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Coach–athlete interaction in Muay Thai: A microethnographic analysis of skill learning in a real-world combat sport

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ABSTRACT

Coach–athlete interaction is a central component of skill learning in sports. When done well, interventions by a coach can shape an athlete's perceptual, motivational, and physical capacities and dramatically improve performance. Such interaction is not well modelled by thinking of a coach as transferring rules and directives to the individual athlete. Instead, an ecological perspective on coaching encourages attention to interactions during play, and the diverse ways it can support athlete development and performance. This paper uses microethnographic analysis of a Muay Thai developmental bout to showcase methods that track rich and dynamic real-world interactions between coach and athlete to ground better theoretical understanding of skill learning in the wild. Based on close analysis of coach–athlete interactions, including during and between rounds of a bout, we examine how skill is achieved in a complex learning environment. We suggest *how* specific coaching interventions scaffold a novice's capacity to perform and identify five coaching functions – diagnosis, strategy, implementation, affirmation and consolidation – that were part of the coach's approach to enhancing the fighter's performance. Intensive field-based methods like microethnography can more precisely chart the complex ecological features of authentic skill learning and coaching and move us beyond individualistic or exclusively laboratory-based understandings of skill.

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Introduction

How do novice combat sports practitioners develop skills in a fighting practice? Recent debates in sports are moving away from a classical motor skill learning approach that explains learning as a transfer of rules and directives from the coach to the individual athlete (Schmidt & Wrisberg, 2008), focusing instead on the development of an adaptive, functional athlete-environment relationship (Araújo & Davids, 2011; Woods et al., 2021). Alternative treatments of skill learning and coach–athlete interaction to date, however, remain severely limited. We use microethnographic analysis of a Muay Thai developmental bout to showcase methods that can better track rich dynamic interactions between coach and athlete on a moment-to-moment scale, to ground better theoretical understanding of skill learning in the wild.

In one sense, all research on coach–athlete interaction in sport seeks to get beyond individualistic attention to the athlete alone and acknowledge the systemic features of the ecology in which skill development occurs. Systems-based approaches to skill seek to avoid the critique levied in a recent *Journal of Sports Sciences* editorial, that 'historically, sport research has focused on isolated components at the level of the athlete, and less so on the interacting components of the broader sports system' (McLean et al., 2025, p. 4). But in practice, it is challenging to study actual interactions between coaches and athletes across multiple timescales, from long enculturation and training across timescales of years and careers, to the meso-scales of practice for a particular year or competition, to the micro-scales of interaction which are our focus here as we study coach–athlete interaction during and between rounds of a live bout. Even the best recent work on sports coaching uses methods which only tap coaches' attitudes or beliefs, or seeks to elicit their mental constructs or schemas about performance, skill learning, and athlete development. Some excellent studies use semi-structured interviews with coaches (Greenwood et al., 2014; Mason et al., 2020; Selimi et al., 2025; Taylor et al., 2023), while others involve surveys or focus groups (Mees et al., 2025; Stoszkowski & Collins, 2016), and others offer theoretical reviews and considerations (Corbett et al., 2024; Lascu et al., 2024; Lindsay & Spittle, 2024; Otte et al., 2024; Selimi & Woods, 2024). These methods run the risk, however, of only or

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primarily tapping explicit and verbalizable beliefs about skill development and may not map onto what actually happens in real-time interaction and practice.

We acknowledge that a few focused accounts directly tap the real-time dynamics between coaches and athletes during training. Cope et al. (2016) examined coaches' questioning practices in top-level youth football using both video-recorded episodes and field-note taking, while Nichol et al. (2023) critically examined unintentional and unsuccessful influence in cricket coaching, using an impressive array of methods, including close observation of 'critical incidents' and stimulated recall interviews to confirm players' retention of instructional output. Both papers take a critical angle on coaching influence, especially in terms of the rhetoric used by coaches, but without analysing the micro-interactional dynamics of coaching embodiment and strategic-affective instructions. In a different approach directly relevant to our work, Halperin et al. (2016) examined coaches' ringside feedback during a major tournament, assessing the frequency and type of instructions deployed during between-round breaks of the competition. Unfortunately, they offer no details of athletes' performances beyond winning or losing bouts, and do not discuss any coaching during rounds when implementational feedback is typically offered by coaches.

In other cases where more intensive ethnographic approaches are deployed, as in interesting work by Corsby and Jones (2020), and in older apprenticeship style work (Downey, 2005; Wacquant, 2004; on apprenticeship methodology see Downey et al., 2015), observations occur over an extended time period, borrowing from the immersive style of ethnographic research in mainstream cultural anthropology. Our microethnographic analysis of much smaller slices of interaction can complement and enhance the more longitudinal approach by making intensive use of opportunities enabled by digital technologies (e.g., video and audio-recordings) to enhance our ability to study fleeting and temporary arrangements of action. Digital tools are particularly suited for catching transient interactions as they occur, like the subtle work that some coaches do to teach and transmit new skillsets to an athlete in fast and dynamic sporting contexts; digitally-enhanced observation enables close and direct insight into the actual proceedings of *in situ* skill learning and coaching praxis.

When we consider skill learning more broadly, we recognize that in recent years 'ecological' approaches to skill have developed more *interactive* and *distributed* accounts of training and performance (Araújo & Davids, 2011; Krabben et al., 2019; Orth et al., 2019; Woods et al., 2021; Yearby, Myszka, Grahn, et al., 2024; Yearby, Myszka, Roberts, et al., 2022). Inspired by James J. Gibson's (1979) ecological psychology, dynamical systems theory, and Tim Ingold's (2021) social anthropology, amongst other influences, this heterogenous body of work encourages a greater focus on the dynamical and interactional facets of performance, rather than treating skill solely as an internalised body of individual knowledge. Ecological dynamics perspectives describe skill learning as an attunement between persons and their environments, acknowledging that learning is a social process that develops 'thanks to participation in a perceptually and socially rich field of relationships' (Grasseni, 2004, p. 49) that may include, for example, creative coaching, community knowledge, and encouragement.

Even though research promoting ecological approaches has advanced, experimental, small-scale studies in this field provide limited capacity to illuminate the complex learning environments that characterise skill learning in naturally occurring contexts (see, for example, recent concerns raised by Collins et al., 2024; Ranganathan & Driska, 2023). The tendency in motor learning experiments to 'rely on constrained tasks that rarely resemble the complexity of real-world' is pointed out by Ranganathan and Driska (2023, p. 2) as a key concern for the transferability of experimental results to authentic sporting environments. Specifically, laboratory-based researchers tend to isolate specific variables for testing in artificially controlled contexts (Hristovski et al., 2006), in computer simulations (Araújo et al., 2005), or in actual competitions (Maloney et al., 2021; Okumura et al., 2012), For instance, Hristovski et al. (2006) examined how distance-to-target information shaped the emergence of boxers' strike choice on a stationary target. Relying on experimental findings, they suggested that 'strikeability' is determined by a fighter's body-scaled range (i.e., leg and arm span) to a static target, reachability successfully predicting when boxers struck.

These approaches, although entirely appropriate for *confirming* dynamic processes involved in skill learning and performance, still have limited application to the full ecological complexity of naturally occurring learning environments, which can be examined with more open-ended, exploratory, field-based approaches. This is stressed by Ranganathan and Driska (2023, p. 2), who point to a 'need for data collection outside of the domain of lab experiments', noting that the absence of such approaches is 'not a new observation', rather, 'the continued lack of field-based data in guiding theories of skill acquisition seems to point to a systemic problem in what type of research is incentivised . . . '.

To address the inherent complexity and richness that characterise the incubators of motor skill learning, like gyms and novice bouts, we need to extend our

measurements to include the wide array of qualitative research methods, including ethnography, practice-based, and phenomenological methods (Sutton, 2024). As Sutton and Bicknell (2020, p. 197) point out: 'Navigating such aspects of the bodily, motivational, collaborative, and environmental settings of performance, while maintaining or intensifying the highest level of technical competence in skill execution, is utterly unlike reproducing a single component of one's overall skill set in simplified training or laboratory settings'. Stripping out the complexity that characterises ecologically authentic accounts of skill, the very challenges that make performance so difficult, means that experimental-ecological dynamics approaches have limited capacity to characterise complex skills composed of many nested abilities. In this paper, we offer one approach particularly useful for evocatively capturing dynamic skill ecologies, a method we refer to as 'microethnography'.

Generally underappreciated in sports research, even in the ecological dynamics literature, microethnography is a qualitative research method that deploys digital tools, especially video and audio-recordings, to facilitate moment-to-moment observation, documentation, and description of situated human activity (Hjortborg et al., *in preparation*; Streeck & Mehus, 2004). In contrast to both experimental controlled studies as well as to traditional ethnographic methods, which typically rely on notetaking, interviews, or recall, microethnography enables researchers to focus on the finer-grained details of interaction, to catch fleeting embodied actions as they occur without losing grip on the complexity and variability of the athletic challenges integral to skill learning and coaching. Given the ephemeral and complex nature of sporting interactions, microethnography is particularly suited to examining complex learning processes that standard ethnographic methods (e.g., sitting in a corner taking notes) simply may not be able to capture. To date, despite the method's prevalence in education, health, anthropology, and social science, only a few researchers have embraced microethnographic and adjacent methods (e.g., cognitive ethnography) to examine skill interactions in sports and movement contexts (Kimmel & Rogler, 2018; Kimmel et al., 2018; Kirsh, 2011; Muntanyola-Saura & Sánchez-García, 2018). Our main objective is to add to these endeavours to demonstrate the utility of microethnography as a method to tap community insiders' knowledge of the ecological dimensions of skill learning and coach–athlete interaction.

Our case study is a Muay Thai developmental bout in which a novice fighter receives ongoing support from her coaches (or 'corner'), including between-round advice and moment-to-moment instructions, as she tries to refine her skills and embodied performance. The developmental fight context is a particularly rich environment for catching in situ learning processes, as the coach actively seeks to fast-track athlete development, for example, by directing the fighter's attention and revising strategy on the fly, concretely illustrating stages of skill developmental transformation. We proceed by briefly explaining our research positioning and design followed by a description of the case study and the methodological procedure. In the bulk of the paper, we present the case study sequentially in four parts, targeting key learning moments in the bout. This account shows how intensive ethnography provides a detailed account of key transitions in skill learning, especially considering tentatively how ecological factors like timing, motivation, and skilled coaching enmesh within a skill like perceiving 'strikeability' in Muay Thai. Based on our analysis of coach-fighter interactions, we end by offering a five-stage model of zones of proximal transformation. We hope that by showcasing the richness and rigour of this form of data analysis, we will inspire more skill researchers to follow suit and integrate observational ethnographic methods into their research design.

Method

Research positioning and design

As researchers we are positioned across anthropological-ecological theory, distributed cognition, and social developmental psychology. In particular, we build on our long-term collaboration and work in the specialised fields of cognitive ecology and distributed cognition, addressing these theoretical frameworks with close connection to ecologically authentic studies of practice (Bicknell & Sutton, 2022; Hjortborg, 2022a, 2022b). In agreement with the ecological dynamics approach to sports, these frameworks from cognitive science tend to take an anti-individualist approach to cognition, seeing cognitive processes, emotional regulation, and action as hybrid attributes, 'unevenly distributed across the physical, social and cultural environments' (Tribble & Sutton, 2011, p. 95). To expand on the present case, we combine these cognitive theories with Vygotskian learning theory, taking the coach-novice dyad as a key example of a socially distributed system, both moment-to-moment, and as a path to long-term development (Vygotsky, 1978; Wass & Golding, 2014). Our conclusions about how skill emerges are based in our microethnographic findings, which we substantiate with selective quantifications of observed changes to performance outputs (e.g., a pattern of more successfully landed

kicks). But our findings are also supported by Hjortborg's expertise within the sport, derived from long-term fieldwork and immersion in the sporting communities under investigation, as well as by consulting experts.

Through a microethnographic approach, we place emphasis on showing *how* skilled action is accomplished by observing and describing events involving key learning complexes, including multimodal instruction. Thus, our approach recognises the role of words and verbal instruction as well as demonstration and non-verbal techniques. We especially reveal the remarkable way that 'words alight on bodies' (McIlwain & Sutton, 2014) as one key component of the extraordinarily high level of skill that a coach demonstrates in finding the right words, gestures, and interactions to support an apprentice fighter under severe time constraints and physical duress.

We acknowledge that qualitative observational methods have limited ability to offer controlled, causal explanations. Nonetheless, microethnographic observation allows us to discover potentially relevant mediating factors of skill phenomena in naturally-occurring events (Hjortborg et al., *in preparation*; Snodgrass et al., 2024). Such an approach is particularly helpful for identifying key variables to isolate for further testing.

The case study

The microethnographic case study was documented during the first author's long-term ethnographic fieldwork on Muay Thai in Sydney from 2019 to 2021. Muay Thai, a full-contact sport and art originating in Thailand, has gained international popularity over the last few decades, culminating in the sport receiving full recognition as an Olympic sport in 2021 although it was denied entry in the 2028 Olympic Games (IFMA, 2019). As a part of this increasing popularity, scaled competitions and sparring events have become an integral component of training in Muay Thai, as advocates establish the structures necessary to offer Muay Thai as a safe and well-regulated sporting activity. In Sydney, the Muay Thai community is large and includes many women who seek out competition to progress into amateur and professional fighting.

The bout that serves as the present case study was observed during one of two inter-gym Muay Thai sparring events promoted under the name, 'Gym Wars', that took place in October and November 2020. These events were considered 'development fights', especially organised for early-career fighters, although several more experienced and professional fighters also participated on the day. Development fights simulate an official fight but are shorter and less rigorous, which is also moderated by wearing protective gear and agreeing to limit violence during matches. The main objective of the events was thus to develop fighters' technical skills in a realistic competitive environment without submitting novice fighters to the unrestrained impact of a full-contact sports fight.

Before the events, for example, fighters were told to 'regulate their level' and not execute techniques at full power. Greater emphasis was to be placed on the tactical and strategic demands of Muay Thai, including the 'scoring' of fights: coaches pointed out that practitioners needed to learn how to score and 'take a win'. Matches were composed of three shortened one-minute rounds with thirty-second rest periods in between. Fighters wore protective gear used in gyms during normal everyday sparring training: 16 oz gloves (heavier and with more padding than competition gloves), shin guards, mouth guards, and groin protection for men. No outside audience was present except for trainers and gym members engaged in activities elsewhere in the facility. The participating fighters themselves served as the primary audience, actively cheering and encouraging greater intensity and boldness from their peers. This aspect of the fight differed from full-scale competition, where the audience is more diverse and numerous, and the volume of crowd noise is dramatically greater (the lower noise also facilitated data collection). Despite all these differences from full-contact competition, many factors normal to Muay Thai matches were present, including a referee, the ring space, the corners, a bell to signal the beginning and end of each round, and judges scoring rounds as well as the overall match. For many participants who trained regularly, including the fighter who is the focus of our case study, these matches were their first time competing at this level of intensity and under these conditions.

The development day contexts offered us excellent access as researchers to sports coaching. Authentic complex learning moments were directly observable and explicit due to the task distribution: coaches provided instructional feedback, and novice fighters attempted to implement their advice and training to outmanoeuvre their opponents. Without overwhelming crowd noise and with the explicit aim to teach the fighters, the setting was ideal to study how learning can occur in interaction, including in moment-to-moment details of adjustment, adaptation, and interaction.

Procedure

Data collection was conducted by the first and second authors, who jointly undertook digitally enhanced participant observation at the two events. Microethnographic

methods facilitate a low-disruption/high-yield approach to event analysis, seeking to generate data without interfering with normal behaviour and drawing opportunistically on resources available, like participant-generated video. 'Gym Wars' was an excellent setting because participants were eager to be videoed but also fully engaged in their first fights and thus unlikely to be distracted by video equipment.

Having two ethnographers on site enabled us to capture multiple perspectives on the same fight. At the first event, we piloted an observational method where, covering a corner each, we undertook close observation and took fieldnotes, including a few sample videos of the fights recorded on a GoPro Hero 8 positioned statically ringside. At the second event, we revised this approach, supplementing our observations with audio- and video-recordings of all fights: the head coaches of both corners agreed to be recorded with lapel microphones. For the most part, assistant coaches' voices were audible on the recordings, although we faced general challenges with noise contamination, especially in one corner. Video-recordings were made from one side of the ring, monitoring on-going events in the matches; video could be synchronised with the audio recordings later. We also collected video made by one coach, who recorded all fights on his smartphone. Thus, we ended up with a mosaic of overlapping information. In all, we generated fieldnotes from observations of about 30 fights, four and a half hours of coaching audio, and over 6 hours of action-dense video.

Following the events, all three authors did a full read through of the fieldnotes and discussions were held about strategies for data analysis. Based on these deliberations, the audio-files from both corners, supplemented by iterative engagement with the video-recordings, were coded using annotation nodes on types of coaching feedback (e.g., strategy, affirmational, diagnostic, executive) and instructional style (e.g., tone, gesture, and gaze) as well as attention to other ecological features like audience engagement and between-coach commentary. The nature of this analysis stage was exploratory, directed by our interest in understanding the dynamics of coach-fighter interactions and collaborations. From this process, we picked out a single case study that was particularly rich in interaction but not out of the ordinary; it represents common challenges that novices encounter during their first fights, and the interactions were clear from the video and audio sources.

The study was approved by the research ethics committee of Macquarie University. In accordance with this approval, participants were given pseudonyms, except for those who requested to be identified by their real names.

Microanalysis of live Muay Thai coaching

In the following four sub-sections, we present a sequential analysis of Muay Thai coaching, matching the progression of the action and the coaching interventions that we thought were especially illustrative of learning dynamics. The sequence makes the case easier to follow and demonstrates the unfolding of advice and implementation more clearly. Images and transcriptions are offered following the Jeffersonian notation system, with a few exceptions where that level of detail is not necessary or helpful to understand the case.[1]

We follow a novice fighter Emily's first fight. Throughout the fight Emily (E) was supported by her 'corner', a team of coaches positioned in one corner of the ring, in this case Andy (A), the head coach, and Noah (N), his assistant coach. Importantly, as will be apparent throughout the analysis, coaching in Muay Thai, like in boxing and mixed martial arts, fluctuates between the fighter's active rounds of fighting and the between-round rest periods. During breaks, coaching proceeds face-to-face and involves longer strategic or tactical inputs for the fighter to embed in the following round, while in-round coaching includes short and condensed instructions shouted in the imperative (e.g., 'kick, now!' or 'hands up') which the fighter will attempt to integrate on-the-fly while engaged in action. The combination of these two forms of coaching, where mistakes and challenges are explicitly pronounced and marked, makes learning points accessible to observation. The style of coaching, as we discuss further below, may appear less interactive than commandeering, especially from a critical coaching perspective that emphasises the limiting effect such approaches can have on athletes' capacity to learn. We highlight the coaches' instructional style as a typical behavioural facet of Muay Thai fighting that is more pronounced during competitions where actions are immediately acute, and the corner is also implicitly teaching the fighter to receive live feedback; novices often report not even hearing shouted instructions given the overwhelming sensory experience of a first fight. In this context, the high instructional load by the coach is also a feature of the fighter being a complete novice to ring fighting who may require more assistance, which we judge from observing changes to the head coach Andy's instructional behaviour when coaching more experienced fighters. With veteran fighters, in-round coaching was much less voluble, and between round coaching at times even turned dialogical between the athlete and the coach. We recognise the coach as an expert, the intervention as part of a longer interactional trajectory and facet of the learner's skill development, and analyse his behaviour as having an effect on the

learner because we could observe direct changes to her performance efficacy (see Figures 1 and 2). We found these successes amidst several hard-won and iterative attempts from the coach and athlete in a particularly challenging environment.

In the present case study, confronted with a more experienced and unfamiliar opponent from a neighbouring Muay Thai gym, Emily encountered challenges she had not faced previously. Her opponent was taller and deployed a defensive fight strategy, requiring Emily to change tactics during the match and better use the space of the ring, a forum she was in for the first time. In Muay Thai, like other combat sports, fighting an opponent with a longer reach means stepping into punches and kicks and thus requires gaining control over the tendency of an opponent with superior reach to retreat to avoid being struck. At the same time, having an adversary with greater reach retreat from contact is not a familiar experience in training, during which fighters typically stay in the same place. This situation requires a fighter with shorter reach to learn to cut off routes of escape and increase forward pressure.

The full match lasted approximately seven minutes. Figure 1 provides a visualisation of the complete fight with markers of key changes in performance outcomes across rounds. These performance changes, as we show in the microethnographic analysis below, were the outcome of expert coaching; they underscore our argument that the ecological dynamics of skill learning can be fruitfully analysed through enhanced ethnographic attention to practice.

Dividing space: 'inside' and 'outside'

During the first round, Emily could not make contact. She chased her opponent, Grace, around the ring, occasionally jabbing or kicking, but she was generally unsuccessful. Whenever Emily saw an opportunity to kick either her opponent's front leg or ribs, Grace blocked and successfully countered, or Emily missed entirely as her target stepped back smoothly out of reach. Emily's primary problem was the marked difference in height between the two fighters, which gave her taller opponent an anticipatory advantage; Grace was able to strike quicker, at longer range, and had more time to respond

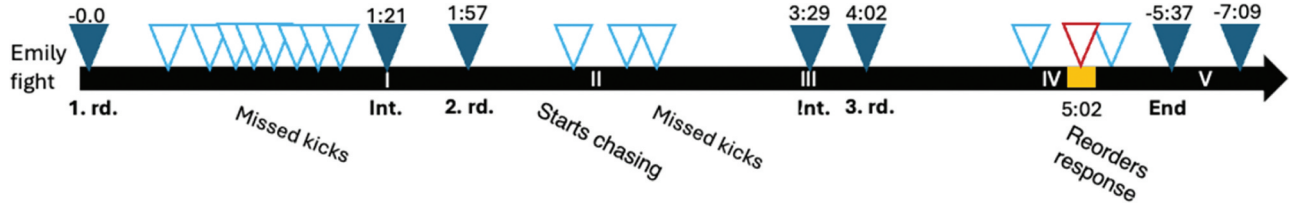


Figure 1. Timeline of Muay Thai coaching events and coach-induced changes to behaviour. The light blue markers represent data points where the novice fighter misses a roundhouse kick and the red marker signals a key transitional event. The numbers in white (I, II, III . . .) show the temporal placements of each transcript excerpt presented below. 'Int'. is short for interval and 'rd'. is short for round.

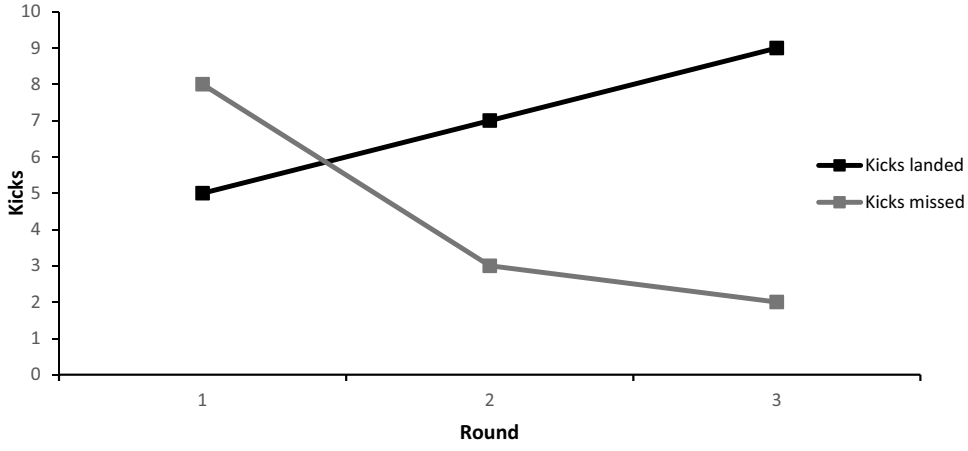


Figure 2. Development of performance efficacy. *Note*. A figure showing the evolution of Emily's actions measured from successfully landed and missed roundhouse kicks across rounds.

to attacks from the shorter fighter, who had to take an extra step or hop to close the distance.

In the first break between rounds, Andy talked to Emily about this problem (see Excerpt 1). Aware of the unfolding issue for his shorter-ranged fighter, Andy used his diagnostic skills, alerting Emily that, if she continued to initiate attacks from her *opponent's* striking distance, she would reliably lose each exchange. He emphasised: 'She's quite a bit taller than you (.) so you can't just throw: like (.) a kick and there' (line 1–2), and 'If you're on the outside (.) she is taller (.) so you can't just throw a kick she'll move away' (line 10–11). He advised her instead that her scoring opportunities were positioned 'inside', within her opponent's striking range. He suggested that Emily advance with her hands ('jab', 'body'), punching to close the distance, and then kicking ('follow up') once she was 'inside', within her own striking range. The tactical advice Andy gave her was common for shorter-ranged fighters: Emily needed to generate forward pressure, to close the distance with Grace to arrive inside her taller adversary's range. While explaining, Andy pantomimed the techniques with his hands. He did not sound rushed nor frustrated but instructed Emily calmly, fitting his message concisely into the thirty-second break.

In his instructions, the coach draws on categorisations of the interactional space common in Muay Thai and many sports fighting communities. In Muay Thai coaching, 'inside' and 'outside' describe the fighter's position relative to an opponent's reach. 'Inside' is the short-distanced relational space *within* an opponent's striking range, whereas 'outside' refers to the distance where

Excerpt 1 [01:31-01:55]

1	A:	So (.) hey:↑ (1.0) she's a quite a bit taller than you (.) so you can't just
2		throw: like (.) a kick here and there↑ (0.7)
3		The (.) combo that you did where you set it up and threw a ja::b down to the
4		body↑ (.) (((hand signals moves)) that's fuckin: s:pectacular
5		(0.5) but you gotta follow up after that (0.4) ((fighter nods her head up and
6		down)) cause that's your opportunity (.) cause you're already inside her range↓
7		(.) ((moves his hands back and forth)) ↑Got ↑it? (0.4) (((Andy nods his head
8		down staring intently at the fighter to confirm that she has understood the
9		meaning of his instruction; Emily nods her head up and down in agreement))
10		If you're on the outside (.) she is taller (.) so you can't just throw a kick
11		she'll move away↓ (0.6) So (.) you gotta throw↓ ((signals kicks with hands))
12	O:	GET [DOWN] clonk-clonk-clonk
13		((hammer taps sounding into the canvas))
14	A:	[Jab-]jab-jab↑-body↑ follow
15		up (.) ((mimics again the striking techniques with his hands))let's↑ go

Excerpt 1: first interval. A is Andy, the head coach, O is an official.

interaction occurs on the edge of an opponent's range. Each distance offers forms of interaction and must generate in the fighter a felt sense of both opportunity and vulnerability. In Emily's case, because of her reach disadvantage to Grace, staying 'outside' increased her vulnerability and limited her striking opportunities. In contrast, moving 'inside' would put Grace on the defensive and allow Emily to make contact. As this action requires slipping past an opponent's defence, enacting such a strategy increases a fighter's risk of getting hit, and can thus be mentally harder to execute. 'Strikeability', although the term was not used in this context, was inextricably linked to vulnerability in the actual setting of the fight sport: to be able to strike, Emily had to get close enough, which meant risking being hit.

In attending to the coach's instructions, we note how he uses several pedagogical tools, especially miming, repetition, and prosodically rich speech. Observing closely how the coach seeks to transmit his knowledge to the fighter reveals the significance of bodily interaction and joint attention in motor skill pedagogy and learning, even in this time meagre competitive environment. This multimodality is important because skill theories that appeal to learning as informational transfer or 'mind reading' can easily overlook the socio-bodily attunement involved in coaching instructions and their uptake. Equally, such instructional features may fail to be attributed much significance in experimental research designs given their evanescent and hard-to-measure qualities.

Every time the coach mentions a technique (e.g., line 3–4 & line 13–14) or a strategically important perceptual element like distancing (line 6–7), he offers a micro-gestural model of the references with his body. From fieldwork observations in Muay Thai gyms and across the coaching styles we observed at the development fight days, we know that this embodied form of instruction – using gestures that visually model techniques – is favoured amongst Muay Thai coaches especially during cornering. Several studies have found that such 'material anchors' convey more information than verbal instruction alone, even when movements are merely 'marked' and not performed in their entirety (Hutchins, 2005; Kirsh, 2011). The gestures function as an embodied-cognitive scaffold that visualises key strategic elements and actions. Andy's oral instructions and mimicry simulate efficiently and concisely the plan he devised. With his embodied model and his prior knowledge of appropriate distancing when contending against a taller opponent, he helps Emily tune her sense of distance to successfully land attacks and score points. This faciliates Emily's development of embodied knowledge – not abstract general knowledge *about* distances and strikeability, but rather an embodied understanding *of* how to respond and act as specific environmental constraints change (compare Sutton & McIlwain, 2015, pp. 99–100).

After laying out the strategy, Andy seeks confirmation from his fighter by emphasising vocally and interactionally that she has understood his instructions: he lowers his head and asks, 'Got it?' The fighter synchronises her head movement with her coach to confirm her uptake (line 7–9); even though she is breathing heavily, his slowed cadence and calm emphasis seems to get through to her. We see many gestural and affirmational coaching techniques repeated in different formats and scales throughout the case study and other bouts (see 3.3 and 3.4 below).

Gauging distance and generating forward pressure

In the second round both coaches increased the frequency and intensity of their feedback. Andy and Noah strongly encouraged Emily to step up her activity level and forward pressure. Whenever they recognised a chance for Emily to push in or thought she was too passive, they shouted urgently: 'forward, forward' 'follow her', 'come on (.) come on', 'Go forward go forward, non-stop', or 'Come on, -you gotta get in close'. They supplemented general instructions with reminders of the strategy: 'You gotta get inside, you gotta go forward!' and, 'When you're inside, you gotta send it out! [that is, strike]' In particular, 'inside' and 'forward' are both key concepts and admonitions to act. They are condensations or 'instructional nudges', highly condensed carriers of meaning that seek to reactivate the strategic advice Andy had offered between rounds (Sudnow, 2001; Sutton, 2007). In the frenetic activity of the round, the coach switches from an explanatory to an imperative rhetoric, seeking to cut through the sensory overload and noise of the fight with more emphatic, schematic advice. The crowd of fighters watching on the floor also shouted support: 'You got it, Emily', 'GO EM!'

As Emily pushed forward, however, her opponent used front thrusting kicks (called *teeps*) and leading hand punches (jabs), to keep Emily on her back foot, 'outside'. Emily walked forward slowly, chasing her opponent, who back peddled and danced out of Emily's range, punishing the shorter fighter as she approached too tentatively.

Excerpt 2 provides one example of the recurring interactions between Emily or 'Em' and her corner team.

Two key themes in the skill learning process are apparent. First, the intensity and timing of the instructions demonstrate how the coaches seek to attune the novice to the appropriate distancing; the point is not just to give her information but to help her perceive

moments of opportunity in the shifting relations between her body and her adversary. Her coaches give Emily immediate feedback when she is too far away and not effective and when she approaches the appropriate distance to strike.[2] Rather than being arbitrary commands that encourage aggression, coaches are, in fact, responding specifically to the situation and alerting the fighter to where she is in relative space ('You're too far away') as well as what she needs to do ('You gotta get inside', 'Go close', 'Forward') to ameliorate the differences between the fighters' opportunities, to make her less vulnerable and allow her to score. Their instructions increased in volume and intensity when Emily was finally 'inside', evoking the urgency of the opportunity ('GO! GO!' 'KICK!'). By shouting to Emily about her relative position, her coaches actively scaffold her bodily attunement to her opponent in real time, helping her to perceive the dynamic interactional space in terms of the range of opportunities to strike. Skill learning here is not immediately integrated; the process of attunement to another moving (and attacking) agent as a part of a novel performance ecology is complex.

Second, the interactions make clear that this form of embodied skill demands focused motivation. Though fatigue likely also confounded Emily's capacity to act on instructions, the fact she could increase her activity level in response to her coaches' encouragement suggests that fitness was not the only limit biasing her activity levels. The affective facets of the instruction (annoyance, frustration, excitement, affirmation) act on the fighter as prompts to add effort. The pattern suggests that motor skill learning in physically challenging environments may rely critically on social processes of affective scaffolding that are not just informational but motivational in nature. A study by (Wulf and Lewthwaite (2016), p. 1384) suggests that motivation, understood as 'energization' sparked by social and environmental influences, can 'initiate or alter the direction and intensity of ongoing behaviour'. The predominance of encouragement and affective support in the coaching transcripts, and the effect they appeared to have on Emily's behaviour (see Figure 2 demonstrating the changes to performance efficacy), both highlight the importance of such prompts to maintain the aggression necessary. Judging by prevalence, these prompts are one of the core ways coaches support fighters, especially novices who, in many fights we observed, repeatedly tended to decrease their activity as rounds wore on.

'Step right' – Integrating a novel perception-action pattern

Where the prior sections demonstrated performance challenges related to the dynamic inter-bodily space, in the third sequence the coach draws attention to another perceptual-tactical element, namely Emily's positioning and dynamic movements in relation to the ring space.

In recurrent loops described in the previous sections, we see how the coaches help the fighter to enact a new strategy to counter her opponent's evasiveness. As the fight progressed, when Emily started successfully pushing forward, Grace, with assistance from her corner, reacted by altering how she used the ring space strategically, circling around Emily by sidestepping to the left (Emily's right) away from her punches and kicks. Sidesteps in place of moving backwards prevented Emily from getting in front of Grace or catching and pushing her onto the ropes. Emily chased Grace in a straight line; Grace started to retreat in a circle. Emily's unschooled pursuit made clear that the novice did not know how to use the ring, especially the corners, to neutralise Grace's modified strategy. Instead, responding to Grace's blows occupied Emily's full attention, and she repeated her unsuccessful tactics. The resulting inefficient footrace, circling retreat pursued straight ahead, fatigued Emily; she gasped for air between exchanges. Emily had to corner Grace to limit her lateral movements, a technique she had not practiced. Emily had trained on the gym floor, where fighting couples are relatively static in group training and do not retreat from contact; in contrast, the ring can seem vast, dramatically *shifting the performance ecology and dynamics of fight interaction*.

Throughout the second round the coaches tried to help Emily solve the problem, signalling to Emily to kick whenever her opponent was about to slip laterally, but the novice fighter did not or could not respond. We interpret this absence of response as an information bandwidth issue common to novice fighters, especially in their first couple of fights. Coaches, like Andy, with many years of coaching and first-hand fight experience are highly aware of the perceptual challenges learners face while engaged in fighting. All novices that Hjortborg talked to during development fight days consistently testified post-fight to not having heard much during the active parts of the fight, despite coaches and team members shouting audible and clear instructions to them at a proximal distance to the ring. Experts, including Andy, would typically recount the same experiential vacuum when reflecting on their early days of fighting. These experiences may be explained by cognitive-motor studies that have found a higher 'dual-task cost' (a reduction in cognitive-attentional resources) when a motor task is both high in difficulty and unrehearsed (Schaefer, 2014). Novices who are allocating attention to predict their opponent's

Excerpt 2 [02:37-02:55]

1	A:	Forward↑ (.) can't sit on the backfoot Em (.) Go-forward go-forward non↑-
2		stop (0.5)
3	R:	Emily is walking forward hesitantly leaning on her back-foot, she throws
4		towards the opponent's front leg, but is not making contact
5		Come on: (.) forward-forward (0.8) come on: (0.5) come on: (0.5)
6	N:	Gotta go in::↑ [gotta come in]
7	R:	Emily throws a kick and misses
8	A:	[You're too far away: (.) Come on you
9		gotta get in close]
10	N:	Yeah yeah follow↑ up↑ (.) follow↑ (.) follow↑-follow↑
11	A:	Go CLOSE! ((sounds frustrated))
12	A:	GO! GO! ((sounds urgent))
13	R:	Emily manages to slide past the opponent's defence, now positioned on the
14		'inside'
15	N:	[Kick-kick-kick-kick-kick]
16	E:	Emily lands a kick
17	A:	EYY:↑ ((timed with Emily landing a kick))
18	S1:	[KICK! One-two (.) one-two]
19	N:	[FOLLOW UP FOLLOW UP with the punches] [Kick-kick-]
20	S2:	[↑GO ↑EM]
21	N:	kick-kick-kick
22	R:	Emily follows up with a punch; the opponent is swiftly circling away

Line 1: Forward

Line 9: Misses kick

Line 14-15: Emily slides past defence

Excerpt 2: gauging distance. R is the ring actions, S1 and S2 are two different audience members whose voices came through clearly in the audiofiles.

behaviour and control their own bodies while under extreme physical duress, are both motorically and cognitively challenged and may not be able to spare much attention to a coach's instructions. The coaches voluble shouting and high use of repetition are a response to the novice's perceptual limitations.

During the second break, Andy explained to Emily (see Excerpt 3):

Andy made circling motions with his hand to illustrate the lateral movements. 'If she steps to the right, you gotta box her in like this', he explained while moving his hands sideways, signalling how Emily could intercept by kicking from the right, demonstrating the tactical procedure needed to corral her opponent.

In the brief interval between rounds, Andy introduced another perceptual-tactical element to his fighter: arriving 'inside' her opponent required Emily to manipulate their geometric relationship within the ring. To stop the ongoing chase, Emily had to stop following and instead *steer* the interaction to cut off Grace's opportunity to move sideways. *Emily had to perceive a more complex relationship of their positions in the ring to better limit her adversary's decision-*

Excerpt 3 [03:35-4:00]

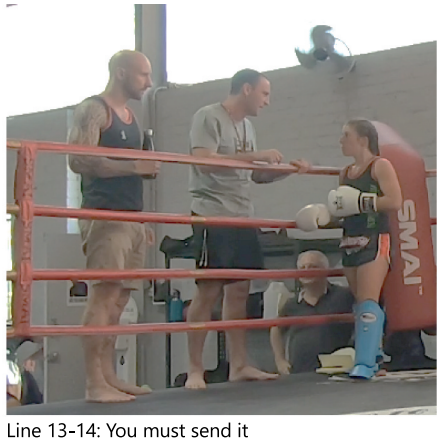
A: Sh-she (.) she is running wraps-laps ((corrective)) around↑ you↑ ((draws a circle with his index finger)) (0.7) She is circling around as you go forward ((draws another circle with his finger and puts his hands in parallel)) (.) you gotta box her in (0.5) okay↑ (0.6) ((moves hands held parallel, laterally from side to side)) Yeah:↑ (0.4) She is too far away from you for you to just throw a single kick ((mimics a kick with his right hand)) (0.5) you gotta go forward↑ (.) and you gotta push on her↑ (.) otherwise she is just gonna keep moving around and running around like this ((draws a long circle with his thumb and index finger))(0.5) if she steps to the right ((makes succinct gesture with his right hand towards the right)) you gotta box her in like this↑ ((moves his hands in parallel from side to side)) (0.5) keep her there and you must send it ((heavy emphasis)) (.)

O: clonk-clonk-[clonk] ((hammer taps sounding into the canvas))

A: [you gotta] be the last ((mimics more kicks))(0.5) so if a kick comes ((mimics kick with swift hand gesture)) (.) you gotta send another one back (.) okay:↑ (.) let's go bud ((pads her twice on the shoulder))


Line 3: She is circling around you


Line 5: You gotta box her in


Line 13-14: You must send it

Excerpt 3: second interval coaching.

making and options. As this was her first time fighting in a ring, the problem and tactics for fixing it were completely new to Emily, but they were one reason an event like Gym Wars was so valuable for learning.

During the next (and last) round of the match, the coaches attempted to help Emily implement these tactics. From the opening bell of the third round, Emily chased Grace, jabbing and throwing right kicks to keep pressure on her. Meanwhile, her opponent tried to keep Emily at a distance, moving backwards and around Emily, using *teeps* (front push kicks) and jabs to keep her back. Emily still left space for Grace to slip out and circle. Emily was starting to gasp for air and struggled to keep up the pressure. When the fighters again reached a standstill, Andy started waving with his hands and yelling to Emily to position herself more strategically in the ring (see Excerpt 4).

After the round and surges of emphatic commands from the corner, the coaches sounded satisfied and were laughing. Both coaching teams had been shouting, and the training hall was bursting with excitement, cheers, and appreciative outcries. Although the judges had yet to reveal their scores for the rounds, the coaches and spectators seemed unanimous in acknowledging a profound shift of momentum in the third and final round. With her coaches' persistent support, Emily had found her range and managed to corner and immobilise her opponent several times. Noah said conclusively with a smile, still laughing, to Andy: '*That's* better'. Emily returned to her corner after the bell rang, and the referee separated the two fighters. She had to ask whether the fight was over: 'Am I done?' Andy replied: 'That's it, yep, that's it'.

Consolidating knowledge

After the fight, Andy followed up with Emily and elaborated on his instructions from the fight (see Excerpt 5). Using a combination of modelling and verbal explanation, Andy summarised the key strategic principles that he attempted to make salient for Emily during the fight, this time having the ring and his entire body at his disposal, to model the opponent's movements in the space, an effect also of having more time at his disposal. While explaining the core concepts for understanding strikeability relative to a fighter's ring movements and reach, Andy showed schematically how the opponent could retreat backwards along the ropes (line 5–8) in response to her forward movement. Holding out his left arm next to Emily's head he then demonstrated where her dynamic area of opportunity was located when facing a taller opponent, on the 'inside' and past the opponent's maximum punching range (Excerpt 5, lines 8–10), neatly summarising the core learning points from the development fight. He sought to consolidate the lesson for the fighter. This practice affords the learner opportunities to attune future actions with increasing knowledge of potential challenges in the performance landscape, empowering the learner to self-regulate within a new set of perceptual constraints (Woods et al., 2020).

Emily's increasing success accomplished with the strategies suggested by her corner was measurable from performance outcomes that we observed across rounds (see Figure 2). The number of roundhouse kicks she landed, the dynamic technique that was causing most challenges for the fighter, improved over rounds, while the frequency of missed roundhouse kicks decreased. These observations were also confirmed by the judges' scores, which were communicated after the fight: Emily had lost the first two rounds and won the last. The fight provided a forum that could generate a *transformative bodily experience for the fighter, with the coach scaffolding her experience during the match, providing meaningful diagnostic structures and perceptual-action cues for her in a chaotic environment, but also reinforcing the lessons when the action was over*. Over time these structures may become more readily apparent to her through her own lived embodiment.

Discussion: Dynamic skill learning in an authentic environment

Many activities, like sports, require that a novice develop skills in context. For aspiring Muay Thai fighters, punching and kicking are not isolated bodily movements but also require complex allied abilities like simultaneously defending themselves, managing the ring space, and changing tactics against differently sized fighters, constellations of skills that are difficult to realistically simulate in normal gym exercises. Although learning designs can be tweaked to support the complex nature of competitive sports fighting (see for example Yearby et al, 2024), standard gym workouts that also respond to limitations in resources like gym space, coaching, and time with appropriate sparring partners, often do not fully simulate the *authentic conditions of sports fighting*, especially the extreme physical and psychological stress, noise, and getting struck at full power while trying to execute techniques.

Combat sports like Muay Thai, contested in a small space, differ from many sports, however, because coaches are so close to athletes. From the corner of the ring and between rounds, they can meaningfully collaborate with their fighters, shout advice, and supplement

Excerpt 4 [04:56-5:10]

S: Kick-back-kick-back-[kick-back] ((background noise and cheering has substantially increased in volume))
A: [Step RIGHT step RIGHT]
R: The opponent moves laterally out of the corner; Emily kicks and lands on her as she slides right.
A: EYY:! ((affirming the landed kick))
Step↓ (.) she is circling you again (.) come ON↑ ((Andy starts waving his hand vehemently left to right, signalling Emily to move to the right))
R: Emily takes two side steps, changing the angle to her opponent in relation to the ring corner.
A: That's it↑ ((affirmational))
R: Grace moves in to kick but misses and lands awkwardly. She takes a moment to regain her balance. Emily has moved her left knee up in response to the kick but creates a wider gap to the opponent.
A: Go↑ GO↑, FORWARD NOW!!!
N: Forward-forward
S: [KICK-BACK!]
R: Emily hurriedly shuffles forward; Grace attempts a front-thrusting kick ('teep' but misses, enabling Emily to make contact with a hand strike to the opponent's face.
A: GO GO! KICK! ((Andy signals kicking moves with his hand))
N: KICK-KICK-KICK!
S: ((Lots of crowd noise))
R: Emily continues to move forward aggressively, now pushing Grace onto the ropes. She releases a kick to the opponent's midsection.
A: EYY:! GO AGAIN:!
R: Grace responds back with a kick, which Emily catches, and they get stuck in a clinch.

Line 7: Step right

Line 12: That's it

Excerpt 4: integrating a novel perception-action pattern.

Excerpt 5 [06:28-07:07]

A: ((Nods head)) Get it↑ (0.8) Understand↑
E: Yeah:↓hhh
A: You just got like (0.4) I just want to punch on
E: [Yeah::↓ heh heh]
[and you were like in there] (.) So (0.4) ↑here she can do every time you step forward (.) she can just (.) do this (1.0)
R: Andy walks backwards following along the ropes, while jabbing with his front hand))
A: So (.) your opportunity is when you're in (.) here↑, (0.7)
R: Andy holds his left arm out next to Emily's head, demonstrating the ideal positioning for her, on the 'inside' and past the opponent's maximum punching range
A: Because you can't (0.7) so you know how you were finding (.) success with the punches:↑ (0.7) all that needed to come after that was a big kick or a knee↓ (0.5) ((mimics kick with his hand to his own rib area)) cause even though she is blocking ↑here
R: Andy moves his arms into a closed guard protecting his face (0.4)
A: It allows you to get into this space ((moves his hand back and forward pointing to the area around his chest)) (0.9)
A: If it's back out there↑ (0.7) ((signals Emily to move further back from him)) then if you kick (.) then (.) ((mimics a swift dodge with his upper body)) she just [moves away]
E: [It's a miss] ((Emily kicks into the air) [yeah↓] ((nods her head up and down))
A: [↑Yeah::] ↑man (.) that's all it was (.) ((Encouraging tone)) that last round was s:ick (0.4) that's what you needed to do ((pushes down middle rope down to help Emily out of the ring))

Line 6-8: Andy modelling the opponent's movements


Line 9: Your opportunity is 'here'

Excerpt 5: Post-fight coaching and knowledge consolidation.

the fighters' skill with their own observations and advice. The close support in an event like Gym Wars, where fighters develop new skills, makes the situation similar to learning environments described by psychologist Lev Vygotsky (1978). Vygotsky focussed on how new skills often develop first in social interactions. According to this theory, a novice's efforts are supplemented by a teacher who coaches them in their 'zone of proximal development', with tasks that lie just beyond individual ability to extend the range of their capacities (Shotter, 1989; Vygotsky, 1978; Wass & Golding, 2014). For novice fighters like Emily, performing these proximal skills is especially difficult given the strenuous context, integrating techniques *against* a struggling opponent, managing relative striking distance, and developing strategies tailored for a specific opponent's idiosyncrasies, like navigating ring geometry and an adversary's movement. With so many facets of the skill being tested simultaneously, and so much stress applied to the novice fighter, coaches must quickly diagnose problems and suggest strategies they believe are within the novice's capacities, taking into consideration their fatigue, sensory overload, and skillset. A simple technique like stepping sideways and kicking, useful to corralling an adversary, is much more difficult to implement in a fight than in training; even knowing when to execute the combination is a challenge that might lie beyond a fighter's capacities. Having a coach cue the action provides direct support to the fighter's activity, taking on crucial parts of the task and supplementing the fighter's timing, perceptions, motivations, and 'fight sense'. In addition, the affective way that instructions were shouted may offer advantages to the fighter's capacity to alter and persist with the recommended strategy (Wulf & Lewthwaite, 2016).

In this sense, the coach and fighter together are a kind of collaborating system, in which the fighter's abilities are 'extended', to use a term from cognitive science (Menary, 2010; see also Orth et al., 2019), by the coach's presence, perception, strategic understanding, and even knowledge of timing and tactics inserted into a kind of socially extended fighting ability. In the case study, for example, we see how Andy tries to teach Emily about relative body distance, when she is 'outside' or 'inside' of an adversary's reach relative to her own range. Between rounds, he explains the concept; during the action, he actively supplements her perceptions of range and motivates her to implement tactics in which an awareness of relative distance is embedded. After the fight, he helps her consolidate the lesson, battling fatigue and excitement as possible distractions so that she will better function in this proximal area of skill on her own in the future.

To return to Hristovski et al. (2006) paper on 'strikeability', examining a case study like Emily's of fighting in ecologically authentic settings rather than in controlled experimental conditions reveals that additional factors influence and are inextricably linked with 'strikeability' in a more open action environment. Crucial for Emily were not just her body proportions and the distance to her target – factors equally critical for strikeability – but also the reach of her adversary and the challenges of keeping herself at an optimal distance given her target's retreating. In this situation, getting within 'strikeable' range and keeping a target at distance were fundamental preconditions of the complex composite skill of Muay Thai striking.

In the authentic ring environment, learning and recognising strikeability is enmeshed with other skills and considerations, including tactics for defence and creating opportunities, the need to maintain aggression, predictions of what an adversary might do, and the identification of temporal windows of opportunity. Our findings suggest, preliminarily, that novices first need to learn to gauge appropriate distancing-*moments* to their opponents – in other words *timing*— especially when the opponent moves and has their own range and offensive capabilities. This aspect of the skill is one that coaches in the novices' corners explicitly supported most strenuously, not just shouting because of urgency, but because, in their expert opinion, their fighter had a specific affordance in the shifting landscape of opportunities between the two combatants.

From a close analysis of actual coaching interventions, and the sequence of advice in cases like Emily's, where coaches supported fighters' moment-to-moment acquisition of more advanced tactics and skills, we propose that there are at least five functions for these types of assistance. In each case, expert coaching identifies a zone of proximal improvement or transformation, an incremental change that an athlete can make that, although modest, will have tangible effects for a fighter (see Table I). We follow the sequence that arises in our case study of Emily although we suspect that this sequence may not be immutable.

In diagnosis, a coach seeks to help a fighter, who may be overwhelmed by the sensory experience of the fight, to understand what is happening and why their techniques might or might not be successful. The coach, either on the spot or from a pre-existing repertoire, chooses a strategy, sometimes making that strategy explicit or condensing it into core concepts (like 'getting inside'), or using forms like embodied mimicry or other tools to pass

Table I. Zones of proximal transformation.

Coaching phases	Description	Examples
1. Diagnosis	Identifying a patterned issue	Dealing with a taller opponent and initiating attacks from the opponent's striking range means that the fighter is not landing her kicks (Rounds 1–2) Walking forward in a straight line against a retreating and circling opponent means that the fighter cannot close distance (Rounds 2–3)
2. Strategy	Devising a strategy that combats the diagnosed challenge	Generating forward pressure and initiating kicks from 'inside' the opponent's range (Rounds 1–2) When she steps to the right, box her in. (Rounds 2–3)
3. Implementation	Real time action support; aiding the fighter to identify the moments ripe for action implementation	'Forward forward' 'Gotta get inside' and 'Step right – she's circling you again'
4. Affirmation	Affirmingsuccessful implementation (this could also be feedback that notifies the fighter of unsuccessful attempts)	'Eyy' (affirming landed kick), 'that's it' and general cheering from the audience
5. Consolidation	Reiteration and reinforcement of key learning points	Opportunities on the 'outside' versus opportunities on the 'inside' against a taller and retreating opponent

it to the fighter. In addition, while in action, coaches often cue when to implement strategies, identifying windows of opportunity to enact a strategy in the flow of action. With novice fighters, we repeatedly saw examples of strong affirmation, including from audiences as well as coaches, helping novice athletes to identify when a strategy had been successful. Finally, as Andy sought to do after Emily's fight was over, coaching can seek to help a learner consolidate lessons, reinforcing their development into the proximal level of skillfulness, trying to make the improved technique more accessible in subsequent fights.

We emphasise that the observations leading us to these findings are based in ethnographic knowledge and engagement with the field sites. Our analysis arises from genuine curiosity about how Muay Thai coaches deploy their own embodied expertise in collaboration with athletes to improve their skill. We do not take a proscriptive stance on best practice including offering directories of appropriate levels of chatter, forms of instructions, or the timing of when it is offered. Real skill learning environments, like the present case study, are mired in traditions and everyday constraints, and do not necessarily represent the most ideal learning forum for novices nor offer the most direct pathway to expertise. We highlight Andy's instructional behaviour because we could observe the effectiveness of his coaching in his fighter's improved capacity to solve the task ahead. However, our analysis cannot causally confirm the specific features that induced the observed changes, including the efficacy (or redundancy) of the frequency, intensity, and instructional style of the coaches' instructions. Some researchers on coaching and physical education caution that overly coach-centred instructional styles can be domineering, using overt direction which might diminish learners' autonomy and ability to reflect on their own performance; researchers like Cope et al. (2016) encourage a more dialogic approach to coaching to engage athletes in discussion. The context of corner coaching in Muay Thai, especially the sensory challenges, difficulties in communication, and urgent collaboration in determining timing in an arduous activity may be a context where directive or one-way communication not only is the only modality possible, but may have advantages for coach-fighter collaboration.

Doing post-event interviews with the fighters to understand their experiences and perceptions of their coaches' instructions could have helped refine our findings. Future studies examining coach–athlete interactions could combine microethnographic observations with athlete reports to better understand how coaches' instructions effect learner-athletes during live competitions. In a more controlled experimental setting, studies could also examine learners' experiences and performance outputs against different modes of coaching (e.g., more and less voluble) to better determine optimal levels of coaching intervention during fights. Equally, a stricter investigation of the timing of the coach's reinforcement of key learning points from the fight, that we describe in coaching phase 5, could offer greater certainty about the degree to which this moment, immediately post-fight, is productive for facilitating knowledge consolidation or if the same problems with sensory overwhelm or communication bandwidth still undermine learners' consolidation of key lessons and skill development. Based on our observations, a final point that could be useful for Muay Thai and other combat sports coaches, is to integrate more training hours in the ring (or the relevant competition space) to support the transition from general training to an authentic competition environment (see Yearby, Myszka, Grahn, et al., 2024 for a specific treatment of combat sports training design).

Conclusion

In a dynamic activity like fighting, skill requires figuring out how, at what point in time, and where in space to perform an action, as well as having the motivation and

capacity to do so. At the same time, in a setting like a developmental fight event, different forms of knowledge – a fighter's emergent embodied understanding and her coaches' multifaceted understanding of fight dynamics – are enmeshed in their collaboration to solve problems that the fighter faces. The fighter and the coach form a system together that is both *distributed* and *developmental*, that is, each one contributes different capacities to a joint performance (even though only one is inside the ring): while the coach, intentionally pedagogical, seeks to encourage greater skill and autonomous ability in the fighter, the fighter strives to integrate the coach's advice and embodied knowledge in the moment and on a longer developmental timeframe.

In this paper, we have shown how a novice, with the continuous support of her coach, manages to gradually attune to a new set of technical principles in fighting during an authentic training bout and overcomes the distinct challenges posed by her opponent. Through close ethnographic observation, we observed how the coach used a range of skilled interventions to aid the fighter to break from an unproductive pattern to implement a more effective strategy, and how he subsequently sought to refine the athlete's ability, consolidating what she learned to eventually be able to embody these skillsets for herself. We saw how the coaches skilfully and empathetically instructed the fighter, during the flow of action, to restructure her actions and attune to new domain-relevant features in the context of the match. Inspired by Vygotskian theory we conceptualised these stages of coach–fighter interaction as five zones of proximal transformation: diagnosis, strategy, implementation, affirmation, and consolidation. Our microethnographic analysis allowed us to observe and demonstrate the real-time dynamics of how these coaching supports enabled the fighter to tune her skills, improvements that we could trace through a measured increase in successful roundhouse kicks across rounds as well as in decline in missed kicks.

Greater attention to the actual occurrences of real-world performance environments in sports draws our analysis to the concrete ways in which social supports, like coaching, are enablers of skill. The closer we attend to the activities of coaches, the more we recognise the distinctive forms of intelligence, tailored advice, and support provided to help novices achieve in the moment, but also to develop over time. Unlike a practice setting, which Hristovski et al. (2006, p. 72) counselled should be, 'less loaded with verbal instructions from the coach to impose decisions', in the training fight, skilful verbal intervention assisted the fighter to perceive opportunities, choose an effective strategy, realise when a tactic was effective, and maintain motivation in pursuit of the strategy. Coaching expertise in this setting includes this acutely perceptive capacity for diagnosis and wisdom about how to intervene efficiently and strategically, even in moment-to-moment activities, for a fighter to operate in the zone of proximal skill development. Although the instructions may appear rudimentary and repetitive to someone not engaged in a fight, we suspect that the style of in-fight instruction and encouragement are finely tuned to the perceptual limits of fighters, or we would not see the same pattern recur across multiple, highly successful coaches.

We emphasise the utility of intense field-based observations, like microethnography, to supplement other approaches to inform sports science and performance; the method facilitates close study of a wider field of interconnected parts that enmesh and influence performance outside controlled environments. When we engage in close analysis of coaching in realistic environments, we find a wide variety of ways that coaches, peers, and observers influence, support, and even participate in sports, even individual sports like Muay Thai. Observing practices outside the laboratory, in the gyms and playing fields where they are learned and refined, can help us to precisely describe this ecological scale and move us away from understanding skill in overly simplistic ways.

Notes

1. Transcription conventions adapted from Jefferson (2004): [] Brackets indicate the start and end points of overlapping speech. (.) Micropause, indicates 0.2 seconds or less elapsed time. (x.x) Numbers in parenthesis indicate elapsed time in tenth of seconds. (()) Double parenthesis contains non-verbal activity. ↑Up arrow is used for rising pitch. ↓Down arrow is used for falling pitch. ::: Colon(s) indicate the prolongation of an utterance. ALL CAPS indicate shouted or increased volume speech. ___ Underscoring indicates stressing., Comma indicates the break and subsequent continuation of a single interrupted utterance. Hhh Exhalation sound signals audible out-breath.
2. It may seem rudimentary to a lay audience that a fighter cannot land a kick. But this common problem is typically solved by Muay Thai fighters through feints (to conceal an attack), or well-timed attacks (e.g., when the opponent is walking forward and will be vulnerable), adding pressure, and cutting off space. In addition, many fighters also use cue points to check their distance before attempting a kick; if one is close enough to touch an opponent's guard with the glove on an out-stretched arm, the distance is correct.

   Self-diagnostics, like understanding why a kick is not making contact or even realising that it is not, can be difficult during competition, especially for novices; fighters often rely on their coaches' external vision to

recognise recurring problems as well as highlight when techniques are working. Knowing even whether one is succeeding or failing can be difficult given the extreme duress and overwhelming sensory experience of a match.

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Data availability statement

Raw data outside of the transcripts provided are not publicly available to preserve individuals' privacy under the Australian National Statement on Ethical Conduct in Human Research (2023).

Compliance with ethical standards

Verbal and written informed consent were obtained from participants after receiving a detailed explanation of the project. Ethical approval was granted through Macquarie University's Human Sciences Ethics Subcommittee (Reference No.: 5201952668931).

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