training sessions were completed across the season.

This study followed the Declaration of Helsinki guidelines. Accordingly, all the participants were notified about the study's scope and purpose, and informed consent forms were signed. The head coach was also informed about his right to withdraw from the study at any time. Confidentiality and anonymity issues were explained and ensured to the participants through pseudonyms.

Study design

This study adopted the *insider* AR design where the assistant coach (who was also the researcher) reflected systematically and critically on the head coach intervention, thus providing useful information for improving the pedagogical coaching intervention (Carr & Kemmis, 1986). Given the reflexive, collaborative, and interventionist nature of the AR design, it was possible to monitor, evaluate, and adapt ongoingly the pedagogical intervention of the head coach (Gubacs-Collins, 2007). Specifically, this *insider* involvement afforded a privileged standpoint concerning the development of a coaching pedagogical intervention framed upon constraint-led assumptions (Davids et al., 2008; Ramos, et al., 2020a).

Overall, two AR cycles were completed, with each one including the stages of planning, acting, monitoring, and reflecting. Each AR cycle lasted three months and corresponded with the first league round (from October to December) and the second league round (from January to March), respectively. As suggested by Gilbourne (1999), firstly we focused on identifying and exploring the pedagogical context during the pre-season—diagnosis phase. Specifically, we sought to pinpoint the pedagogical and methodological fragilities of the training process. Accordingly, and aligned with the study's purpose, the first and the second AR cycle focused on improving the head coach's pedagogical intervention supported by the CLA principles. At the end of each AR cycle, any problems identified by the assistant coach that remained unresolved guided the subsequent pedagogical interventions of the head coach.

The role of the insider researcher

As already mentioned, the insider researcher worked as the assistant coach playing an important role in providing pedagogical suggestions to help develop training tasks based on the pedagogical principles of CLA (Sullivan, Woods, Vaughan, & Davids, 2021). Specifically, the information provided, which was tailored to the team's needs as well as the head coach's requirements, was extracted from MA and translated into practical terms through two different scout reports: the first report was dedicated to the head coach's team (i.e., the team involved in this study), while the second report was concerned with the subsequent rival teams (Sarmento, Bradley & Travassos, 2015). Thus, the first report provided contextualized information about which team-specific game situations need to be improved, and how it can be accomplished (e.g., the reception in a specific field zone or the attack effectiveness when playing with perfect setting conditions) (O'Donoghue, 2006). The rival reports, on the other hand, focused on providing contextualized information about their rival's tactical characteristics, namely the defensive and offensive tactical game patterns (e.g., double, or triple block organization defensively, or playing with an attacking combination offensively) (Groom & Cushión, 2004).

Coaching instructional intervention

Each training session included the design of learning tasks based on the CLA principles. Table 1 provides a detailed description of the main CLA pedagogical principles considered, while Table 2 exemplifies how, supported by MA reports, the planning of training sessions evolves over the season.

Table 1. Detailed description of the main CLA instructional principles considered

Concepts
Constraint manipulation—tasks constraints (e.g., rules, playing space, number of players, etc.) were manipulated to develop the ability of players to recognize and interpret opportunities for the most appropriate actions, encouraging their technical and tactical problem-solving skills within dynamic and diversified learning environments.
Affordance design—the structure of learning tasks was designed to enhance players' understanding about how, where, when, and why they have the opportunity to perform an action.
Representative learning design—framed upon competitive data, the learning tasks were designed so that players could sustain and practice the same perceptual-motor relations demanded in competitive environments.
Co-adaptation—learning tasks were built so that players can achieve the task goal through the cooperation among teammates—self organizing processes—to satisfy the interacting individual-task-environment constraints.
Task complexity—the complexity of the learning tasks was increased according to players tactical level to promote instability in players' actions so that they could explore adaptative perceptual-motor solutions.

Table 2. Example of a training plan design of each phase of the competitive season (i.e., pre-season, 1st AR-cycle and 2nd AR-cycle), based on competitive data extracted from MA

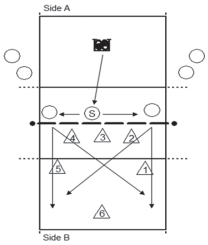
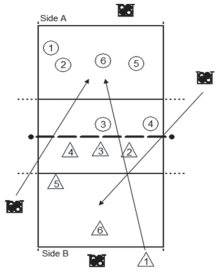
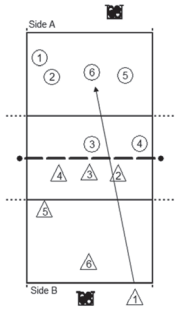
	Coaching practice		**Competitive data extracted from match analysis**		
	Description	*Graph*	**Ecological dynamics**	**Task representa-tiveness**	**Collective dynamics**
Pre-season [September to October]:	Defence against attacks from zones 4 and 2, according to the following sequence: (i) line attack, (ii) cross attack. - The features or main offensive trends of the next rivals are not considered. - There is not tactical feedback to the blockers. - The main focus is to be technically efficient.		None	None	None
1st AR-cycle [October to December]:	Conditional 6x6 game-form from 0 to 15 points. The rallies start according to the following sequence of four distinct ball: (i) service from side A, (ii) service from side B, (iii) freeball from side A, (iv) freeball from side B. Task constrains – Serie 1 – blocking line at zone 2, blocking diagonal at zone 4, scoring in counterattack was double-awarded (2 points), the unforced errors removed 1 point. Task constraints – Serie 2 – blocking diagonal at zone 4 and 2, scoring in counterattack remained double-awarded (2 points), but triple-rewarded if the defense at zone 1 fails (3 points). The service error removed 1 point. It is only allowed to fail 4 attacks over the counterattack.		Team depicts low defence percentages in zone 1 when opponents were attacking in zone 2 (i.e., cross-attacking). Asynchrony between blocking and defensive lines	Opponents' setting patterns, percentages of attack by zone and players' rotation	Increments in defense efficacy when performing the cross-blocking at zone 4
2nd AR-cycle [January to March]:	Conditional 6x6 game-form from 20/20 to 25 points. Series 1 and 3, side B was serving, series 2 and 4 side A was serving. Task constraints: the team in the counterattacking phase can only score on 1x1 situations and block-out. Scoring from the attack-coverage situation is double-awarded (2 points) if the attack was performed by the middle-blocker. Note: the players over the side-out phase were invited to explore the same attack tendencies as the next rivals.		Percentage of variation in team performance at defensive actions against different types of attacks (e.g., line, diagonal, tip, roll-shot)	Distribution of attack percentages from each player considering the zone of attack. Rival's playing configurations regarding the 1st and 2nd defensive lines	Low score percentages in the counterattack phase. Low percentage of ball recovered by the attack-coverage system. The attack efficacy of the team increases when plays in 1x1 situations and/or using the middle-blockers

Table 3. Instructional checklist

Elements of training sessions	Present	Absent
1. Competitive data supported the ongoing manipulation of within-learning tasks		
2. The learning tasks provide the opportunity for players to explore different tactical solutions and/or optimize the same tactical option within variable environmental scenarios		
3. The tasks were designed according to the main tactical features of the next opponent		
4. The specific needs of the team are considered to create challenging learning situations		
5. The design of learning tasks addressed a tactical problem that encouraged collective interactions to achieve the learning task goal		
6. The learning tasks encompassed the manipulation of constraints in terms of rules, number of players, space and/or time		

Instructional and treatment validity

To guarantee that the CLA pedagogical principles were implemented, the coaching pedagogical intervention was validated by three external researchers. All the external researchers had prior experience as coaches and with the CLA principles. Accordingly, a checklist, comprised of six items, was adapted from the studies by Práxedes, Álvarez, Moreno, Gil-Arias, and Davids (2019) and Ramos et al. (2020a). Overall, 10 training sessions, hence more than 10% of the total sample, were randomly analyzed for the presence or absence of the items included in Table 2 (Tabachnick Fidell, & Ullman, 2007). A 100% agreement between the researchers validated the application of the CLA pedagogical principles by the head and assistant coach.

Data collection

The present study used several data collection techniques to extend current understandings about how competitive data might contribute to the enhancement of a coaching pedagogical intervention grounded on CLA principles. Accordingly, the data were collected through: (a) interviews, (b) training videotape records, and (c) field notes.

(a) Interview

Due to its usefulness in dealing with themes that require participants to talk about their experiences, semi-structured interviews were conducted by the *insider* researcher with the head coach at three different moments over the season (Braun & Clarke, 2013). The first interview was conducted at the beginning of the pre-season and aimed to elucidate the head coach's understanding of the global organization, methodology, planning and development of the training process. The second interview was performed at the end of the first AR cycle with the purpose to: (i) understand whether the competitive data were playing an important role in the design of learning tasks using the CLA principles, and (ii) diagnose any issues that need further attention. Finally, the third interview was conducted at the end of the second AR cycle and sought to comprehend how the head coach perceived the impact of competitive data on developing the didactical contents of training sessions framed upon the CLA principles. All interviews comprised 12 questions related to different themes (e.g., structure of training, type and aim of learning tasks, etc.). The interviews were recorded using a digital voice recorder, being afterwards transcribed verbatim by the first author to obtain an accurate and complete data collection. During the interviews, the *insider* researcher acted as an active listener with a neutral attitude, fostering a relaxed environment and hiding her opinions to encourage the head coach to convey his realistic and true thoughts (Smith & Sparkes, 2005).

(b) Training videotape records (TVR)

To gain in-depth access to the events that occurred in training sessions, the assistant coach recorded and observed one session every week, so to obtain relevant training data that enabled a contextualized interpretation and understanding of the head coach's decisions and players' behaviours (Mesquita, et al., 2015). Following the recommendations of Pereira, Mesquita, and Graça (2009), who indicate that choosing a mid-week workout in the micro-cycle is desirable, the weekly training session was recorded on Thursdays. Overall, 90 minutes of practice were observed per training session, in a total of 2160 minutes observed throughout the season. The video recorder was located at the bottom of the training court, at a height of 7-m, to ensure optimal vision and sound, as well as to enable the observation of the interactions among all the participants (Mesquita, et al., 2015).

(c) Field notes (FNs)

The FNs were used to capture any critical incidents in training sessions. They therefore reflect the most critical observations, perceptions and personal experiences that help strengthen the comprehension of how the head coach evolved the design of the learning task and its didactical contents. The FNs were collected during training sessions and technical-staff meetings, and they were written by the *insider* researcher across the two AR cycles.

Data analysis

The data from interviews, TVR and FNs were analyzed over each AR cycle following thematic analysis procedures (Braun & Clarke, 2012). Explicitly, thematic analysis was chosen because it allows to systematically identify, analyze, and report patterns of meaning (themes) within a broad data set (Terry, Hayfield, Clarke, & Braun, 2017). The first phase involved a repeated reading of the transcripts, followed by an inductive and open data coding to capture perceptions, meanings and look for patterns (i.e., draft of categories and subcategories). The second phase referred to the identification of possible links between codes to form congruent themes and subthemes (i.e., focused coding). During this analytical process, the conditions, context, strategies of action/interactions, and outcomes were analyzed to form a contextualized understanding of events. The third phase comprised a back-and-forth work process among data and theory. The conceptual framework of CLA and ecological dynamics (Sullivan, et al., 2021; Woods, et al., 2020b) was used to examine and reflect in-depth about the data. Importantly, an explicit effort was made to search for patterns and understand how they can inform theory, rather than forcing data to fit the current conceptualizations.

Trustworthiness

To favour the change over time, the *insider* AR requires a balance between closeness and distance of the *insider* researcher (Gubacs-Collins, 2007). Thus, the first author sought to minimize the impact of her presence by being honest and transparent about the purpose of her actions (McNiff & Whitehead, 2009). In addition, three other trustworthiness procedures were used: (i) data triangulation, which includes the iterative and cyclical collection of data from different sources (i.e., interviews, TVR and FNs) (Denzin, 2012), (ii) verification of transcripts from interviews, to add, remove, or change any incongruent information, (iii) a group of three specialists in volleyball (with experience in coaching and qualitative methodologies) conducted collaborative interpretive analysis in regular meetings to continually redefine the formation of codes, subthemes and themes. In addition, the insider researcher underwent a specific formative process in qualitative methodology. This process was important to minimize the risk of individual research biases and thus enhance the validity of interpretations (Patton, 2015).

Results

The data analysis generated three main themes that represent the evolution of the head coach's pedagogical intervention, namely: 'Ecological design' (i.e., the manipulation of task constraints and exploration of action opportunities by players), 'Representative use of competitive data' (i.e., the head coach's ability to design representative learning tasks, based on competitive data, retrieved from MA reports, so that players can establish a coherent perceptual-motor link between training practice and competitive environments), and 'Tactical dynamics' (i.e., the head coach's ability to promote functional and co-adaptative tactical behaviours).

Pre-season [September to October]: Ecological learning tasks? What is it?

Ecological designs

Throughout the pre-season, the head coach presented difficulties in introducing and manipulating constraints during learning task designs, adopting fixed and thereby less adaptive tactical configurations of play in comparison to the competition requirements. Particularly, a poor manipulation of spatial constraints was identified during the game phase of the counterattack. The following excerpts represent this idea:

"Training defense (counter-attack phase) without determining the zone that the blockers should cover against different types of opponent's attacks or without establishing the spatial responsibilities in the defensive system that need to be developed as a function of block."

(FN, training session 2)

"When players were practicing the attack action, the design of the learning tasks did not consider the space that both blockers and defenders must occupy in line and cross attacks, mainly in what the defender of zone 1 regards. Indeed, for this particular zone the attacks only came from zone 4 (cross-attack)."

(FN, training session 3)

Representative use of competitive data

During this initial phase, the head coach conducted training sessions with unrepresentative learning tasks, that is, without any intention to simulate the demands of competitive environments. The following excerpt exemplifies this absence of task representativeness:

"No tasks have been proposed to create game situations that simulate authentic game contexts. At the end of the training session, a 6x6 game task was proposed without any information about the context, future rivals, or tactical or technical objectives.

(FN and TVR, training session 3)

"During the work of the first and second defensive lines in a 6x6 game-form, the head coach did not inform players about the attacking system or the future tendencies of the opponents' attacks."

(FN and TVR, training session 3)

Tactical dynamics

Throughout the pre-season, the coach did not usually introduce challenging and complex learning tasks to promote co-adaptative interactions between players. Indeed, the coach prescribed tasks with simplistic and non-contextualized learning goals. As such, the players were not challenged to either solve tactical problems or develop their collective self-organization tendencies. Thus, in this phase, the practice was merely reproductive. The following excerpts support this idea:

"The coach ended the training session designing a 6x6 game-form that was initiated through a service action, but in which the tactical problem was not addressed that such game- form intended to resolve nor its goals were specified."

(FN, training session 2)

1st AR cycle [from October to December]—Moving towards a more ecological coaching intervention

Ecological designs

At this stage, the head coach started to manipulate the task constraints considering the team's tactical needs. The competitive data, extracted from match-analysis by the assistant coach, seemed to guide this initial change in the pedagogical intervention of the head coach. The next excerpt emphasizes the start of this process:

"During this first round of competition, the head coach observed, through the competitive data analysis, that the defense had decreased its performance in terms of efficacy, and also noted a lack of coordination between the blocking and defending lines (e.g., the players cannot understand if they must move forward to dig a tip when block cover the line attack). To address this issue, the coach designed a learning task adapted to the different tactical block action (i.e., covering the line or the cross attack). Specifically, the head coach stated that if the blockers cover the line attack, the defender must move forward, while if the block covers the cross attack, the defender must hold their initial position)."

(FN, training session7)

Indeed, supported by the match reports elaborated by the assistant coach, the head coach progressively understood the importance of drilling different game scenarios to enrich the players' adaptability skills. The following excerpt exemplifies the modification of learning task designs focused on the attack action:

"When you propose that players make three consecutive shots, with ball arriving from three different directions (e.g., after actions like service, defense, or block), the only thing you are doing is individually empowering each of the players according to their in-game role ... and at this point, you make sufficient adaptations so that each player is able to practice specifically the actions needed considering their function inside the team."

(Interview, 1st AR cycle)

Moreover, in this phase, the head coach began to change the composition of the teams and add game rules (i.e., task constraints manipulation), particularly during small-sided games. The next excerpt exemplifies how the introduction of technical-tactical variability in the attack action, via constraints manipulation, encouraged exploration of affordances and the adoption of self-organizing processes on the block and defensive actions (i.e., counterattack phase):

"The coach, understanding that the players of the next rival team had distinct attack characteristics, proposed a learning task to practice the defensive system (i.e., 5x5 without middle-blockers). Specifically, one team played in side-out phase and must perform three different actions of attack (i.e., line, cross and tip), while the other team played in counter-attack phase blocking and defending the diversified attack actions. Additionally, the coach proposed that the players who attacked the ball had to rotate after the ball contact to promote line or cross attacks, roll shots, or tips from different players."

(FN, training session 12)

Representative use of competitive data

Framed upon the competitive data, analyzed by the *insider* researcher and subsequently reported to the head coach, he starts to recognize the importance of considering and scrutinising the opponents' tactical game patterns. Thus, guided by the MA reports, the designs of learning tasks started to include perceptual-motor stimuli as similar as possible to the competitive environments. The next excerpt clarifies this process:

"[...] from the study of the rival team, we identified which were their preferred attack zones. Thus, during the training sessions, we practiced, in an isolated fashion, different defensive systems that could be used to overcome the opponents attacking actions (e.g., the types of block that we could use in each zone, what second defensive line we could apply) [...] therefore, I would say that understanding

the rival teams gave us a weekly plan for the tactical execution of the match, this was an aspect that I cared about a lot"

(Interview, 1st AR cycle)

Tactical dynamics

To highlight the team's co-adaptative behaviours during the counterattack phase, as well as to overcome the strengths of opponents' game patterns, in the first AR cycle, the head coach started to propose accountability criteria for the technical and tactical domains, via task constraint manipulation, that must be achieved collectively. The next two excerpts exemplify the operationalization of this pedagogical intervention:

"I am thinking about modifying the learning tasks regarding the counterattack phase once the MA reports indicate that we have serious difficulties for scoring during this game phase… but more important than scoring in this game phase is to fail less."

(Interview, 1st AR-cycle)

"The head coach, acknowledging that the team was displaying difficulties in scoring during the counterattack phase even over the training session, decided to design learning tasks to specifically control the number of unforced errors during this game phase. To exemplify, the learning task designed reinforced the score in-counterattacking (rewarded with two direct points), while performing 4 unforced errors per team removed one point."

(FN and TVR, training session 8)

2nd AR cycle [from January to March]—Reaching an ecological coaching intervention

Ecological designs

At the end of the season, the head coach raised his intentionality in selecting the most specific constraints so that the design of learning tasks encompassed the practice of a broad variety of game scenarios featuring competitive environments, like playing *in*-system (i.e., all hitters available) or *out*-system (i.e., only outside-hitters and/or opposite available). Specifically, and as the next excerpts describe, at that point the learning tasks included the manipulation of space using distinct materials:

"In the last part of the training session, the head coach designed a learning task focused on the practice of different defensive playing configurations in out-system game scenarios. Such drill encompassed the defensive action with non-cohesive blocks, 1x1-block and block-out situations (using a fit ball to enlarge the blocking area)."

(FN, training session 19)

Furthermore, the head coach stimulated the players' exploration of distinct game-related resolutions and attentional focus, for instance, by task constraint manipulation, promoting the identification of who was the best and worst opponents' blockers. The following excerpts exemplify this type of learning task:

"The head coach, being aware of the players' characteristics namely their low attacking height, proposed a drill for attacking the short-diagonal or block out (explaining that both attack types should be performed against a high-block) because some players were not able to perform these types of attacks consistently, and it would be an important technical-tactical skill for the next match."

(FN and TVR, training session 18)

"He designed a learning task to increase the variability of our setting during the counterattacking phase, with the set action depending on the position that player occupies on the court, the hitter availability, and the level of opponent blockers. By doing so, the head coach sought to emphasize the various, and best, attacking options in each one of the players' rotations."

(FN, training session 21)

Representative use of competitive data

At this point, an evolution was observed in the design of representative learning tasks once they were conceived considering the characteristics of the team's game model. Accordingly, the planning of the training sessions involved learning tasks focused on practicing real-game situations (i.e., the attack vs. defence drill was designed according to the individual and collective features of the next opponent) The following excerpt exemplifies this development in designing ecological learning tasks:

"At the end of the session, the head coach proposed a 6x6 task being representative of a real-game situation by simulating the initial rotation of the next rival on one side of the court. Here, he gave detailed feedback about the strongest rotations, the possible attack options, and the characteristics of some players to consider (for instance, the Swedish player in slide attack) at the blocking and defensive lines. Moreover, he also indicated the zone to serve in each one of the six rotations."

(FN and TVR, training session 18)

"Head coach: I have noted that we practiced a lot of defence situations against the ideal line and cross block, but through the analysis of competitive data we understood that the problem is in the blocker and not in the defender.

Researcher: And what do you plan to do about it?

Head coach: I am working on it… trying to conduct more real-game situations…"

(Interview, 2nd AR cycle)

Tactical dynamics

In the last part of the season, the head coach designed ever more learning tasks with specific and challenging goals so that players could functionally cooperate on the sharing of collective action opportunities. The following excerpt supports this idea:

"So far, we have focused a lot on analyzing the rival… it would be interesting in the viewpoint of what is happening, if we look more deeply at our team in this second round of the league… it would allow us to focus on how to improve and plan our game plans addressing and adapting our strengths and weaknesses according to the rivals' features."

(Interview, 2nd AR cycle)

Supported by the MA reports, the head coach observed the difficulties of his team when playing against a cohesive double block over the counter-attack. To reverse this trend, the cooperative work was underlined by designing a learning task that awarded the creation of offensive conditions that could favour 1x1 game situations. The next excerpt clarifies this process:

"He designed learning tasks to promote greater variability in offensive actions and consequently favouring our counterattacking phase with 1x1 situations. Also, he explores the block-out situations, and underlines the importance of our attacking-coverage system. Thus, in this learning task, the team only could score in 1x1 counterattacking situations (double awarded if the middle-blocker scored) or block-out action."

(FN, training session 19)

Discussion and conclusions

By implementing an AR design over a competitive volleyball season, this study examined how competitive data, extracted from MA, supported the development of a coaching intervention based on the CLA principles. Overall, results showed that competitive data proved to be a relevant source of information to support the implementation of an ecological pedagogical practice. Specifically, the planning and structure of training sessions, progressed from an initial point where the manipulation of constraints was scarce, non-representative and did not stimulate players' problem-solving abilities, to an end point where it was conceived based on the next opponent's features and the development of functional and co-adaptative technical and tactical skills. From a methodological viewpoint, the insider AR design afforded contextualized insights that allowed daily adjustments in designing ecological tasks and contextualized interpretations of the pedagogical process.

Throughout the preseason the assistant coach identified the CLA principles disregarded in training sessions. In this phase, players were not encouraged to explore functional tactical behaviours or distinct action opportunities to solve game problems featuring competitive environments. Moreover, tactical cooperative interactions among teammates were not emphasized, and the head coach's feedback was mainly individualized and focused on technical issues. In reason of this initial reproductive practice, our findings suggested that players' attentional focus—in tactical terms—was undervalued, limiting their identification and interpretation of the most relevant action opportunities (affordances). As the focus of the head coach was placed on a technical-oriented and decontextualized practice, the tactical domain of performance was neglected firstly by the head coach and in consequence by players.

To reverse this trend, during the 1st AR cycle, the assistant coach starts to share relevant competitive data (e.g., attack tendencies and efficacy, setting patterns, etc.), through match-analysis reports, so that the head coach could progressively address principles of ecological dynamics and CLA during the planning and design of training sessions, improving its quality. To exemplify, the assistant coach informed the technical staff about the low percentages on individual and collective defence, at different court zones, and against distinct opponents. Hence, by using informational task constraints (e.g., establishing a scoring system during learning tasks focusing on defence), a desirable level of instability was intentionally introduced to help stimulate players' problem-solving skills. Also, given the difficulties of the team in scoring in the counterattacking phase, the coach double rewarded the points reached in this phase during the small-sided conditioned game forms performed in training.

Still, during the 1st AR cycle, the assistant coach started providing specific information about the technical and tactical features of the subsequent rival, like the most effective scoring zones of attack. Through this information, the head coach could enrich the representativeness of learning tasks, and narrow players' attentional focus on the perceptual attunement to relevant action opportunities, for instance, by manipulating the attacking zones in blocking-defensive drills. This ecological coaching intervention is aligned with the recent idea by Woods et al. (2019) of sampling constraints; that is, with the need to design individualized practice task constraints based on competitive data during the performance preparation.

Still, during the 1stAR cycle, the head coach started to be aware of the teams' technical-tactical

errors (e.g., counting the number of services scored and failed). To address this issue, the head coach conceived learning tasks constrained in terms of the number of errors (e.g., performing four unforced errors in counterattacked implied losing one point). This practical inter-relationship between ecological designs, representative tasks and collective sport dynamics corroborates and reinforces the fundamentals from the studies by Passos, Araújo, and Davids (2016) and Woods et al. (2019). Possibly due to the assistant coach's role, who continuously informs the building of learning tasks, the design of training sessions by the head coach broadly improved during the 2nd AR cycle. In fact, the training sessions started to integrate CLA concepts, leading to more contextualized training practice once players were invited to identify and explore the key informational constraints that help them to self-organize within competitive environments (Woods, et al., 2020b).

The improvements in the design of ecological learning tasks were supported by detailed task representativeness (Pinder, et al., 2011). For instance, grounded on competitive data, the learning tasks were constructed around the opponents' offensive and defensive play configurations (Gréhaigne & Godbout, 2014) and technical-tactical characteristics. Mainly during the 2ndAR cycle, the coach used competitive data to establish specific, common, and challenging learning-task goals so that the teamwork could be highlighted (i.e., exploring co-adaptative processes). Indeed, at the end of the season, the focus was not merely placed on adapting to the opponents' game patterns, as the technical staff did during the 1st AR cycle, but also on developing the game strengths and weaknesses of his team. Such change in the pedagogical intervention is aligned with the studies of McCosker et al. (2021), and Ramos et al. (2022), who underlined that changing from a reproductive to ecological coaching perspective represented a stepping forward in what training design and performance development regards. Moreover, this coaching practice also supports the recent assumptions of Singh and Wull (2022), namely the importance of considering an external attentional focus to improve volleyball skills.

In conclusion, we highlight the relevance of competitive data for sampling the most representative task constraints and the consequent design of ecological learning tasks. Supported by our findings, we strongly encourage coaches to manipulate task constraints to induce action variability and guide players' attentional focus. However, it is vital that such a pedagogical intervention was conducted, and systematically adjusted, according to the needs of players and team. Following the same rationale, we endorse the use of representative learning scenarios so that the players' understanding of which-how-when-why should perform an action in competition could be facilitated. For future avenues, we endorse the analysis and monitoring of CLA implementation by inexperienced coaches (i.e., at their initial career stages) to extend and update current understandings and challenges regarding the operationalization of CLA concepts in practice.

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