‘Embracing turbulent waters’: Enhancing athlete self-regulation using the ‘PoST’ framework for performance preparation at the 2020 Tokyo Olympic Games

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'Embracing turbulent waters': Enhancing athlete self-regulation using the 'PoST' framework for performance preparation at the 2020 Tokyo Olympic Games

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ABSTRACT

Sport science has increasingly witnessed use of contemporary ecological approaches to athlete development, preparation, and skill acquisition, providing alternatives to traditional pedagogical approaches. Here we examine an ecological perspective on transferring theory into coaching practice for athlete self-regulation and performance preparation, by presenting the case example of one lead coach and three athletes representing Team GB in the sport of Canoe Slalom at the 2020 Olympics in Tokyo. The aims of this case exemplar are: (1) to offer insights into how an ecological dynamics rationale supported integration of nonlinear pedagogy and (skill) training periodisation, underpinning athlete preparation for world class Canoe Slalom competition; and (2), to provide a first-hand perspective on transfer of theory to support self-regulation, skill learning, and performance preparation in high-performance sport. In the case example, the 'Periodisation of Skill Training' framework (i.e., termed 'PoST' framework) for venue specific preparation at the Tokyo Olympics was applied and adapted. Principles of co-design, the Constraints-Led Approach, perception-action coupling and representative learning design were embedded within collaborative application of the framework across a support team including athlete, coach and psychologist. To conclude, facilitating athlete self-regulation is highlighted in practical exemplars to support paddlers to cope with the dynamic environments in canoe slalom.

Introduction

Sports science has witnessed an increase in application of contemporary approaches to practice design and skill development e.g., Ecological Dynamics and the Athletic Skills Model (for a recent update see Button et al. 2020). While these insights have influenced applied practice at the micro level of practice and training design (i.e. at the level of coach-athlete interactions), ecological dynamics also addresses challenges on a macro level (scale of talent development). This contemporary integrative perspective on performance preparation teams, and models, across talent development pathways and in high performance sport, has challenged traditional athlete support approaches that have dominated the landscape for some time (e.g., Lascu et al., 2020; Rothwell et al., 2020). The theoretical and conceptual tenets of ecological dynamics have proposed principles for nonlinear and dynamic aspects of learning, development, and performing in sport, and there is a need for further empirical evidence on applications in performance (for notable exceptions see Woods et al. 2020a, Otte et al. 2020a,b, McCosker et al. 2019, McCosker et al. 2021, McKay et al. 2021).

The framework of nonlinear pedagogy addresses the complexity inherent in learning movement skills, viewing the learner, environment and coach as a complex interacting system (see Chow et al. 2022). Key principles of practice design advocated within this approach include: (i) representative learning design; (ii) developing relevant information-movement couplings; (iii) manipulation of constraints; (iv) functional (movement) variability; and (v), reducing conscious control of movement by directing the attentional focus (Correia et al., 2019). An increasing focus on studies applying these key principles is critical to develop understanding of how ecological dynamics can support athlete self-regulation during learning, development and performance (Otte et al., 2020b, 2021).

The aim of this paper is twofold, first to offer insights into how an ecological dynamics rationale supported the integration of nonlin-

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ear pedagogy and (skill) training periodisation, underpinning athlete preparation for world class Canoe Slalom competition at the Tokyo 2020 Olympics. Second, to provide a first-hand perspective on transfer of theory to coaching practice, athlete skill learning, and performance preparation in high-performance sport. To achieve the aim, a case study details how a coach and three Team GB athletes adapted the 'Periodisation of Skill Training' framework (i.e., termed 'PoST' framework; see Otte et al 2019) for venue-specific preparation at the Tokyo 2020 Olympics. In close collaboration with the athletes, the lead coach (also the first author here) positioned the 'PoST' framework to integrate training volumes, session intentions, practice designs (i.e., the use of specific course gates), and video analysis to support the athlete's performance preparation.

The motivation of the first author was to address the fundamental goal of enhancing self-regulation of paddlers under the constraints of competition. The concept of self-regulation is closely related to the concept of self-organisation in ecological dynamics. Self-organisation is a narrower term, in sport performance typically referring to the spontaneous (re)-organisation of motor system degrees of freedom under varying task constraints (Davids et al., 1994). With regards to sports performance and preparation for competition, an ecological dynamics rationale has been provided for conceptualising self-regulation more broadly, also referring to emotional control and resilience when facing problems and challenges in performance. For example, Guignard et al. (2020) have outlined in some detail a rationale for considering self-regulation in open water swimming. Thus, self-regulation from an ecological perspective has been conceptualised in a broad behavioural framework, referring to an individual's capacities to use actions, perception, cognitions and emotions to enhance learning and performance when interacting independently with the environment (Guignard et al., 2020). Individuals learn to self-regulate in sports performance by being given the opportunity to become increasingly attuned to a wider range of specific informational variables in their practice and performance environments (i.e. educate and calibrate their attention; Jacobs and Michaels 2007).

Practically, self-regulation in an ecological dynamics rationale involves an athlete developing adaptive behaviours (perceptual-, cognitive- and movement-based) to solve emergent performance problems during competition (Button et al., 2020). To exemplify, paddlers are required to descend white water rapids, navigating a course of up to 25 upstream and downstream gates, hung over a river, in a race against time (an Olympic run lasts in the region of 75–110 s). Athletes can incur time penalties for hitting a gate (+ 2 s) and missing a gate (+50 s). Every venue is unique both by design (water volume, direction and shape of channel, water speed, gradient of descent etc.) and specific gate sequencing set for competition. Once a competition course is set, athletes have no opportunity to practise on the water, with all route planning done from the riverbank. In addition to these challenges, the role of the coach during competition is unlike other sports where they may influence performance during half time team talks or by providing direct feedback and instructions during competition. In canoe slalom, distance between the river and bankside, coupled with auditory challenges of raging water mean that, any attempt by the coach to communicate is both highly challenging and time redundant. Therefore, athlete self-regulation in performance is mandatory. Accordingly, in preparation and training for competition, the role of coaches and sports science practitioners may be viewed as less passive. For example, coaches may manipulate task constraints, such as reducing the width of gates, to help guide paddlers attention toward a broader field of affordances, thus promoting paddlers to become active perceivers and problem solvers. Therefore, design and integration of performance preparation models that place athlete-environment interactions at the heart of the learning process, can support paddlers at all levels to cope with the dynamic environments presented in canoe slalom.

Coaching within an ecological dynamics framework

Coaching as conceptualised through an Ecological Dynamics rationale (Davids et al., 1994), is viewed as the facilitation in practice of an evolving and reciprocal relationship in the athlete-environment system Woods et al. (2020a). placed the co-creation of environmental design as a key challenge for coaches and sports science practitioners. Put simply, athletes and support staff need to closely collaborate when designing training environments that are rich in information and opportunities for action, providing freedom for exploration, search, and discovery (Otte et al., 2020a; 2021). The role of coaches and support staff is to create environments that facilitate learning, which by design, require athletes to self-regulate, continuously perceiving information and acting on opportunities for action. In ecological psychology, these opportunities for action are known as *affordances* (opportunities for action) (Gibson, 1979). Embedding an athlete's practice experiences in environmental contexts that consist of value (opportunities for action) and meaning (information) is the basis of an ecological dynamics informed coaching approach and serves to strengthen athlete functionality within a performance environment (Araújo et al., 2019).

The challenge for coaches, then, is to understand which constraints to manipulate at particular time points to support athlete functionality. Specifically, coaches need to become aware of how dynamic interactions between various constraints foster the utilisation of key affordances to support the emergence of skilled performance during practice and in competition. Based on the work of Newell (1985, 1986), constraints may be framed as action-facilitating features of the environment (e.g., water stability, weather conditions, social support), the individual (e.g., each athlete's performance goals, intrinsic dynamics [dispositions and tendencies]) and the task at hand (e.g., gate positioning, course design, racing after incurring time penalties). Despite colloquial language often positioning the word 'constraint' as a form of restraint, limitation or barrier, the Constraints-Led Approach to skill acquisition suggests that constraints *invite* actions that shape athletes' learning and action behaviours in development (Oppici et al., 2018). Coaches may utilise this knowledge by manipulating interacting constraints (individual, task and environmental) to explore multiple affordances available to the individual paddler in response to their action capabilities.

An iterative process of both observation and facilitation shapes how interacting constraints invite appropriate actions, allowing athletes opportunities for skill adaptation, self-organisation and exploration. Observing the affordances paddlers utilise for good or ill in relation to performance problems, invites a coach to consider how to facilitate the broadening or narrowing of a field of affordances through manipulating task constraints, whilst maintaining action fidelity. An idea from social anthropology that encapsulates this approach, is the concept of 'wayfinding' (Ingold, 2000; Woods et al., 2020b; likened to a process of transiting a performance landscape, moving from one stable region to another. Different to navigation, where one travels 'across' a landscape from point to point (perhaps supported by GPS technology), wayfinding describes journeying 'through' a performance landscape where people feel their way toward a goal through continual calibration of movement and ongoing perceptual monitoring of surroundings. Skilled coupling of perception and action gradually becomes fine-tuned through experience and learning (Ingold, 2000, Woods et al, 2021; Warren, 2006).

An ecological lens on coaching and training periodisation in canoe slalom

Within canoe slalom, an ecological perspective on (motor) learning situates the coach as a creative inquirer engaging in a recursive process of self and world both alone and in collaboration with athletes and other support staff (Montuori, 2011). Athletes and support staff are co-creators of a variety of challenges (environmental designers), inviting paddlers to problem solve through decision making amidst a rich landscape of affordances. Coaches can operationalise the pursuit of multiple functional movement solutions to motor tasks through a 'many times,

many ways' practice approach, known as 'repetition without repetition' (Bernstein, 1967). Exposure to such approaches enhances the coupling of perception and action in athletes relying on specifying, performance-relevant environmental information, and supports variable adaptation of movement solutions within dynamic environments (Button et al., 2020). Adaptability is key in canoe slalom, due in part to the unstable nature of water within the competition environment. As Heraclitus once infamously said: "No man ever steps in the same river twice, for it's not the same river and he's not the same man". In the pursuit of developing variable and adaptable movement solutions to emergent motor problems, it is important for athletes to practise in environments where multiple solutions are invited. To facilitate the development of variability, coaches may look to regularly adjust course design to destabilise preferred self-regulation tendencies, replicating the unpredictable nature of competition, therefore inviting emotional control and resilience when exploring a broad field of affordances. Adding gates into practice tasks amplifies task complexity and presents different challenges to the paddlers, as they seek to satisfy task goals as opposed to simply finding the fastest route between two gates with little consequence for what comes thereafter. Consequently because of such perturbations, the position paddlers arrive at and move through a gate sequence becomes highly variable and thus, more representative of competition.

The uniqueness of each competition venue in canoe slalom, coupled with the malleability of the modern-day artificial course requires exposure to high levels of variability and representative learning designs in practice (Pinder et al., 2011). Ensuring the presence of specifying and representative information is vital for the efficiency and effectiveness with which athletes can learn to attune to surrounding information sources at a venue (e.g. training in the same afternoon light as competition). With a myriad of contrasting venues to prepare for, the structuring of athlete development and training programmes, to target periods of skill development in marriage with physical development, is essential to optimising development and performance over micro and macro scales. In identifying timelines and purposes of key blocks of practice, athletes and support staff can calibrate intentions, manage physiological and psychological load, optimise skill adaptation and prioritise athlete health and wellbeing. Skill training periodisation enables strategic manipulation of the interacting constraints on the athlete-environment system (see Otte et al. 2019, for an introduction); with the goal of targeting 'local-to-global' adaptations (Ribeiro et al., 2019). For example, a reduction in physical loading, causing less fatigue, may invite greater capacity for innovative and adaptable self-regulatory behaviours during an upstream gate skills practice. Furthermore, a clear purpose to training, coupled with an understanding of constraints acting upon the athlete-environment system, enables coach and athlete to strategically dial up and down the level of representative learning design (RLD; see Brunswik 1955, Davids 2012), targeting specific adaptations at specific times.

The 'PoST' framework for athlete development

Originally, the 'Periodization of Skill Training' framework (termed 'PoST' framework; see Otte et al. 2019) was developed in support of specialist coaches working with individuals and small groups of athletes. In an attempt at transferring training periodisation principles, commonly applied in physical training science (Farrow & Robertson, 2017), an approach towards the systematic planning of skill development over various timescales in sport was facilitated. By merging contemporary motor learning theory and training concepts (e.g., nonlinearity in learning and RLD), the aim was to encourage an individualised approach towards athlete development and training session design (e.g., see Otte et al. 2020a, for a practical application towards football goalkeeper training). While the framework is theoretically underpinned by an ecological dynamics rationale and a nonlinear pedagogy, the work of Bernstein (1967) and Newell (1985) in motor learning present key drivers in establishing this developmental model (see Fig. 1). Here, the nonlinear nature of (skill) learning, as well as pedagogical principles, including the representativeness of training designs (i.e., the level to which skills transfer from practice to competition), the manipulation of (task) constraints and movement variability are highlighted. Put simply, the framework for guiding skill development approaches and coaching interventions establishes the notion of 'information regulates action and vice versa'. It encompasses a holistic integration of self-regulating sub-systems of perception, action, cognition and emotion in athlete learning.

The 'PoST' framework, linked to Newell's (1985, 1986) model of motor learning, presents three skill development and training stages termed: 'coordination training' (bottom-left stage in blue), 'skill adaptability training' (bottom-central stage in green) and 'performance training' (bottom-right stage in maroon). First, the 'coordination training' stage focuses on self-organisation and stabilisation of (general and sport-specific) movement patterns. In contrast to tradition and decontextualised skill acquisition approaches, exploratory activities in training encourage athletes to learn to perceive relations between environmental information (as affordances or action invitations) and movements. Here, use of task-simplification, coach-supported constraint manipulations and guided discovery, are adopted. Second, the 'skill adaptability training' stage facilitates athletes' perceptual attunement to most relevant information sources that become directly coupled with functional actions. While environments are purposefully designed to be varied and complex in terms of informational richness, the representativeness and fidelity of training designs is paramount. By (over)challenging athletes in training, it is possible to enhance their problem-solving abilities, movement variability and skill robustness under perturbation; for example, adding multiple gates into a compressed space on the river, places paddlers under significant time pressure to more quickly attune to information that matters most to achieve an outcome. Finally, the 'performance training' stage stresses athletes' direct preparation for competition on various levels of perception, cognition and action. Again, providing high levels of representative design, implementing an athlete-led and coach-supported approach, is highlighted.

The specific adaption of the 'PoST' framework outlined in the following case study, emerged from a desire to apply principles of contemporary science in practice design in a more holistic, skill led manner. Principles of a nonlinear pedagogy, using a Constraints-led methodology, were applied within a holistic skills-led periodisation across a micro cycle into the Olympic Games. In the subsequent sections we introduce the contextual case, elaborate on the rationale for the proposed approach, and showcase the entire application process in detail.

Case study

Context and venue specific preparation for the Tokyo Olympic Games before and during the Covid-19 pandemic

This case study focuses on a lead coach and three athletes representing Team GB in the Olympic sport of Canoe Slalom at Tokyo 2020. The emergence of the Covid-19 pandemic in early 2020 meant the feasibility of the games taking place was under grave, understandable pressure. Resulting challenges to training periodisation through lockdowns, a 12-month postponement of the games and uncertainty over qualification places and international travel, all imposed significant constraints upon athlete preparation. Planning in emergent contexts became the 'new normal' within an Olympic sport that generally is characterised by high dependency on venue-specific preparation. To bring to life the challenges with planning and using the 'PoST' framework, the paper adopts a first-hand perspective from the first author. As coach and lead author in this case study I have been engaged in the sport of Canoe Slalom for over 30 years, including 16 as a coach. As a British Canoeing certified Level 3 Coach my coaching career to date has seen me employed across a broad paddler pathway spanning beginner through to high performance.

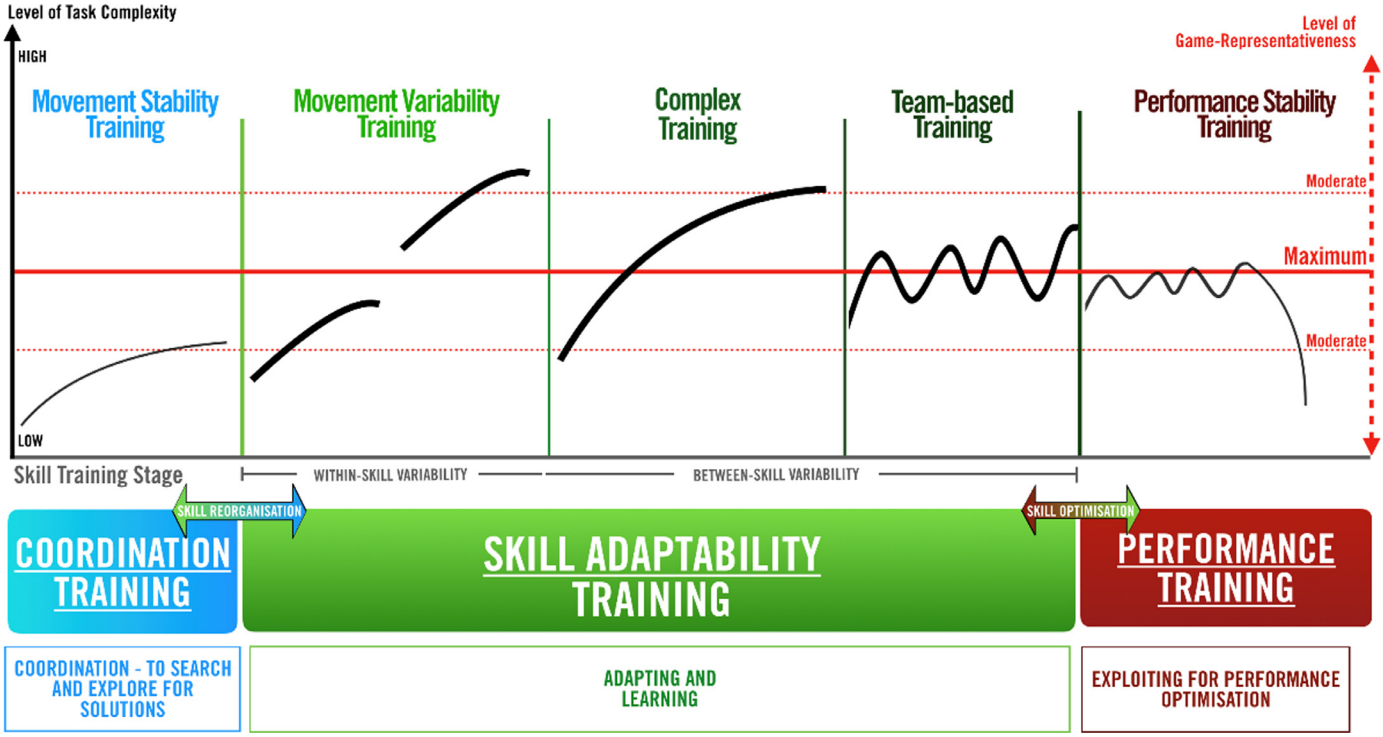

Fig. 1. The 'Periodization of Skill Training' framework (adopted from Otte et al. 2019), integrating movement between three skill development stages of 'Coordination Training', 'Skill Adaptability Training' and 'Performance Training'.

Fig. 2. Plan A for British Canoeing – The original plan towards the first ascent in preparation for the 2020 Olympic Games.

'The mountain has no respect for the plans and intentions of those who wish to climb upon it!'

With two training camps completed in 2019, a further five were planned into the Olympic Games in 2020, amassing over ten weeks training on the competition course (see Fig. 2). Due to Covid-19, one by one, training camps were cancelled and ultimately athletes had just *three weeks* training on venue leading into competition. These emergent challenges to conventional planning embody the highly dynamic, constraint-shaped world of sports performance preparation, further reinforcing the need for a highly flexible and individualised approach to practice periodisation.

Due to limited venue preparation time, I (the lead coach) perceived a need for collaboration with athletes and our psychologist, to emphasise self-regulatory activities in each practice session leading into the games. Consequently, our group's collaborative work was framed by the overarching need to achieve co-created clarity of intentions for each period of training leading into competition, and establish understanding

of where and when attention could be placed (e.g. exploring multiple affordances of properties of the aquatic environment during the coordination phase). Specific intentions would be used to provide a frame of reference with which to anchor the role of the athlete and coach in practice.

Motivations, aims and rationale for applying the 'PoST' framework prior to the Olympics

From my own experiential knowledge, both athletes and coaches can become overly obsessed with performance outcomes (e.g., times, scores) in the final phase prior to competition. This form of emotional attachment can act as a barrier to learning where, for example, athletes and coaches become bogged down in repetition of a single sequence in the search for a putative 'perfect' performance solution, losing sight of the higher order principles of functional task outcomes (i.e., was a performance solution effective?). For example, athletes may be seen practising through the lens of error correction, placing non-proportional weighting on a particular sequence or movement technique that they predict will be in the competition course. Consequently, less time may be spent exploring a variety of functional performance solutions both on a specific move and in general in response to dynamically changing conditions. To overcome the lure of evaluation against 'perfect' navigations, rehearsed timings and other factors hindering performance preparation, the 'PoST' framework was used to assist functionality in relation to two key intentions:

(1) To utilise a scientifically-informed framework to assist planning and delivery of skill training to support athletes' interactions with environmental and task constraints.
(2) To invite athlete self-regulation in their collaborations with the support team, communicating with clarity their wants and needs in terms of challenge and support at a pivotal time.

The 'PoST' framework was selected based on its underpinning foundations in contemporary motor learning theory and its perceived malleability to a micro scale of skill development. Overall, it supported the notion of 'learning in development' (Adolph, 2019), which suggests that learning emerges in the midst of development changes over multiple timescales (O'Sullivan et al., 2021). Thus, the PoST framework supported attempts to enhance athlete intentionality amidst the learning that emerges within development and through the co-design of activities by athletes and support staff.

Application of the 'PoST' framework in Tokyo

Following collaboration between coach, athletes, physical preparation coach and psychologist, a co-created adaptation of the 'PoST' framework was designed for use (see Fig. 3). Whilst skills-led, this holistic approach to periodisation also considered a myriad of interacting factors in shaping training phase transitions including physical loading (e.g., established tapers and jet lag) and psycho-social factors, such as moving into the Olympic Village and spending a month away from established support networks.

In performance preparation meetings, athletes were introduced to the 'PoST' framework, and through group discussions it was agreed how the framework would be implemented. This approach interlinked with a collective group philosophy aligned to the key characteristics of each phase of skill training in preparation for Tokyo 2020 (see Table 1).

In contrast to the original 'PoST' framework, our adaptation marginally prioritised time in the performance training phase in a 'little and often' exposure approach aligned to an athlete's physical taper into competition. Transitions between development phases were not set in stone, witnessing flexibility in response to coach and athlete reflections. Of note is that this adaptation of the framework shifts emphasis from skill development over longer timescales to the creation of a learning environment with a specific preparation focus over a specific timescale (e.g. how the team's collective practices influence athlete intentionality during skilled action; Rothwell et al., 2021).

Following the agreement of a whole-group philosophy, athletes co-created a bespoke adaptation of the framework to suit individualised development needs leading into competition. The content of these individual frameworks (see Fig. 4 for an example of one athlete) formed the centrepiece for practice design throughout the preparation period. Detailed examples of what this looked like in practice in terms of session content and the role of coaching within the framework are outlined below for each phase.

Coordination training

What did it mean for practice?

In week one, 'coordination training' was designed to offer maximum exposure to the broad landscape of affordances on the course. Noting the performance level of the athletes, this training phase was more about co-ordinating actions with respect to the environment, rather than simply replicating movement techniques. Since 2019, the course had undergone changes to block formations on the riverbed that determine gradient, features and flow of the water. Furthermore, environmental conditions were in stark contrast to those experienced in 2019, with temperatures in the mid 30 degrees Celsius, humidity above 80%, and extreme solar glare from water reflection and the predominant concrete surround. Subsequently, time was invested in attuning the perceptual systems to the new environment whilst managing the personal constraints of jet lag (on cognitions, actions and body rhythms). At this stage, practice was largely concerned with perceiving affordances ("for good or for ill"; Gibson, 1979, p.119) of the water and less about negotiating gate sequences or specified tasks. Rich exploration and discovery of (un)stable water features and lines to afford different boat speeds were highlighted. Athletes sampled a broad range of challenges, sensing what the movement of the river and gate sequences had to offer them; this was exemplified by paddlers seizing the opportunity to explore surfing stoppers, crossing waves and playing with edge control. A 'many times, many ways' approach to environmental exploration was employed, aimed at giving paddlers opportunities to discover variable movement solutions, such as using a curl, feeding in and jumping on to experience the same desired outcome of moving left to right across the river.

Notably, due to the elite nature of the athlete group, variability in this stage could be relatively high compared with co-ordinating movement toward a new skill. Here, our adaptation of the original framework was concerned primarily with co-ordination of movement within a specific ecology as opposed to the dynamics of movement. With exposure to high levels of task variability, task complexity was scaled back (e.g. isolated gate sequences versus linked sequences), whilst maintaining information-movement couplings representative of the race. The dialling up and down of complexity was largely self-regulated by individual athletes, and emerged under practice constraints. For example, ranging from isolated water feature efforts with or without gates, to multi-gate work on the same feature dependent upon factors including affordance perception, time constraints and athlete perception of success.

What was the role of the coach?

In this training phase, I played a more passive role in the design of practice structure than in subsequent phases. As such, pre-determined or coach-created tasks were low in frequency, with the location and nature of task challenges predominantly led by athletes. The purpose here was twofold: (1) to allow athletes to interact with the environment as they individually saw fit, exploring what is important to them, and picking up the affordances available to them in this new ecology; and (2), to enable me (as coach) to step back and experience a

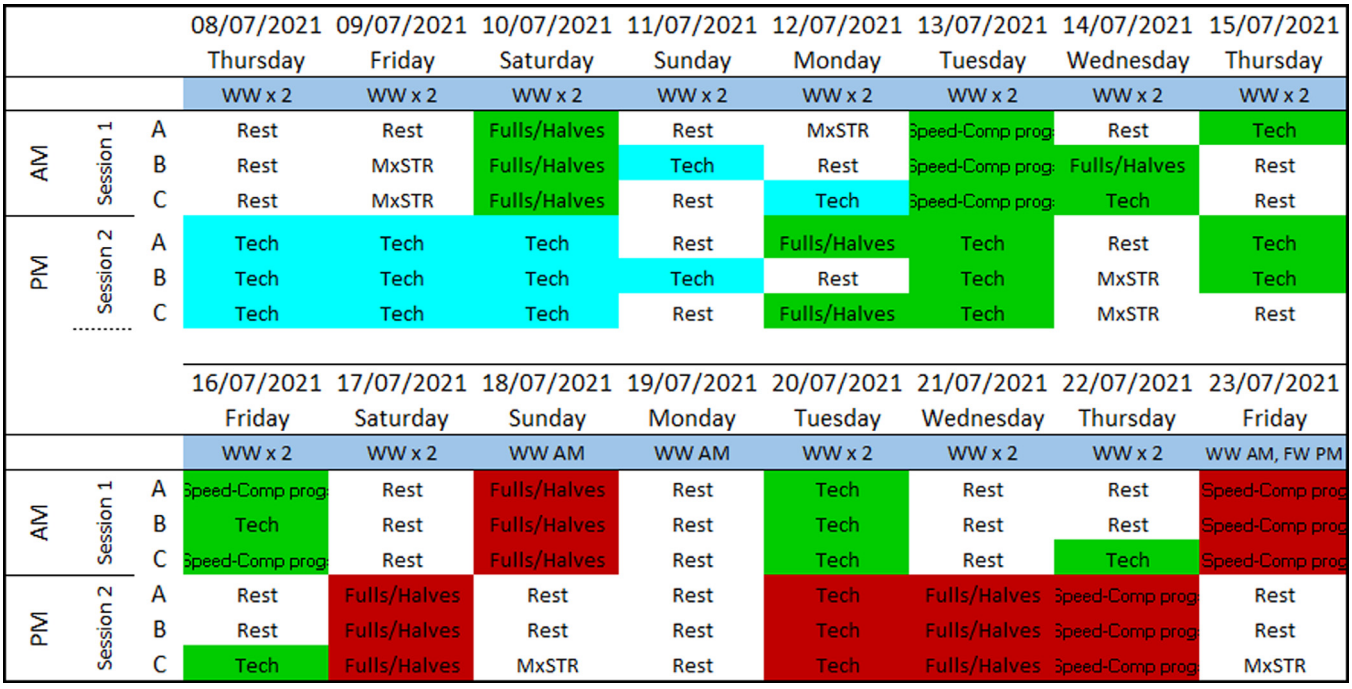

Fig. 3. Detailed overview of skills training periodisation used by athletes A,B and C into the Tokyo 2020 Olympics by session type, colour coded in alignment with the development phases of the 'PoST' framework.

Table 1
Example characteristics of each training phase (adapted from the 'PoST' framework).*

Coordination Training*Coordinate and explore*	**Skill Adaptability Training***Adapt and exploit*	**Performance Training***Exploit to perform*
- Broad landscape exploration	- Increased representativeness (CS)	- High representativeness (CS)
- High Volume, short sections	- Linking skills/high complexity	- Reduced and focused complexity
- High levels of variability	- Repetition without repetition	- Increased and focused structure
- Low repetition (unique tasks)	- Longer sections of work	- Low volume, stabilising performance
- Explore and create ecological niche (individuality)	- Constraint manipulation	- Increased intentionality in planning of route
- Low structure (high freedom)	- Testing boundaries of affordances	- Increased recovery
- High task autonomy (athlete led/coach observed)	- Design for failure (permissions)	- Conditions relating to reward and threat
	- What does it mean for the race?	- Consequences to performance in practice (competition simulations)
	- Balanced task autonomy (self-regulation and co-creation)	- High levels of coach/external task setting
	- Video analysis increasing objectivity	
	- Competitive sessions	

* (CS) = Canoe Slalom, indicating levels of representativeness of the race

'drone view' of how athletes are constructing and exploring the practice environment to consequently inform my subsequent engagement and inquiries with them in the adaptability phase. Questions, such as 'what opportunities for action are they attending to and acting upon?' and 'what might they be missing or rejecting?' were reflected upon throughout this training phase. Further, I was continually looking to observe training from different perspectives, to experience multiple perceptual landscapes. This approach helped me to avoid a single lens bias, in terms of trying to interpret the athlete's first-person experience, regularly challenging my own perspective and reminding me that an athlete's experience of 'doing' is what should dominate our discourse.

My interactions with paddlers focused on the enjoyment and encouragement of discovery and creativity, with dialogue intentionally limited to facilitate maximal time on task. Interactions typically sought to clarify athlete intentions and the subsequent information that was being attended to during actions. This period of exploration started with a blank canvas, as opposed to meeting a pre-determined largely de-contextualised itinerary and was epitomised by the sense of journeying through an environment, open to the lived experience in the present, as opposed to navigating across it (Rothwell et al., 2021).

Skill adaptability training

What did it mean for practice?

In transitioning to 'skill adaptability training', a shift toward more representative learning designs in practice occurred. A collaborative review of 'coordination training' identified where athletes would like to spend their time adapting and learning within training phase two. While athletes' effort had been on broadly self-regulating perception, action, emotions and cognition to search the performance landscape, focus was now placed on enhancing functionality and adaptability of performance solutions under the challenge of more representative race contexts. Single, more isolated sequences were expanded into combinations, in which I played a more active role in practice design. Specified task challenges (course design) were increasingly pre-determined by athlete and coach, using more gates than in training phase 1. With increased complexity, this second phase challenged paddlers to search for relevant information sources more actively from their surrounds. A 'safe to fail' invitation to athletes in practice characterised the early phase of this training stage.

Competitive sessions involving international peers were introduced with the intention of adding additional representative constraints and emotional-perceptual-cognitive perturbations during individual preparation. This progression signified transition towards more frequent ex-

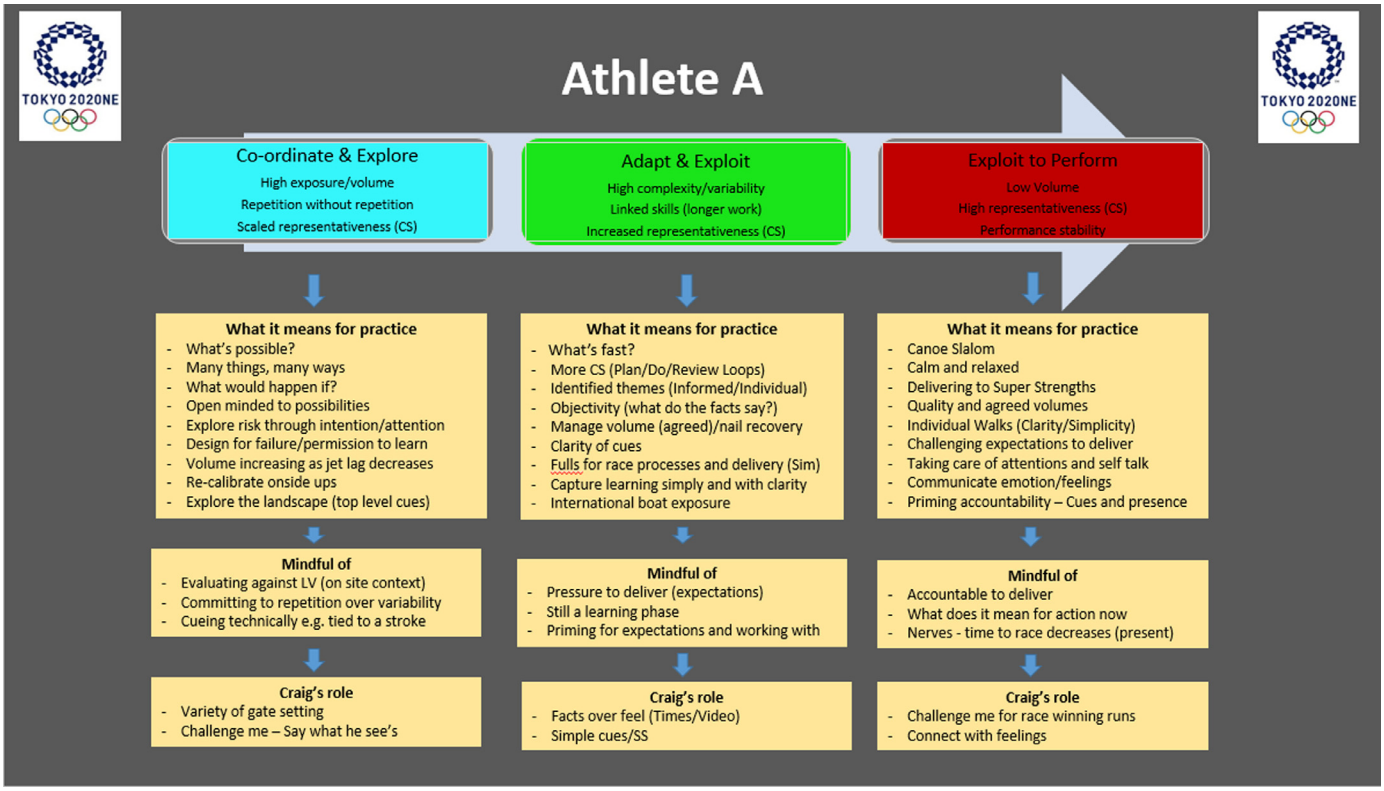

Fig. 4. Individualised application of the 'PoST' framework for preparation.

posure to competition-simulation training as competition grew nearer. Simulation training has a high level of representative design related to race conditions. Races were broken down into 3-4 sections of roughly 20–30 s each. Gate sequences were specified in advance, either pre-session or on water in the session, and courses were changed at regular intervals. In this practice, paddlers may be exposed to high levels of task complexity and 'over-simulated' race conditions. This design may include directly viewing competitors' performances with reduced time in comparison to the race, to sense check what (if anything) it means for subsequent efforts before being required to go again. This approach is useful when a competitor performs a move in a manner that had not been identified as possible by others. For example, it may simulate times where an athlete may be in the start pool and observe a competitor deliver a high risk, high reward move minutes before they start their own run. Higher numbers of practice repetitions and increased task complexity were assumed to provide exploratory search activities for relevant affordances, in order to refine functionality of movement adaptations.

What was the role of the coach?

The coach's main role was to manipulate task and environmental constraints to destabilise movements and operationalise the process of 'repetition without repetition'. Constraints manipulations targeted performance variability by inducing competition with peers, adding or taking away gates to adjust complexity and challenging athletes to manage physical and cognitive fatigue through relatively high volumes of work, inviting different approaches at different speeds to fundamentally similar tasks. For example, adding gates in a tight sequence placed time pressure on the stability of a movement pattern, so athletes could not remain in a 'technical comfort zone'. Coaching here involved challenging and affirming athletes' self-regulation without being overly tied to technical instructions for actions (e.g., "this needs to be done on a left blade"). Specifically, effective coaching in this training phase concerned noting the skill adaptation of athletes, detailing what athletes adapted to well and what that meant for action (re)organisation. For example, instead of simply praising a penalty-free navigation of a sequence, I would affirm perception-action couplings, focusing on how an athlete adapted their attention after spotting the danger of a penalty and acted accordingly before redirecting their attention to the next information source.

In addition, while remaining actively present and socially engaged to provide support during this phase, coaches may further invite opportunities for action either directly or in co-creation with athletes. Such an environment is heavily reliant on good communication, shared permissions regarding dialogue and a strong coach-athlete relationship. In essence, the intention here is to use co-created permissions to challenge an athlete's attempts to attune to key information for performance regulation in the environment.

Performance training

What did it mean for practice?

'Performance training' was the focus of the final training phase of preparation, based on exploiting 'learning in development' and optimising and stabilising performance. Practice volume was lowered as athletes reduced physical loading into competition and session preparation was emphasised through discussions during individual bankside course walks. With my support, the focus was on establishing simple cues of attention that were detached from technical instruction. The transition to this training phase was marked by a two-day simulation race, attempting to make practice as representative of competition as possible. These were designed to simulate the experience of Olympic competition by replicating preparation time, using external coaches to set the course, inviting international peers into the session and sharing subsequent performance data.

Tactical route planning entered a *race-day decisions philosophy*, predicated on collaboration of coach and athlete on how to use conventional information (Galonka & Wilson, 2019) in the planning phase to guide attention during the performance. The notion of race-day decisions refers to an individual's balance in perception of risk and reward in tactical de-

cisions when preparing to negotiate the course and during the run itself. Clearly, these decisions are entangled amidst interacting constraints acting upon an individual at any one time (e.g. periodisation – development or delivery, competition perception – opportunity and threat, individual capacity – affordances). Whilst the majority of training in this phase was high in representative design, certain sessions, both planned and in response to athlete needs involved more discovery and unstructured play; this mixture was intended to balance the psychological load of simulation training. In comparison to previous training phases, task complexity was on the whole more closely representative of the race and as such course design was 'race-real'.

What is the role of the coach?

In simulation training my role was largely to ensure an environment representative of competition, whilst facilitating processes of priming and (re)calibration to the best version of self for each athlete.

Previous training phases had established some of the specifying affordances available in the environment. My role now was to support athletes in guiding attention to the key dynamics in the 'task scape' to realise perception-action couplings. Importantly, this approach presents a shift away from having a rigid, pre-determined plan toward one of *skilled intentionality* (e.g., supporting paddlers to engage with multiple relevant action possibilities), therefore, directing attention to the key information in the environment during performance (see Vaughan et al. 2021). The relevance of this approach to periodisation is that, whilst representative information of the race is maintained throughout each training phase, the scaling of the information may differ depending on whether we are looking to extend or limit opportunities for affordance perception. For example, in the coordination phase, paddlers were broadening their affordance perception as they searched for specifying information sources. Conversely, in the performance training phase, the goal is to deliver stability of functional movement solutions. Hence, athletes are now seeking to narrow their attention toward affordances more specifying for stable actions. In terms of periodisation, this is critical, as it acknowledges the importance of having representative information of the race throughout all training phases. In more linear models of acquisition, skill may be broken down into a series of techniques trained in largely contextually impoverished environments. Here, information-action couplings present in the race are sampled in training, with the level of complexity and representativeness scaled appropriately to the individual without separating information from action.

A 'principles-over-rules' approach primes dynamically-adaptable self-regulating interactions in the actual experiences of the paddler during the run (law-based information; see Galonka and Wilson 2019); this, in my experience, frees up athlete cognition from the threat of evaluation against pre-determined actions. Such threats have been expressed through language such as "I knew it was coming but I couldn't do anything about it!" when referring to incurring a time penalty. In this example, the paddler was heavily attached to a particular stroke technique and when implementing this technique presented a problem to the actual context in the run, they froze and were unable to adapt. This approach to facilitating athlete self-regulation is exemplified by cueing attention on movement across a river into space (emphasising visual search), as opposed to pre-determined stroke mechanics of how to get there.

Overall, in performance training, intention, attention and reflection cycles become more targeted toward immediate competition demands. A blend of subjective and objective analysis, support athlete self-regulation here. Finally, tasks need to be representative in design, but also void of any bias coaches may have regarding a particular style of taskscape design.

Transitions between training phases: embracing turbulent waters!

Following the introduction of practice and coaching approaches within each presented training phase, the idea of transitioning between phases in preparation for Olympic competition warrants more elaboration. Here, it must be acknowledged that 'learning in development' is nonlinear and thus, movement back and forth between training phases displays a critical element of athlete development, as highlighted in the 'PoST' framework. In my own experience, learning and coaching are well aligned to 'wayfinding' (Ingold, 2000; Woods et al., 2020b). A key role for coaches, therefore, is to seek to be in tune with the specific needs of an athlete, regarding skill progression, across multiple timescales, to embrace the uncertainty that exists under constraints in the paddler-environment interaction amidst these turbulent waters. The realisation is that we may have to dial up or down task complexity in response to performer needs, whilst always seeking to maintain the presence of representative sources of information in practice, to facilitate functional perception-action couplings.

In Tokyo, movement and transitions between training phases were typically situated around a full day of recovery, allowing the athletes to reflect on their intentions and experiences in each phase. This process was critical to enable a 'principles over rules' philosophy to be realised; for example, pressing pause to adapt session content and intentions in response to gate setting (competitive environmental design) by the international federation that may not have aligned to pre-determined practice design intentions.

Altogether, allowing flexibility for paddlers to update intentions and attend to evolving motivations in response to task constraints became a critical driver for transitioning between the training phases. This approach stands in contrast to athletes becoming frustrated by a lack of agency in the task design process, which often appears to be provoked by coaches' attachments to a more rigid route to the destination.

Concluding remarks

This case study illustrated how the contemporary theoretical skill training principles of a Nonlinear Pedagogy and the Constraints-Led Approach can be implemented within a holistic, skills-led periodisation and adapted across micro timescales (hours, days, weeks), in preparation for Olympic canoeing competition. Coaching interactions throughout preparation were highlighted as being guided by motor learning principles within an ecological dynamics rationale, centred upon individual athlete intentions. Specifically, a creative adaption of the 'PoST' framework (see Otte et al. 2019) was used, showing potential for its malleability across differing timescales of athlete development and performance preparation. The application of a skills led holistic periodisation framework, and specifically the adaptation across a micro scale highlighted here, may have significant connotations for development and performance within a myriad of sports at both team and individual level.

The adapted 'PoST' framework offers insights into supporting individual athletes' skilled interactions to enhance their self-regulation in preparation for high performance competition. Benefits identified included an unparalleled clarity of purpose achieved by the coach, both for himself and through the eyes of the athletes during the lead into major competition. Furthermore, the individuality of development plans gave a clear line of sight regarding levels of task complexity and representativeness of training for athletes, informing clear purpose and subsequently, guiding perception in and around practice. Complimented by scientifically-informed and co-created designs for skill development introduced by the coach, athletes individualised their own frameworks in line with motivation and how they wanted to experience this period from a psycho-social perspective. Consequently, in embracing these clear intentions across the coach-athlete dyad, a clear sense of direction was achieved within the complexity of the athlete-environment interaction. Indeed, as lead coach, my ability to quickly reference individual plans when preparing for sessions gave clarity in processes, such as practice design, manipulation of constraints and the nature of dialogue with athletes.

What this meant for practice: a detailed, phased approach to skill development and practice offered clarity of intentions for each ses-

sion across the preparation period. This approach supported a unity of purpose when co-creating constraints of a training environment and supporting athlete performance intentions when interacting with a novel course under temporal constraints. Specifically, the individually adapted, theoretical foundations guided and anchored coach-athlete interactions, decision making and reflection. Co-design, embedding psychology and physiology, fostered highly productive athlete autonomy and motivation toward practice. This approach ensured no surprises regarding the nature of practice that athletes would be engaging with, inviting time for psychological preparation. Critically, it was discovered that co-created permissions regarding attitude to risk and the exploration of affordances in a 'safe-to-fail' mindset during the coordination and skill adaptability training phases proved invaluable in exploring the practice ecology for each athlete. This contributed to achieving a sense of perceived 'readiness' for whatever course would be set come competition days, and thus, enabling paddler embracement of the turbulent waters of this dynamic sport. In comparison, a more disciplined approach of the narrowing of attention evolved during the performance training phase, whilst in pursuit of increased stability of performance outcomes to facilitate confidence into racing. Athletes reported and showed a sense of calm in the knowledge that they had time to move through these training phases and indeed, they had autonomy in adapting them in response to experiences along the journey.

What this meant for the coach: Autonomously-led session intentions were utilised as 'waymarkers' to check progress, calibrating direction of travel through each training phase toward the goal of being in the best possible place for racing and enabling refocussing of attention where required. It was found that in-session dialogue was more closely matched and maintained to these intentions, resisting temptations to get caught up in a desire to be 'race ready' from day one. It also ensured a shared language was present in interactions. This language, in synergy with athlete-led permissions, meant the coach was clear on how athletes felt coaching could augment practice, critical when transitioning quickly between people and ensuring they received personalised coaching. This facilitating and communicative approach undoubtedly freed up cognition across the coach-athlete dyad, enabling efficient manipulation of task constraints within sessions depending upon where affordances were accepted or rejected. Consequently, these facets of coaching enabled developments to be clearly acknowledged and affirmed, and any bumps in the road to be reviewed efficiently and collectively.

Finally, whilst it is beyond the scope of this paper to explore athlete reflections of the 'PoST' framework in action, the authors acknowledge their upmost importance in evaluating the value of this approach to venue specific preparation. The aim of a future paper is to explore athlete perceptions to further augment applied coaching studies in the field of skill development. Overall, we hope this case study exemplifies the ever-growing practical application of ecological approaches to sports coaching and athlete development and preparation. The application of an ecological dynamics approach at the highest levels of international sport aligns greatly with the nonlinear nature of human performance, learning and development amidst the pressures and constraints of high-performance sport.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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