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Applying an ecological dynamics framework to mixed martial arts training

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ABSTRACT

In this paper, we outline an ecological approach to training in mixed martial arts (MMA) to support coaches in helping fighters coordinate skilled movement solutions to the ever-changing problems they encounter in the cage. Orienting one's perspective on the *fighter-cage system* may require coaches to re-align their role towards being designers of alive and representative training sessions that are filled with opportunities for (inter)actions, where constraints are purposefully manipulated to facilitate the emergence of skilled behaviours for mixed martial artists of all levels. We conclude by offering three case examples ranging from amateurs to professional champions to highlight the significance of adopting an ecological dynamics framework in MMA.

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Introduction

Mixed martial arts are dynamic, offering "alive", rich, and varied movement problems for combatants to solve. *Alive movement problems* are those that challenge fighters to perceive dynamic information and the specified *affordances* (opportunities for action; Gibson, 1979) to effectively (re)organise an *integrated movement solution* (IMS) to meet intended performance goals (Lee, 1975; Myszka, Yearby, & Davids, 2023a, 2023b; Yearby, Myszka, Roberts, Woods, & Davids, 2022). Therefore, an objective for coaches working within mixed martial arts (MMA) is to support fighters in developing skilled combative movements that are highly adaptable, helping them to successfully solve the contextual performance problems they could potentially encounter in competitive environments. To do this, coaches may need to consider making changes to their learning environments, which includes embracing the messiness that comes with learning. This is needed because,

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while progress has been made in many training environments across MMA, numerous training activities still deviate from the highly alive nature of the complex problems found in the cage.

Supported by contemporary scientific developments in understanding skill acquisition, this insight article seeks to discuss how coaches might consider re-aligning their role towards being *designers* of training sessions through creating tasks that invite various opportunities for (inter)actions (i.e. they are alive) to facilitate more skilled behaviour in mixed martial artists at all levels (Button, Seifert, Chow, Araújo, & Davids, 2020; Woods, Rothwell, Rudd, Robertson, & Davids, 2021; Yearby, Myszka, Roberts, Woods, & Davids, 2022). This re-alignment is underpinned by the framework of *ecological dynamics* (Araújo, Davids, & Hristovski, 2006; Seifert & Davids, 2017), which combines ideas from ecological psychology (Gibson, 1979), constraints on dynamical systems (Newell, 1986), the complexity sciences (Edelman & Gally, 2001), and evolutionary science (Araújo, Davids, & Renshaw, 2020). Ecological dynamics (Araújo, Davids, & Hristovski, 2006; Seifert & Davids, 2017) places the *performer-environment relationship* (Williams, Davids, & Williams, 1999) and unfolding interactions at the core of practice designs, promoting the development and enrichment of reciprocal functional relationships between the performer and performance contexts (Araújo & Davids, 2011; Yearby, Myszka, Roberts, Woods, & Davids, 2022). Adopting an ecological dynamics framework in one's coaching could practically play out by respecting the problem-solution dynamics (i.e. changing states of organisation) that emerge in practice and performance contexts (Myszka, Yearby, & Davids, 2023b). MMA performance preparation could be approached by applying important pedagogical principles of *nonlinear pedagogy* (e.g. representative learning design and constraint[1] manipulation), which were developed and constructed upon an ecological dynamics approach (see Chapter 4 in Chow, Davids, Button, & Renshaw, 2022 for a comprehensive list of the principles with definitions). Moreover, other ideas espoused by ecological dynamics, such as "aliveness" and "repetition without repetition" (Bernstein, 1967; Myszka, Yearby, & Davids, 2023b; Yearby, Myszka, Roberts, Woods, & Davids, 2022), will be discussed in the following sections. In this article, through adopting systems thinking and offering an ecological vantage point, we seek to highlight the key interacting constraints of MMA and conclude by offering three case examples to illustrate how coaches could approach their practice activities differently.

The evolution of MMA as a competitive sport domain

MMA as a competitive sport has proven to be highly polarising – too violent for some viewers but a true work of art for many aficionados. Few sports

have consequences as dire as those in MMA, creating a rich environment for movement scientists seeking to study skill acquisition as an adaptive process, or skill adaptation, which can be thought of as a functional relationship – a process of continual adjustment between a performer and a specific environment (Araújo & Davids, 2011).

Fighting, in the form of hand-to-hand combat between humans, dates back throughout history. For example, the ancient Olympic Games in Greece (Welcome to the Ancient Olympic Games, n.d..) featured an activity known as Pankration (Pankration, n.d.), an unarmed combat sport similar to modern-day MMA, where its participants combined a wide range of combat skills and techniques like wrestling, boxing, and kicking. Eventually, competitive fighting events became codified, such as Vale Tudo (Portuguese for "anything goes" and "everything is allowed"), which is a no-holds-barred type of Brazilian combat martial arts competition with very few rules, pitting fighters of different styles against each other. These types of early events paved the way for modern MMA, especially in the form of the now-popular Ultimate Fighting Championship (UFC). Early UFC events were an invitation-only, tournament-style format where masters of various disciplines and arts (e.g. shootfighting, Tae kwon do, boxing, and wrestling) matched up in an octagon-shaped cage. Over time, the UFC and other MMA organisations expanded their rules to prohibit a larger number of techniques deemed dangerous (e.g. strikes to the back of the head and knees or kicks to a downed opponent) while also incorporating standardised weight classes and time limits on bouts, further increasing combatant safety and legitimising the sport in the process.

Over the last number of decades, the sport of MMA has continued to gain immense global popularity (Scott, 2022). With it, the skills of its participants have naturally evolved, and creative, novel, and functional performance strategies have emerged (Orth, van der Kamp, Memmert, & Savelsbergh, 2017), becoming battle-tested as a diverse range of fighters with authentic styles compete across levels. More recent noteworthy examples include an increase in fighters switching stances (i.e. moving between "orthodox" and "southpaw"), the inclusion of lead calf kicks as a main offensive weapon, the use of the cage in both offensive and defensive exchanges, the evolution of various ground control methods, and increasing recognition of the value of feints and fakes to deceive opponents, potentially creating opportunities to shoot or strike. However, further developments in coaching and training methodologies could be enriched by insights from contemporary skill acquisition principles that have been applied in other sport contexts (McKay, Davids, Robertson, & Woods, 2021; Yearby, Myszka, Roberts, Woods, & Davids, 2022), perhaps representing the next practical frontier leading to the further evolution of MMA. It is here that an ecological

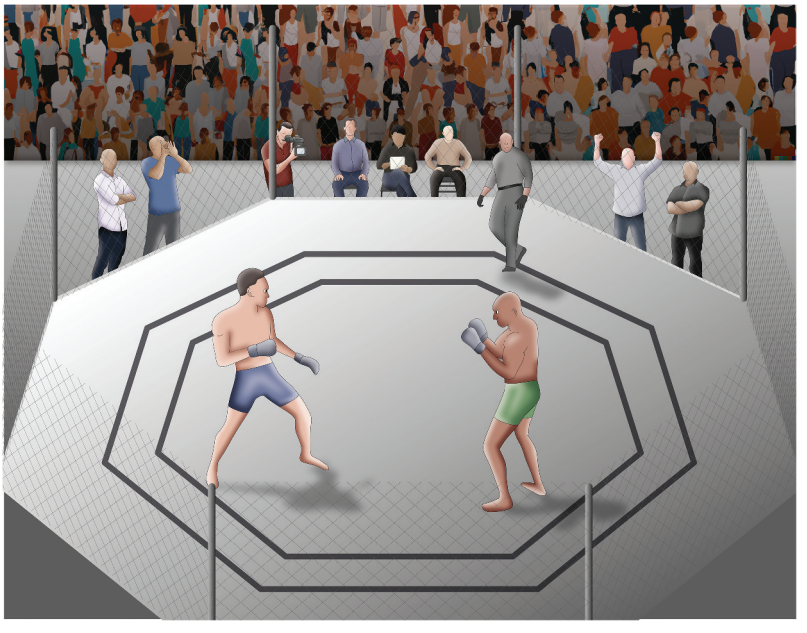

Figure 1. An illustration of the constraints on behaviour making up the "fighter-cage system" (e.g., the fighter and their opponent, the shape of the cage, and the crowd).

dynamics framework may be a perfect fit for the study and training of MMA (Krabben, Orth, & van der Kamp, 2019).

The nature of MMA (A fighter-cage system)

An ecological dynamics framework acknowledges and uses a performer-environment relationship as the appropriate scale of analysis to investigate expertise in sports (Seifert & Davids, 2017). Within the context of MMA, this reciprocal relationship could be reconceptualised as a *fighter-cage system*, which would begin to capture the plethora of unique constraints present in MMA. Here, the fighter and their emerging skill would be contextually situated within a highly specific environment where the "cage" encompasses the many different variables present in an MMA fight (e.g. opponent, referee, judges, coaches, fans, and the shape of the cage; see Figure 1: A snapshot illustration of "a fighter-cage system").

Mixing different styles

In MMA skill training, fighters prepare by working on many different combat sport disciplines unfolding in various areas where the fight could potentially go (i.e. stand-up, clinch, ground) through coordination modes associated with those ranges (e.g. boxing, kickboxing,

wrestling, jiu jitsu, judo). Here, combatants search the *affordance landscape* (Rietveld & Kiverstein, 2014), attempting to weave actions together to form an authentic fighting style. This is imperative to becoming an adaptable martial artist, as "specialists" (i.e. those predominantly adhering to the use of only one art) are finding less success in modern MMA. Thus, a key objective for the ever-evolving MMA fighter is to be prepared for wherever the fight might go. Another differentiating factor from many other sporting contexts is that both fighters are constantly shifting between states of attack and defence, and these relations could change dynamically (Krabben, Orth, & van der Kamp, 2019). Because of this, combat could be conceptualised as an *interpersonal synergy* (Krabben, Orth, & van der Kamp, 2019) between competing athletes, framing self-organised, emergent behaviours in the athlete dyad, as evidenced in other sports (e.g. Passos, Araújo, Davids, Milho, & Gouveia, 2009).

Rules, judging, and scoring

Beyond direct interaction with an opponent, the rules of MMA competition and its scoring system represent a key constraint on the fighter-cage system, significantly shaping specific fighting behaviours. Since fights are judged by humans, there will be a certain degree of subjectivity involved, and fighters may factor in a judge's track record when carrying out their fighting strategy (and possibly referee behaviour too). Just like in other sports, competitive rules[2] act as constraints on behaviour, especially because they may differ slightly based on the organisation within which the fighter is competing (e.g. rules of engagement in situations where an opponent is considered "grounded").

Fighter challenges

Championship and main event fights generally have five five-minute rounds, compared to preliminary bouts, which usually consist of three five-minute rounds, each with a one-minute rest period between rounds. This will culminate in tremendous physiological, psychological, and emotional demands on the human movement system of the fighter; for example, the requirement to strike or defend in fatigued states. Additionally, the dimension and shape of the cage fighting area could also differ between organisations or even between specific events. Thus, differences in successful fighting strategy and performance could emerge under different constraints during competition based on the contextual specificities of the cage fighting area. Furthermore, in the lead-up to a MMA fight, several physical and mental challenges are

encountered, such as the need to cut weight and handle the psychological stress that may come with dealing with pre-fight press conferences and face-offs with one's opponent. The psychological context of these lived experiences (i.e. pressure and anxiety) needs to be managed since it could potentially lead to fixed or rigid *degrees of freedom* (DoF) of the system (when thinking, perceiving, and acting; Chow, Davids, Button, & Renshaw, 2022), with the fighter unable to achieve expected performance levels.

Coach-fighter communication and guidance

During competition, coaches have the opportunity to speak to their fighters during the one-minute rest period between rounds. Some coaches will use this opportunity to tell a fighter exactly what they believe they should do. Similarly, the coaches also sit cage-side and can often be heard inundating their fighters in the cage with augmented verbal instructions of an overly technical sort during combat, as perceived from their cage-side perspective. On the surface, this may seem harmless, as the coaches are clearly attempting to assist the fighter; however, affordances are individual and frame-dependent, which means that opportunities to act are unique to a specific fighter at that moment. Rather than overusing verbal information and feedback that can impede opportunities for self-regulation (Davids, Button, & Bennett, 2008; Otte, Davids, Millar, & Klatt, 2020), educating a fighter's intentions and attention using one word or simple phrases could offer a platform for authentic problem-solving (examples are provided in the second case example below). Moreover, adopting an ecological approach could more effectively prepare the fighter to self-regulate performance, trusting in the fighter's intertwined perceptions, cognitions, and actions during the moment. To achieve an ecological approach to practice, MMA coaches could operate as "learning environment designers" or facilitators of the fighter's skills (Myszka, Yearby, & Davids, 2023b; Woods, Rudd, Robertson, & Davids, 2020). This necessitates a learner-centred approach, where a coach would manipulate task and environmental constraints, presenting contextualised problems for fighters to solve in practice, ultimately facilitating fighting skills to emerge through exploratory self-organisation.

Movement behaviour as a problem-solving activity in MMA

Under an ecological dynamics framework, the movement behaviours that emerge within any sport interaction (including an MMA fight) could be reconceptualised as problem-solving activities carried out by the athlete in a performance environment (Myszka, Yearby, & Davids, 2023b; Yearby, Myszka, Roberts, Woods, & Davids, 2022). Here, the integrated processes of

perception (i.e. information detection), cognition (e.g. intentions, decisions), and action (i.e. coordination and control of body parts) underpin the *movement problem-solving process*, which emerges tightly coupled to relevant information sources in the contextualised environment, which specify affordances offered to an athlete (Myszka, Yearby, & Davids, 2023b).

In this movement problem-solving paradigm, the processes of perception, cognition, and action are interdependent, interacting with circular causality as the system's DoF are continuously (re)organised to achieve intended performance goals (Myszka, Yearby, & Davids, 2023b). Using these ongoing relational and interactive processes in practice, a fighter can be challenged to solve a specific problem (i.e. individualised and contextualised) emerging around them in a performance environment by making constant adjustments within and between subsystems (i.e. perception, cognition, and action) of their movement system. This relational, ecological description of self-organisation frames practice, training, and preparation for MMA competition (i.e. when fighters regulate their behaviours in relation to the emergent problems of the environment).

When a mover has achieved the highest level of this type of problem-solving in their performance, they can be thought of as expressing *dexterity*—displaying the ability to solve any emerging movement problem in and across a variety of situations and conditions (Bernstein, 1996). In team sports, for example, additional ideas, such as *gamespeed* or *football speed* (Yearby, Myszka, Roberts, Woods, & Davids, 2022), have been offered to capture the complete movement problem-solving process, describing an athlete's ability to operate at optimal speeds and interact appropriately with the environment based on the nature of specified problems that emerge in competition. Applying this concept to the context of MMA, we contend that *fighting speed* could be utilised in describing a fighter's capacity to adjust functional actions during a fight to utilise affordances made available by an opponent. Many affiliated with combat sports (e.g. athletes, coaches, analysts) often describe this quality as "fighting IQ". However, this connotation around performance *intelligence* is an organismic asymmetry (i.e. it may be considered overly neurocentric). This reductionist approach may lead a fighter to believe that they only need to work on performance planning (so-called "hot executive function"; Holfelder, Klotzbier, Eisele, & Schott, 2020) in the cerebral cortex, acting by over-relying on the formulation and implementation of a detailed and comprehensive plan for competing that takes advantage of an opponent's weaknesses. Instead, the idea of "fighting speed", framed by skill adaptation, still allows for this type of *knowledge about* (Gibson, 1966) the environment to frame a fighter's initial intentions but also encapsulates more of a *knowledge of* it (Gibson, 1966), ultimately describing how a MMA fighter could adapt their movement behaviours in real-time based on how interactions emerge during a fight.

Facilitating authenticity and a fighter's form of life

In MMA, the word "unorthodox" is sometimes used to describe a fighter's style, which refers to someone who does not display an "ideal" movement or a putative "correct" technique. However, the differing styles of solving problems displayed by "unorthodox" fighters are something that could be weaponised (i.e. harnessed and facilitated), helping them to become innovative and adaptable movers who present unique challenges to opponents. Unorthodoxy could be shaped by an individual's "form of life", described as the common ways of being, acting, and behaving (Rietveld & Kiverstein, 2014; Vaughan, Mallett, Davids, Potrac, & López-Felip, 2019). This could facilitate or limit one's perception or utilisation of affordances in a particular niche (i.e. fighting within the cage). Consequently, a *fighting form of life* could be described as the personality, essence, customs, or style of one's performance behaviours – the unique, authentic movement properties that are expressed when a fighter enters the cage.

For instance, former UFC Middleweight Champion Israel Adesanya fully embraces his fighting moniker of "The Last Stylebender" in the octagon as he attempts to adjust and match the nature of his movements and skills to meet the specificities of the opponent he is facing. Adesanya seemingly embodies Bruce Lee's ideals around "using no way as way" within Jeet Kune Do (Lee, 1975, 2020), conveying how a martial artist can express their skills in individualised fashions. Adesanya's authentic fighting form of life and the showmanship style associated with it has been channelled through numerous social and cultural influences, including his immersion in a culture of dance and his interest in anime. These influences have proven to be integral to the development of a unique fighter-cage system when Adesanya fights.

The fighting "form of life" of other fighters has also been shaped by the unique environments in which they live and train. For example, UFC Champions Khabib Nurmagomedov and Islam Makhachev, both sambo fighters coming from the Republic of Dagestan (Russia), have a fighting form of life that is a product of the unique experiences that have helped shape their skill and style over longer time frames (from their youth through their professional careers). Nurmagomedov, training under the tutelage of his father (Abdulmanap Nurmagomedov, decorated fighter and coach), was said to have wrestled an unmuzzled bear at just nine years old (Ryder, 2017). Similarly, Nurmagomedov would later become known in the cage for his relentless, pressure-filled style of fighting, oriented around grappling and exerting his will to dominate an opponent on the ground.

These examples suggest that MMA coaches need to understand the key social and cultural constraints that have shaped each fighter as an individual outside of the cage. This could allow them to harness and continue to

facilitate authenticity within the cage by leveraging their uniqueness, supporting them to understand, harness, and exploit these key ongoing influences throughout their performance, learning, and development. Coaches may ask, "What brought this fighter to where they are now?" and "What qualities make this fighter different from their peers?" The answers to these questions may provide helpful knowledge and insights on how to make the most of the fighter's unique developmental experiences, personal properties, and environmental influences, shaping the future individualised expression of fighting skills. Furthermore, a fighter's form of life is something that should be taken into consideration by their opponent during preparation for the fight. Doing so can shape their training and how they attempt to exploit certain tendencies of the opposition, which could lead to them landing more strikes, executing takedowns, or successively employing their fight plan. For example, if the opponent's form of life is deeply rooted in a wrestling or grappling style, a fighter may be able to bait their opponent into prematurely dropping their centre of mass, head, and eyes if they are abruptly charged, leading to the landing of a devastating knee that could result in a knockdown or knockout (e.g. Jorge Masvidal versus Ben Askren in the UFC on 6 July 2019).

The importance of adaptability in an MMA fighter's skill

During an MMA fight, fighters need to be simultaneously sensitive to both their own action boundaries (i.e. what intended actions are currently possible for them) and those of their opponent. Ecological psychology proposes that "behavior affords behavior" (Gibson, 1979, p. 135), where the actions that emerge from an opponent will give rise to possibilities for performance behaviours for an individual to emerge. Quite simply, the behaviour of one's opponent provides context for performance. Opponent behaviours dramatically influence what information is available for detection, what intentions unfold, and how actions need to be coordinated and adapted within context (Yearby, Myszka, Roberts, Woods, & Davids, 2022).

For these reasons, to be successful in competition, it is essential that fighters are not overly adapted to a specifically prescribed way of acting. Instead, the need for adaptability is one of the key performance indicators within MMA. Before one can express adaptability, one needs motor system abundance (Latash & Latash, 2000), i.e. more ways of using movement system components to solve problems within their skill set, as abundance precedes adaptability. An abundance of usable system DoF provides a foundation for a fighter to transition to new behavioural patterns and adjust between functional states of coordination (Button, Seifert, Chow, Araújo, & Davids, 2020; Davids, Glazier, Araújo, & Bartlett, 2003; Gray, 2021). Variability in movement systems is fundamentally linked to

adaptability, supporting search and exploration as a fighter looks to coordinate the interrelated DoF across the system (i.e. perceptual, cognitive, and motor; Myszka, Yearby, & Davids, 2023b) to form an IMS and *become one with* the problem (Myszka, Yearby, & Davids, 2023a).

Developing abundance in movement systems can occur in many ways; for example, by exploring how to authentically express oneself within the environment – ground flows combined with dancing-like expressive behaviours; by pushing the boundaries on traditional callisthenics, varying the speed and path of action; and by playful sparring with another fighter to see how to move into and out of range at different speeds, angles, and levels while trying to land strikes. To further facilitate creative behaviours, the coach might encourage the athlete to try different movements if invited by the problem to create an opening or draw another behaviour out of the opponent. For example, simple questions (which could act as a constraint) can be asked, such as "Have you perceived an opening for a spinning strike?" Consider a fighter who can vary the speed of their kicks and their path to the opponent to effectively land strikes accurately and timely. Or picture a fighter well-versed on the mat who can find different openings for submission, even under challenging conditions such as excessive sweating, unfavourable positions, or fatigue. Diverse movement options and "water-like behaviour" are important because conditions like the environment, task requirements, and one's intentions can change every time we act (Davids, Bennett, & Newell, 2006; Myszka, Yearby, & Davids, 2023a).

Key information variables specifying affordances in MMA

Thus far, we have discussed how functional movement behaviours in MMA, characterised by the intertwined processes of perception, cognition, and action, depend on the detection of surrounding information, specifying potential affordances for moving within the environment (Fajen, Riley, & Turvey, 2009; Myszka, Yearby, & Davids, 2023b). Some research has begun to explore the nature, role, and use of information in regulating movement within combat sport contexts (e.g. Hristovski, Davids, & Araújo, 2009). In particular, investigators have begun to study interpersonal coordination tendencies between fighters and other key information variables that may guide an athlete's actions in combat.

For example, Hristovski, Davids, and Araújo (2006) investigated how distance-to-target information led to the emergence of a diversity of adaptive actions for striking a blow (e.g. jab, uppercut). The task utilised in this initial study was a boxer performing a striking activity while hitting a stationary bag, replicating a traditional training drill. Although the findings were relevant for understanding the emergent organisation of a variety

of hitting actions, particularly relating to changes in distance-to-target information, the contextual relevance of this discovery is limited to the analysis of hitting stationary targets, as this task is unrepresentative of actual combat performance.

Enhanced representative design is essential to investigating these ideas in the context of two competing fighters attempting to perceive and act upon affordances that emerge for striking while interacting with one another (Pinder, Davids, Renshaw, & Araújo, 2011). Research by Okumura, Kijima, and Yamamoto (2017) found that the interpersonal distance between two competing participants can change the organisation of movement behaviours. They showed that skilled combatants frequently maintain a preferred interpersonal distance for *both* striking and evading through a refined coupling of perceptions and actions to available affordances. Enhancing attunement to key information from a moving target (opponent) could lead to the development of *brinkmanship* (Krabben, Orth, & van der Kamp, 2019), where a fighter is so acutely aware of their own action boundaries (i.e. what is possible based on the current *fighting measure*) that they exploit this quality by purposefully existing at this range.

However, it is likely that information about interpersonal distance alone may not be enough to explain the behaviours that emerge in context, especially given the diversity of behavioural actions afforded to a fighter at any moment – meaning, they may become attuned to other informational variables (e.g. postural characteristics of the opponent) to specify the affordances present when faced with solving complex movement problems in the cage. Additionally, the perceived information channelling the movement actions of athletes is not just visual; it could also be haptic or even auditory. This is highly relevant in a sport like MMA, with the close physical contact between a fighter and their opponent requiring athletes to hear and feel (through touch and impact) information to regulate their actions.

The dynamic interactions present within combat sports provide an intriguing context for studying how perception, cognition, and action can be coordinated in an integrated way for skilled fighters to navigate the "rivers" of information surrounding them in a fight. Frankly, most research has neglected to capture the complex richness of two athletes in actual combat. However, Krabben, Orth, and van der Kamp (2019) offered a helpful list of recommendations for both research and practice, oriented around maintaining the representative nature of combat between two rivalling competitors (pp. 1831–1834).

Ultimately, changes in an opponent's behaviour can lead to variations in the important informational variables available for detection, which can channel abrupt shifts in the available opportunities to act from moment to moment. From a training perspective, it seems clear that skilled fighters are likely to become attuned and adaptable, perceiving and acting upon a range

of information sources. For example, a skilled fighter may couple their actions to several information sources or even a combination of variables, depending on a specific fighting context (e.g. individual opponent tactical tendencies), that likely have not been researched or empirically verified yet. These information sources could include (a) unfolding opponent behaviours (e.g. posture, the centre of mass height, velocities of movement, locomotive stepping behaviour/footwork); (b) spatial relationships within the cage (e.g. distance from the cage in each direction); and (c) nuances of the cage environment (e.g. dimensions of the combat workspace). These potential information variables could specify both simultaneous and

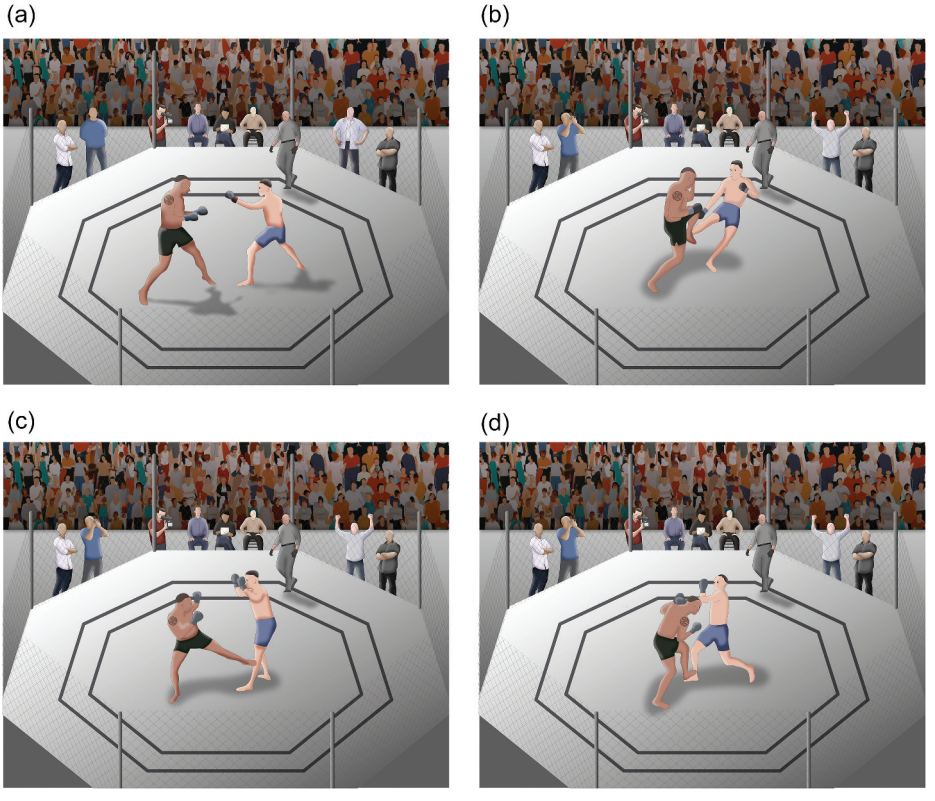

Figure 2. The illustrations depict an unfolding MMA fight sequence where there are numerous information variables specifying affordances, which are individually and frame-dependent for each fighter. (a) Both of the competing fighters could be perceiving information related to interpersonal distance and the kinematics of their opponent to determine attractive affordances. (b) The fighter on the right attempts a calf kick to the lead leg of the opponent, which draws a subsequent 'check' of the kick. (c) Once the fighter on the right's foot from his kicking leg touches back down, leaving him vulnerable to a kick to the shin of his lead leg, the fighter on the left perceives and aims to time an intentional counterattack of his own. (d) Both fighters, now having a more attuned and calibrated movement system to the emerging and decaying affordances, attempt simultaneous offensive attacks while evading their opponent's strikes in an individual fashion.

successive affordances for MMA-specific behavioural actions to emerge, such as informing a fighter about *strike-ability* or *takedown-ability* during exchanges on the feet; *clinch-ability* and *grasp-ability* when attempting to latch onto an opponent to take them down or hold them in place; or *submit-ability* during grappling interactions (for example, see Figure 2).

This type of skilled attunement and adaptability can be witnessed as high-level strikers from specialised stand-up disciplines like Muay Thai and kickboxing compete in professional MMA (e.g. Jose Aldo, Israel Adesanya, Valentina Shevchenko, and Alex Pereira). Many of these fighters often adopt a "hit and don't get hit style", which requires a high attunement to surrounding information and available affordances to evade striking attacks and make their opponent miss. They frequently accomplish this through (a) moving their head off the centreline; (b) slipping laterally after their last strike thrown in a combination; (c) leaning back to pull the trunk and head away from straight attacks; (d) moving in multi-directional fashions (e.g. with stance switching and creating lateral escape angles); and (e) feinting or faking to make the opponent think they are entering a striking range but "not being there" when the opponent attempts to throw a counter. Additionally, they are often masters of octagon control through constantly perceiving nested information sources (Araújo, Hristovski, Seifert, Carvalho, & Davids, 2019) around interpersonal distance and the unfolding behaviours of opponents in various fashions, often through grabbing and manipulating the lead hand of the opponent or by using a jab or lead kick to "measure" how far away the opponent is.

Using an ecological approach to help facilitate this type of behaviour in fighters, a coach could set up a practice activity where they would allow an opponent to throw various attacks at a developing fighter, who is only allowed to use strategies to defend in the activity by blocking, catching, parrying, slipping, and evading the opponent's attacking attempts (e.g. through footwork). This type of practice design, where a coach would be attempting to "constrain to afford" (Renshaw, Davids, Newcombe, & Roberts, 2019), could allow the fighter to become perceptually attuned to specifying information regarding affordances for evading or defending attacks in practice, so more adaptable solutions may emerge in competition. Additionally, a coach could attempt to facilitate the enhanced use of feints and fakes to deceive or disguise by asking the fighter, "Can you act in a deceptive way that would invite potential openings to your opponent's targets?" This exploration could lead to attunement concerning these related affordances while educating the fighter's intentions (Gibson, 1979; Jacobs & Michaels, 2007) to act deceptively in "setting up traps" for their opponent to enter into. This could lead to the presentation of "false" or "misleading affordances" (Ramsey, Dicks, Hope, & Reddy, 2022) and may materialise in an offensive fighter (a) throwing a light jab to move the opponent into an

optimal striking distance or co-adapting their position so they can throw a power shot; (b) moving their chin forward to get the opponent to throw a certain strike and subsequently open up a vulnerable target; (c) offering a hip feinting action to see how the opponent may defensively act if and when the fighter does execute a kicking attack; or (d) intentionally varying the timing and rhythm of their attack so the opponent never knows when the "real" offensive attack will truly arrive.

Alive movement problems

In any fight or across fights, no matter how similar an unfolding situation may appear to another one, no emerging combative problem is ever the same. As stated earlier, alive movement problems are ever-changing and require fighters to detect dynamic information and pick up specified affordances. In MMA, this aliveness usually results from the behaviours of a resisting and uncooperative opponent who is attempting to carry out their own intentional strategies, leading to a certain level of unpredictability and indeterminacy for a fighter. Therefore, alive movement problems are vibrant and vary in complexity and intensity, so fighters must remain sensitively connected to the intricacies of the unfolding problem to effectively make decisions and flexibly adjust their actions, coordinating an IMS (Myszka, Yearby, & Davids, 2023a, 2023b; Yearby, Myszka, Roberts, Woods, & Davids, 2022). Traditional MMA training often emphasises *passive* problems where a predetermined movement strategy is rehearsed and reproduced (e.g. striking a dummy or repeating katas). We contend that these "drills" inadequately prepare fighters to adapt their behaviours for competitive situations. Conversely, practitioners could adopt a learner-environment-centred perspective on coaching by harnessing the coaching methodology known as the *constraints-led approach* (CLA)[3] or using other nonlinear pedagogical ideas such as *representative learning design* (RLD)[4] and *repetition without repetition*.[5]

These pedagogical principles, underpinned by ecological dynamics, can be instrumental in setting up alive movement problems that faithfully capture the dynamic nature of MMA, where fighters are required to solve problems that vary in complexity, potentially leading to attunement, intentionality, and adaptability (Myszka, Yearby, & Davids, 2023a; Yearby, Myszka, Roberts, Woods, & Davids, 2022). Practically, this could unfold through a fighter getting an abundance of different "looks" by practising against many opponents, each of whom embodies their own authentic style or may reside at various skill levels; this type of learning situation leads to natural repetition without repetition, channelling a fighter's need for constant problem-solving (i.e. adjusting the relational nature of perceptions, cognitions, and actions). For example, performance analysis may reveal that

a fighter struggles to evade striking attacks from tall, powerful punchers in tighter ranges (i.e. closer interpersonal distance). To compensate for this tendency, they may look to stay at a longer range (i.e. increase the interpersonal distance) or move laterally via sidestepping footwork to find escape routes whenever possible to avoid offensive attacks. However, this adaptation may not be possible to use against every opponent or in every fighting situation.

This type of gap within the fighter's repertoire can be addressed through practising in alive environments, where problem designs can be intentionally manipulated, requiring the fighter to (a) face opponents of differing heights and limb dimensions each round; (b) accumulate rounds sparring against an opponent who may be in a heavier weight class; (c) contend with opponents who tend to pressure their adversary through bullying or via operating in the clinch or at close boxing ranges; and (d) operate in tighter, confined fighting spaces by constraining the activity area, shape, or size so the fighter is crowded by their opponent from the beginning of the task (e.g. starting the practice activity in the corner of the octagon or near the "warning track" of the cage). Each of these constraint manipulations could enhance aliveness (Lee, 1975; Myszka, Yearby, & Davids, 2023a), creating problems the fighter may face while intentionally addressing any specific weaknesses they possess. It is here that skill adaptation could unfold as a search process where the fighter learns to attend to relevant informational variables, leading to the adaptation of skills to solve performance problems (Button, Seifert, Chow, Araújo, & Davids, 2020; Davids, Button, & Bennett, 2008). Next, we will offer three case examples, highlighting how concepts of an ecological approach could be utilised to help facilitate the skill adaptation process for fighters of various levels, ranging from hobbyists to MMA champions.

Case example #1 - dynamic constraints for high-calibre hobbyists to pro-champions

MMA gyms around the world are often built and developed by practitioners of other forms of martial arts that are distinct from MMA, including Brazilian Jiu Jitsu, Muay Thai, kickboxing, and karate. These sports serve as the foundation for MMA training. However, there are very few standalone MMA gyms that exclusively cater to MMA fighters at a professional level. Many MMA schools blend different training methods to create their own version of MMA. While most students who take up martial arts training are not aiming to fight in a cage, they do it for various reasons, such as having fun, getting in shape, meeting peers, learning self-defence, and gaining confidence. Thus, one of the main challenges in developing MMA athletes at any level is finding a balance between the needs of

"hobbyist" martial artists with varying levels of commitment and the serious commitment required by high-performance MMA fighters preparing for competition.

To gain a deeper understanding of how a practice environment might be structured to meet the needs of all students, we offer reasons why key principles of ecological dynamics could be used to design a learning environment for all learners. Most MMA fighters, like most aspiring pro athletes, will not make it to professional status. Most MMA gyms are not powerhouses generating pros but are built with a group of recreational hobbyists (non-fighters), amateur fighters, and pros. Coaches must take into account the varying levels of experience, attributes, and skills of each individual attending practice. The future amateurs who become pros often emerge from the hobbyist group. Developing high-level MMA performance under the current approach requires a high level of sensitivity to the wide variety of individuals who attend practice sessions.

The following case example highlights several ways one martial arts academy has used key principles of nonlinear pedagogy to assist athletes with skill adaptability and bridge the gaps between hobbyists, amateurs, and professional fighters. Stats from 2014–2020 UFC fights show that most wins are not overwhelmingly knockouts or submissions (Statista Research Department, 2023). The results indicate that fighters who effectively blend striking with wrestling and grappling/submission are likely to succeed more often in MMA than fighters who do not. The coaches of this team use a four-phase approach to MMA training, consisting of shoot boxing, which combines striking with takedowns; clinch fighting, which combines close-quarter strikes and throws; fence wrestling, which includes wrestling and close-quarter striking on the fence; and ground fighting, which includes ground striking, positions, and submissions. In alignment with a nonlinear pedagogy, it should be acknowledged that coaches can start with any phase and transition between them with different amounts of time spent in each. The amount of time spent on each is associated with individual needs. While there are alternative ways to mix the combative arts, this approach is believed to be most useful, helping those within the academy prepare professional world champion MMA fighters, both male and female, along with amateurs aspiring to improve their fighting skills. With the four-phase approach in place as a guide, it becomes possible to design alive problems that the athletes will actually face in the cage, as opposed to practising movement patterns that detach athlete behaviour from the context in which it emerges. Aligning with Bernstein's (1967) principle of repetition without repetition, becoming skilled in fighting is the process of repeatedly finding performance solutions, not copying other athletes' solutions, or rehearsing techniques.

The first phase (i.e. shoot boxing) is used to help athletes develop a heightened attunement to information variables that specify actions (Gibson, 1979). Coaches assign one athlete to "timing spar boxing strikes" (i.e. soft sparring) while offensively shooting takedowns, and the other athlete is challenged to timing spar boxing strikes while defending takedowns. The traditional prescriptive coaching approach to training boxing and wrestling would be to get the "fundamentals" down in each respective discipline and then repetitively rehearse the back and forth of punching combinations followed up with wrestling shots. For beginner-level to intermediate students, practice task constraints can be manipulated to help develop a heightened attunement to relevant information variables (e.g. interpersonal distance; Okumura, Kijima, & Yamamoto, 2017). For newer practitioners, the intention behind the offensive entry into wrestling can be to "fit in for the takedown" (i.e. to adopt a position where the takedown could happen without taking it all the way down to the ground on every trial). Yet, higher-level athletes could increase the difficulty by finishing the takedowns down to the floor.

For phase two (i.e. clinch fighting), athletes are instructed to "Thai clinch" (i.e. neck wrestling while throwing soft knee strikes to the body), and they are both allowed to attempt a takedown from Greco-Roman wrestling or judo that does not touch the hands to the legs. Knee strikes to the body can be some of the most devastating strikes a human body can produce, so the challenge is to design a representative learning environment that is also safe during practice. The Thai way of practising the clinch has similarities to what might be seen in a CLA; however, it can be improved with the purposeful manipulation of constraints. For example, with the addition of upper body throws and foot sweeps, we can add focus and awareness to maintaining balance while avoiding the ground if desired. For the hobbyist student who wants to learn basic self-defence, the benefit of training in clinch fighting is the very real likelihood of being in that range during a self-defence scenario. The complexity can be modified so that each athlete attains relevant benefits. Coaches can constrain the maximum number of upper-body throws allowed as well as the types of takedowns, which can emphasise a fighter's search for openings. Through observation, coaches have found that foot sweeps and trips are easier to fall with than any technique that lifts the opponent high off the floor.

The training of phase three (i.e. fence wrestling) has long been a special focus in high-level MMA competitions. Conversely, hobbyists may not have an interest in wall wrestling, and many pure grappling coaches have no experience in this area. Thus, this area is often least focused upon by typical hobbyist students in combative martial arts schools. There is a focus on bridging the gap between professional and amateur fighters when designing practices to develop fighting skills near or on the fence. Situational cage

work has served as the primary method of skill development for this team. Having one athlete *start in on* a single- or double-leg takedown while both athletes simultaneously struggle provides an information-rich environment to develop cage control. For hobbyists, wall work is conceived of as a method for developing situational awareness in self-defence. Using the wall in self-defence can limit an attacker's ability to injure. Finally, wall work requires a high energy output and can serve as a great method for increasing fitness levels.

The fourth phase (i.e. ground fighting) is of special interest to self-defence -inspired hobbyists and aspiring MMA athletes alike. In our academy, working out of bad positions such as mount, knee mount, bottom half guard, and side control, all with the inclusion of light striking, has been an effective way for both athletes in the competing dyad to develop their skills. Often, beginner-level grappling students have an interest in being able to protect themselves and deliver ground strikes because of the reality of self-defence. The force of ground strikes can be less than that of standing because the capacity to generate ground reaction force is usually lower in grappling positions. Keeping the striking soft in this situation is important for safety. An example of a constraint-based live round in this phase is to have one student start in top half guard with the options limited to staying on top, using simulated ground strikes, and advancing to side control, mount, or back mount. The athlete underneath can search for opportunities to get to the top position, either using a leg takedown or getting up to a standing position using an overhook. In this example, the athletes are given the opportunity to explore individualised solutions to alive movement problems.

Conceptually, these four different phases (i.e. shoot boxing, clinch fighting, fence wrestling, and ground fighting) offer both MMA students and future MMA athletes opportunities to adapt and exploit movement system self-organisation tendencies and begin to educate their perception and action systems to gain knowledge of the affordance landscape in a competitive MMA fight (Rietveld & Kiverstein, 2014).

Case example #2 - the value of sparring from the onset

The Foundations MMA programme (described below) is designed to immediately expose beginners to the fundamental dynamics of MMA through the adoption of an ecological approach. Each session is planned to provide novices with the opportunity to experience different elements of the sport from the onset of their training. In addition to striking, clinching, and ground fighting, participants also experience the physical conditioning demands of the sport. It is important to note that head contact from strikes is prohibited in this programme.[6]

Dynamic skill-specific warm-ups and striking games

Typically, variations of tag boxing are utilised, where both training partners attempt to tag each other on specific target areas (e.g. shoulders or torso) while evading being scored upon. These games can be creatively varied to add novelty and challenge. From a motivational standpoint, the immediate gamification of practice is generally well received by developing martial artists, leading to high engagement and determination. From an athlete safety perspective, these warm-up activities and games should be designed to be appropriately challenging, posing a varied range of risk to performers in training, from relatively low to increasing risk, perhaps being periodised (Otte, Millar, & Klatt, 2019) according to the intentions and specific needs of each fighter in preparation for imminent combat in competition. Therefore, demands on perception and action may be scaled to the fighter's intentions and needs, where the detection of information to regulate actions may be modulated according to the fighter's aims with respect to an immediate opponent (Segundo-Ortin & Kalis, 2022).

These warm-up activities and games can also be utilised as learning opportunities, continuously cultivating essential movement qualities required for effective striking, such as footwork (i.e. stable base, posture, and balance) and range (i.e. developing skills in interpersonal distance management and brinkmanship). New learners are not explicitly told how to stand or move; they are only presented with a problem to solve and offered task objectives. Coaches often observe that relatively effective movements (e.g. in-and-out footwork) and postures (e.g. defensive guards) self-organise almost immediately under practice task constraints. While no explicit prescriptions are given on how to move, usually a very brief demonstration of the activity and the objectives are given. Students are reminded that attacks are essentially thwarted by evasion (i.e. avoiding) or interception and redirection (i.e. blocking).

Most importantly, beginners start to "pick up" the movements of their training partners, even though they may initially have limited attunement to perceiving key information sources. This exposure, with practice and experience, becomes crucial as beginners begin to effectively coordinate their movements with those of their training partners. Perception-action coupling is a key underlying concept in this type of practice design, emphasising activities that facilitate the integration of perception and action, shaped by the intentionality of the learner (Davids, Button, & Bennett, 2008). These types of warm-up games offer engaging, low-risk activities to initiate the training sessions and are designed to be appropriately challenging for the learners' level. Loosely assembled lesson plans provide coaches with opportunities to approach practice creatively as they vary these simple games while adding or removing elements of novelty and challenge. Where this

ecologically driven approach and more traditional pedagogical approaches share common ground is that of repetition. We certainly want our learners to accumulate numerous repetitions. However, these repetitions should be exercised in an appropriately challenging context and include an element of decision-making as martial artists interact with the affordances presented by a live training partner. Gamifying the activities achieves this objective where more traditional rote repetition on bags or pads might not.

Clinching and wrestling

As we turn our attention to developing clinching and wrestling competencies, our students are introduced to standing interactions via goal-oriented gameplay, where strategies and tactics are developed through game rules and task constraints. Dominance in such standing entanglements relies on effective grip fighting, centre of mass control, and balance disruption. Likewise, successful takedowns are achieved when the opponent's base of support is removed or their centre of mass is moved beyond it. Communication to guide learners' intentions and attention (Jacobs & Michaels, 2007), such as phrases like "inside space" to encourage dominant gripping and control positioning, "be the bully" to prompt aggressive disruption of the opponent's base, and "own their hips" to direct them towards achieving hip (trunk) control, is often used to facilitate their search and assist in the problem-solving process. For beginners and less confident learners, full takedown execution may not be appropriate. Instead, one could aim to introduce takedown finishes from various positions as learners advance (e.g. already engaged in a single-leg takedown, from a clinch, against the cage). Moreover, both open floor and wall or fence settings are used for clinching and takedown games, as they demand different strategies offensively and defensively.

Ground fighting

The third aspect of this foundational training is dedicated to ground fighting strategies. Unlike Brazilian Jiu Jitsu or submission grappling, MMA favours a top fighter position due to the potential for increased force delivery and favourable scoring. Therefore, MMA ground fighting activities should focus on maintaining top positional control and strategizing escapes from the bottom of the dyadic relationship. The key tactics involve pinning and controlling the opponent's torso and hips while maintaining a stable base and posture for the top fighter. In contrast, the bottom athlete should look for opportunities to destabilise the opponent's base of support and create space to exploit a counter or escape route. Emphasising a hierarchy of effective positions, learners are guided to explore a series of strategies that

shape intentions for maintaining top control and escaping from the bottom. Key dominant positions in MMA, such as back mounts, full mounts, and side pins, are focal points in our foundational ground sessions, and a large portion of training time is typically spent exploring the functionality (i.e. practicality or usefulness) of these positions.

In our specific training approach, we emphasise dynamic interactions between training partners. While everyone is conceptualised as a complex dynamic system, it is the integrated dynamic system (i.e. the fighter-cage system) that is of greatest interest (Krabben, Orth, & van der Kamp, 2019). Given that this perspective shapes session design, we consider "less alive" activities, such as technique-oriented shadow boxing, bag and pad work, and scripted partner drilling, to hold relatively little value during group training sessions. This viewpoint may contrast with traditional combat sports training methods, yet our primary objective is to facilitate skill attunement and adaptability. Nevertheless, it is acknowledged that the aforementioned activities could potentially contribute to the motivational, psychological, and physiological aspects of a comprehensive development programme. Consequently, students are encouraged to incorporate these activities outside group practices as supplements, rather than substitutes, for live partner training. Therefore, our foundation session is considered to be almost exclusively live and unscripted.

Case example #3 - enhancing aliveness in high-level MMA

Five years after his initial MMA lesson, Brian Bowles became the World Extreme Cagefighting (WEC) Bantamweight Champion. On 9 August 2009, Bowles, then 7–0, knocked out Miguel Torres, who held a remarkable record of 37–1. The victory was considered one of the greatest upsets in MMA history. Following his recovery from a broken hand suffered in the fight, Bowles was scheduled to defend his title against Dominick Cruz at WEC 47 on 6 March 2010. Cruz, 14–1, was known for his unique and authentic movement skills, dubbed "neo-footwork" by MMA writer Jack Slack (2016) and sometimes likened to the great Willie Pep. Outlined below is how one of the authors of this article and his team prepared Bowles for this fight with their earlier grasp of ecological dynamics, followed by changes they would make with an expanded understanding of the key principles.

Every new opponent is a study of the fighter-cage relationship. A fighter's preparation must take into account a new set of movement problems and a novel array of threats and opportunities relative to the upcoming opponent. According to ecological dynamics, the discovery of solutions to these problems should emerge in alive training environments (Yearby, Myszka, Roberts, Woods, & Davids, 2022). Developing the necessary skills needed against a specific opponent requires attention to the potential strategies and

tactics that may be employed against them. While this can be a straightforward task in some fights, facing a fighter with the skill set of Cruz posed a particular challenge. At the time, Cruz's footwork involved constant motion, fakes, and stance switches, enabling him to apply continuous pressure and create new angles of attack. The nature of this authentic and novel movement allowed him to manipulate values of interpersonal distance versus his opponents by disrupting typical MMA meta-stable regions and exploiting his own adaptive behaviours (see Hristovski, Davids, & Araújo, 2006; Myszka, Yearby, & Davids, 2023a). During preparation and film study, threats and opportunities to attack (affordances) were identified by coaches. It is important to note that during this pre-competition preparation, knowledge about the opponent (Gibson, 1966) could be used to help educate the athlete's attention, assisting them in deepening their knowledge of competitive interactions, which is developed during fighting, leading to more adaptable behaviour (Araújo, Davids, Cordovil, Ribeiro, & Fernandes, 2009). Coaches identified that Cruz was adept at low-line attacks (i.e. low kicks and knee tap takedowns), but these tended to compromise his balance, agility, and defensive responsibilities. This vulnerability made him susceptible to head kicks and attacks while recovering his base. Bowles and Cruz operated with a highly contrasting fighting form of life: Bowles demonstrated exceptional power, and Cruz excelled in aerobic conditioning, allowing him to control the pace of the fight. The movement and positioning of Bowles were underpinned by strong fundamentals: an athletic base and posture, as well as excellent interpersonal distance management. These qualities enabled him to take advantage of opportunities for action in each MMA range (i.e. stand-up-clinch-ground) and the transitions between them. His style and approach to the fight allowed him to strike proficiently with speed and power in both hands, remaining defensively responsible while displaying *skilled intentionality* (i.e. a selective openness and responsiveness to a rich landscape of affordances; Kiverstein & Rietveld, 2015). Bowles was a world champion for a reason, and Cruz was likely well aware that the fight could end by knockout or submission at a moment's notice.

In 2010, our understanding of ecological dynamics and the CLA was called the I-method: introduction, isolation, and integration. This approach represented a continuum of representative practice design, with the isolation and integration phases specifically guided by our current conception of aliveness. We applied the I-method during that specific fight preparation as follows:

- The introduction phase included pad work to address the use and targeting of head kicks, counterattacking, and increasing pace.

- The isolation phase included daily, high-intensity sparring rounds dedicated to each range independently and increased sessions focused on wrestling.
- The integration phase included twice-weekly MMA sparring with increasing representativeness, intensity, and volume using multiple partners per round to ensure a high-pressure, information-rich environment.

In addition, to optimise functional movement solutions, we addressed Cruz's specific problems in every session. Bowles's training partners attempted to embody "Dominick Cruz" to create a learning environment filled with relevant information. By the end of training, Bowles was well prepared for the challenge and ready to defend his belt. Unfortunately, Bowles would go on to lose to Cruz after breaking his hand in the second round. In retrospect, Cruz was able to frustrate Bowles, taking away his ability to dictate the ranges and exchanges. Cruz would go on to defend his new title seven times over the next six years. In the time after the fight, Bowles's coaches have spent many hours pointing a critical eye at their preparation for MMA.

Now, with an increased understanding of ecological dynamics and through the application of the CLA, the following is a look at some methods that could have been incorporated into Bowles's training to fight Cruz:

- Eliminate less representative tasks that could be conceptualised as "passive" activities (i.e. pads, choreographed exchanges, technical repetition by rote) and conceptualise the introduction phase as an alive method to develop the fundamental skills that underpin our strategies and tactics. In these sessions, we would "turn down the volume" (e.g. make practice design more constrained and focused) and search for solutions to the specific challenges presented by Cruz as an immediate opponent (e.g. functionalising the head kick).
- Increase isolation rounds with controlled intensity but added aliveness and representativeness. Constraints could be manipulated to test skill adaptability, focusing on tools, ranges, transitions, positions, and situations. For example, training partners would continue to act in ways that simulate the challenges offered by Cruz (e.g. pushing the pace and pressure).
- More targeted work with Bowles during the integration phase to maximise fight night performance, where he would become more attuned to the specifying information likely offered by Cruz. This would occur through a purposeful manipulation of constraints to allow Bowles to become accustomed to adapting across situations (e.g. distances and ranges) or conditions (e.g. under fatigue). Ultimately, this would all be

done in the hopes of allowing Bowles to spar against the most accurate simulation possible in a training environment. Most rounds would be full MMA with multiple partners per round (sometimes called "shark tank"). Safety is a challenge solved through careful consideration of constraints (e.g. dedicated and skilled training partners, use of safety gear).

- Reduce intense MMA sparring to one session per week while adding more of the relevant variables that occur as part of the fighter-cage system. This could include scheduling sessions to coincide with the fight day and time, mimicking fight-day behaviours, activities, meals, warm-up and walk-out, and sparring in the presence of corners, judges, and crowd noise.
- All the fight preparation was completed in the same cage; however, the cage in the training environment was smaller than the one used on fight night, so it may have led to false confidence in the ability of Bowles to use the cage as a constraint to curtail Cruz's movement (i.e. as the fighting area changed, so may have the affordances). Through frequent training in a more open area, Bowles could have increased his attunement to the movement behaviours offered by Cruz, specifically his ability to "run" from attacks.

Conclusion

Traditionally, MMA practice environments see fighters frequently training in passive, reductionist designs where they look to "drill a technique" removed from the performance context. This deviates from the alive movement problems fighters are asked to solve when stepping into the cage on fight night (Myszka, Yearby, & Davids, 2023b). In this paper, we highlight the development of a fighter-cage system grounded in an ecological dynamics framework to help reframe how coaches could approach athlete development and performance preparation in MMA. Numerous ecologically-based ideas were presented, such as the fighting form of life and fighting speed, to assist coaches in conceptualising the problem-solving process that unfolds when a fighter adapts their skill to the challenges and opportunities present within the cage. Further, three case examples were utilised to illustrate where and how these concepts may be used within the learning environments that MMA coaches design.

Notes

1. It is important to consider that constraints act as information and can be viewed as informative boundaries, meaning they do not prescribe solutions but rather limit some from emerging (Gray, 2021; Renshaw, Davids, Newcombe, & Roberts, 2019).

2. For interested readers, see: https://www.ufc.com/unified-rules-mixed-martial-arts
3. The basis for a CLA originated from the work of Newell (1986). Constraints consist of three interacting categories, which include *task* constraints (e.g. rules, equipment, fighting area dimensions, and opponents); *environmental* constraints (e.g. ambient light, temperature, altitude, and social expectations); and *organismic (individual fighter)* constraints (e.g. height, body weight, limb segment lengths, emotions, and states of fatigue). Armed with an understanding of interacting constraints, coaches can identify and manipulate key constraints to help athletes enhance movement coordination and decision-making during practice and competition (Chow, Davids, Button, & Renshaw, 2022).
4. The notion of *representative design* in experimental psychology (see Brunswik, 1955) was reconfigured as *representative learning design* (RLD) in sport performance contexts by Pinder, Davids, Renshaw, and Araújo (2011), which recommends that individuals be embedded within the constraints that emerge in competitive settings, where they can sample the informational variables (and specified affordances) used to organise an integrated movement solution.
5. Bernstein's (1967) notion of *repetition without repetition* emphasises an individual's need to repeat the *process of solving* a movement problem by changing the nuances of the solution instead of repeating the *means of a solution* through repetition by rote during practice.
6. As authors, we acknowledge that removing head strikes from this foundational program may be considered contradictory to a key aspect of ecological dynamics – that of representative learning design. However, this training adaptation is advised as an ethical tradeoff that helps reduce the risk of injury, develop confidence, promote group trust, and manage expectations for future development. Any consent to head contact as students advance needs to be informed on an individual basis with the permission and oversight of a supervising coach.

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