

Integrative self-regulation model for sport and exercise: Theory and implications for comprehensive training

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ABSTRACT

Self-regulation is essential in sport and exercise, enabling athletes to manage emotions, motivation, and performance under pressure. However, research remains fragmented, often isolating aspects such as self-control, coping, and emotion regulation without integrating them into a cohesive framework. This paper introduces the Integrative Self-Regulation Model for Sport and Exercise, which unifies these processes to provide a structured yet adaptable approach to self-regulation training. The model consists of four core components: self-awareness and motivation for change, strategy selection, self-regulatory behaviours, and mental control, emphasizing the ability to regulate self-regulation by continuously monitoring and refining strategies. Despite its importance, self-regulation is prone to failure. Excessive self-awareness can lead to over-analysis and negative self-judgment, poor strategy selection may result in maladaptive coping, and overuse of mental control can cause cognitive fatigue. These pitfalls highlight the need for systematic training to develop adaptive, flexible, and context-sensitive strategies. To bridge theory and practice, the article presents a comprehensive checklist for self-regulation training and suggests evidence-based methods aligned with different aspects of the model. It offers a conceptual framework for studying self-regulation in sport and exercise, guiding both research and applied interventions to optimize performance and well-being.

1. Introduction

Self-regulation is fundamental in sport and exercise, enabling athletes to manage emotions, motivation, and performance at various levels of practice. It is not just an outcome of expertise but a mechanism that drives it (Vealey, 2024). Without effective self-regulation, athletes risk inconsistent performance, difficulties in maintaining exercise routines, poor stress management, and burnout (Nicholls et al., 2016; Sakalidis et al., 2021).

Self-regulation can be defined as a goal-directed, adaptive process that enables individuals to plan, monitor, and adjust their emotions, thoughts, and behaviours to achieve desired outcomes (Inzlicht et al., 2021). It involves not only setting and striving toward goals but also protecting them from distractions, modifying strategies as needed, and sometimes even abandoning goals when necessary. These regulatory processes influence a wide range of behaviours, from sustaining motivation in exercise to managing emotional and cognitive states under pressure. Given its cross-disciplinary relevance in psychology, self-regulation has been studied from multiple perspectives. However,

progress has been hindered by fragmentation, with different models emphasizing distinct mechanisms rather than offering an integrated framework (Inzlicht et al., 2021).

Some theories focus on goal pursuit, describing how individuals compare their current state to a desired outcome and adjust accordingly (Carver & Scheier, 1998; Kruglanski et al., 2002). Others highlight cognitive control, differentiating between impulsive and deliberate regulation (Hofmann et al., 2009) or exploring how self-control depletes over time (Baumeister et al., 2018). Meanwhile, personality-based models emphasize stable individual differences in self-regulatory tendencies (Roberts et al., 2014). Although these perspectives offer valuable insights, their lack of integration limits our understanding of self-regulation as a dynamic, adaptive system. This limitation becomes particularly critical in sport and exercise, where athletes must regulate actions under physical exhaustion, intense pressure, and rapidly changing conditions.

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1.1. Self-regulation theories in sport and exercise psychology

While general self-regulation theories provide a foundation, sport and exercise introduce unique demands—such as high-stakes decision-making, rapid action execution, and dynamic emotional regulation—that require tailored adaptations (Nicholls & Polman, 2007). In sport and exercise psychology, some models focus on reactive coping, helping athletes manage stress in the moment, while others emphasize proactive regulation, enabling them to optimize performance in advance. Together, these approaches contribute to a layered understanding of how athletes adapt to the complex demands of their environment.

At the reactive end of the spectrum, Lazarus' (2000) transactional model of stress and coping conceptualizes coping as an adaptive, situation-dependent process rather than a fixed trait. Athletes assess stressors, select coping strategies, and adjust their responses based on effectiveness. While essential for handling challenges, coping primarily addresses stress as it arises, rather than proactively enhancing performance (Nicholls et al., 2016). Beyond coping, self-regulated learning provides a proactive approach to self-regulation. McCardle et al. (2019) adapted Zimmerman's (2002) self-regulated learning model to sport and exercise, showing how athletes plan, monitor, and refine their training and competition strategies. A key mechanism in this process is metacognition—the ability to reflect on and adjust cognitive strategies to improve performance (de Bruin, 2019). Unlike coping, which is largely reactive, self-regulated learning equips athletes to anticipate challenges and systematically develop their skills over time.

Emotion regulation plays a role in both proactive and reactive self-regulation. Gross' (1998) process model of emotion regulation, applied to sport among others by Beatty and Janelle (2020), categorizes strategies as antecedent-focused (preventing emotions before they arise) or response-focused (modifying emotions after activation). Tamminen et al. (2021) highlight that emotion regulation is critical for optimizing performance, operating at both an individual level (intrapersonal regulation) and a team level (interpersonal regulation). Managing emotions effectively allows athletes to maintain composure under pressure, enhancing both decision-making and execution (McCormick et al., 2019). While emotion regulation helps manage affective states, self-control operates as a regulatory safeguard, allowing them to resist impulses and distractions in high-pressure situations (Baumeister et al., 1994; Kotabe & Hofmann, 2015). It is particularly relevant when resisting temptations (e.g., deviating from a game plan) or overcoming fatigue (e.g., maintaining pace in endurance events) (Milyavskaya et al., 2019). Unlike broader self-regulation, which combines proactive planning and reactive adjustments, self-control is narrowly inhibitory, requiring immediate impulse resistance to protect long-term goals.

In contrast to these theoretical perspectives, mental skills training focuses on developing self-regulation as a trainable skillset rather than explaining its underlying mechanisms. Vealey's (2024) mental skills training framework provides a developmental approach, categorizing psychological skills into four key areas: personal foundation, performance, personal development, and team skills. Unlike models that focus primarily on emotion regulation or coping, mental skills training emphasizes deliberate psychological skill development, structured training, and long-term adaptability. However, despite the wide range of models addressing different aspects of self-regulation, no single framework currently unifies these perspectives into a dynamic, adaptable system for athletes. This gap in the literature underscores the need for a more comprehensive model that unifies reactive and proactive strategies within a dynamic, adaptable structure.

1.2. Rationale and objectives

Self-regulation research is fragmented, with models focusing on isolated mechanisms—goal monitoring, self-control, or emotion regulation—rather than treating them as interconnected processes (Inzlicht

et al., 2021). Recognizing this issue, researchers have begun integrating elements across different traditions (e.g., Achtziger & Gollwitzer, 2018; Frieze et al., 2024; Inzlicht et al., 2021). For example, Frieze et al. (2024) propose the concept of self-regulatory flexibility by drawing from self-control, emotion regulation, and coping literatures, and combining diverse theoretical models to explain how adaptive regulation depends on matching strategies to situational demands. These works are a testament to the importance of integrated models and exemplify how combining aspects from different perspectives enriches our understanding about self-regulation. Nevertheless, a model specifically tailored to the sport and exercise context is still missing—despite self-regulation being a foundational concept in these domains (Vealey, 2024).

Accordingly, the present work introduces the Integrative Self-Regulation Model for Sport and Exercise, a unified framework that bridges fragmented theories and enhances self-regulation training in sport and exercise settings. In this model, self-regulation is viewed as an in-the-moment process of managing internal challenges—such as calming anxiety before a penalty kick. This perspective aligns with dominant views in the emotion regulation (Gross, 2015) and coping (Nicholls et al., 2016) literature, differing from broader behaviour change models (Achtziger & Gollwitzer, 2018; Zimmerman, 2002), where self-regulation is embedded within extended processes like adopting exercise routines or self-regulated learning of a skateboarding trick. By integrating insights from both general and sport psychology, the model offers a dynamic, practical, and evidence-based approach to optimizing athletic performance, resilience, and adaptability. Beyond sport and exercise, it equips athletes with transferable self-regulation skills applicable in broader personal and professional contexts.

2. The integrative self-regulation model for sport and exercise

2.1. Basic outline of the model

The Integrative Self-Regulation Model for Sport and Exercise follows a structured process that begins with self-awareness and motivation for change, progresses through strategy selection, and engages two primary regulatory mechanisms: self-regulatory behaviours and mental control (Fig. 1). The upper part of the model presents the three main phases of the self-regulation process—monitoring, planning, and execution—and highlights its dynamic nature. Rather than following a fixed sequence, self-regulation is portrayed as an adaptive process that allows individuals to continuously adjust their strategies in response to experience and changing demands. The lower part of the model outlines the specific components involved in self-regulation, each of which is introduced here and discussed in greater detail in the following sections of the manuscript.

Self-awareness and motivation for change form the foundation of self-regulation. This phase involves recognizing one's emotional, cognitive, or behavioural state and understanding its impact on performance. Motivation for change ensures that self-awareness translates into action by fostering a commitment to improvement, making it a necessary precursor to effective self-regulation. Once individuals commit to self-regulation, they engage in *strategy selection*—identifying and applying self-regulation techniques based on situational demands, personal preferences, and past experiences.

These strategies result in two primary regulatory processes: *self-regulatory behaviours*, which involve actions directed at managing internal states through external means (e.g., movement, sensory stimulation, or environmental interaction), and *mental control*, which involves internal self-regulation techniques (e.g., self-talk, imagery, relaxation). While self-regulatory behaviours use behavioural strategies—such as taking a walk, drinking a cup of coffee, or seeking social interaction—to influence one's internal state, mental control relies on neurophysiological processes predominantly in the prefrontal cortex to regulate aspects like emotions and thoughts for the benefit of enjoyment and performance.

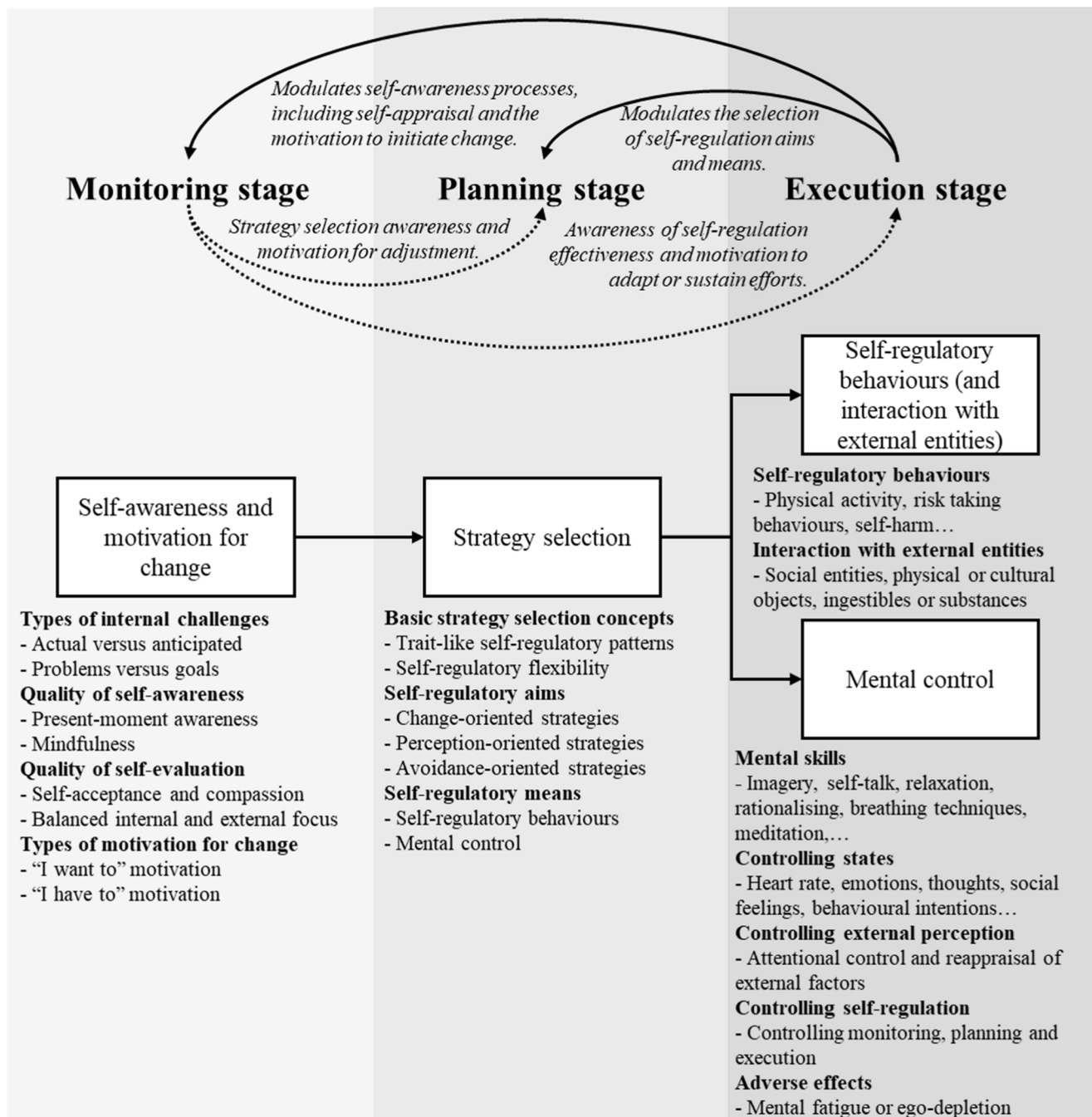


Fig. 1. The integrative self-regulation model for sport and exercise.

Although these processes function independently, they can also complement each other; for example, individuals may use mental control techniques like self-talk or imagery while engaging in self-regulatory behaviours like taking a walk or drinking a cup of tea to reinforce their regulatory efforts.

2.1.1. Self-awareness and motivation for change

Self-awareness is the psychological state in which individuals become the object of their own attention, allowing them to reflect on their actions and assess how well those actions align with personal values, beliefs, and social expectations (Heatherton, 2011). In the context of sport and exercise, self-awareness is an essential skill that enables athletes to identify the psychological and physiological conditions necessary for peak performance and recognize when adjustments

are needed to optimize their state (Andersson et al., 2014). Without this capacity for reflection, athletes may struggle to regulate their emotions, cognitions, and behaviours in response to sport, exercise and competitive demands (Hyland-Monks et al., 2022).

In the present model, self-awareness is centred on internal challenges, although some self-regulation frameworks consider internal and external challenges simultaneously. For example, Bonanno and Burton (2013) emphasized the concept of context sensitivity, underscoring that adaptive regulation relies on perceiving and responding to both internal states and external situational demands. This model distinguishes between the perception and appraisal of external factors—which may be interpreted as challenges or threats (Williams et al., 2010)—and self-awareness, which involves identifying internal states as such. These two processes are interconnected: external events can directly reveal

internal challenges, such as an opponent's goal highlighting the need to revise tactics, or indirectly, by influencing internal states—for instance, when the appraisal of a goal conceded elicits anger that interferes with continued performance. This distinction is valuable as it clarifies the difference between problem-solving—such as restricting an opponent's attacking options—and self-regulation—such as redirecting anger into constructive effort. It also illustrates how both processes may interact, for example, by using emotional energy to boost defensive performance.

Self-awareness is not limited to immediate challenges; it also encompasses anticipatory processes that allow individuals to prepare for future obstacles. The concept of preventive self-control suggests that people do not only regulate impulses in the present but also take proactive steps to shape future self-regulation (Hofmann & Kotabe, 2012). While immediate challenges often enter awareness due to their intensity or through unintentional self-representative processes such as spontaneous self-talk (Latinjak et al., 2023), anticipating challenges depends more on self-knowledge, including metacognitive insight (Hennecke & Bürgler, 2023). The ability to foresee potential challenges is largely influenced by how well individuals understand their typical responses in specific situations. However, when self-knowledge is limited, external input—such as guidance from coaches or parents—can serve a similar anticipatory function (Collins et al., 2014). By anticipating difficulties, athletes can engage in strategic preparation to minimize the emergence of counterproductive emotions, thoughts, or behaviours, increasing their likelihood of maintaining focus and discipline when facing high-pressure situations.

However, how an internal issue is appraised may be just as important as recognizing it in the first place. Just as external stressors in competition can be perceived as either a challenge or a threat, internal difficulties can be framed either as problems that hinder performance or as goals that drive improvement (Jones et al., 2009). Athletes who approach self-regulatory challenges as opportunities for growth may be more likely to engage in adaptive adjustments, whereas those who perceive them as barriers may disengage or become frustrated.

Yet, self-awareness alone does not drive self-regulation—it must be accompanied by motivation for change, which transforms recognition into action (Inzlicht et al., 2021). Rather than being a static trait, motivation for change is a dynamic state that emerges from self-awareness, shaping how individuals respond when self-regulation is required. Research suggests that goals pursued for autonomous (want-to) reasons are more likely to be achieved than those pursued for extrinsic (have-to) reasons, as autonomous motivation is associated with greater persistence and well-being (Werner & Milyavskaya, 2019; see also Deci & Ryan, 2000). More recent findings suggest that more intrinsically motivated (want-to) goals require less effort, making them easier to sustain, whereas controlled (have-to) motivation demands greater cognitive effort and can lead to regulatory fatigue (Werner & Milyavskaya, 2019). In sport, athletes who recognize performance obstacles and are autonomously motivated to adjust are more likely to engage in effective, sustained self-regulation, whereas those motivated by external pressures may comply in the short term but disengage over time.

Self-awareness not only enables individuals to initiate self-regulation but also to refine and optimize it over time by evaluating its effectiveness. This metacognitive component ensures that individuals continuously assess their regulatory strategies, making necessary adjustments to enhance performance (Snyder et al., 2011). Calibration—the degree to which one's perception of their own regulatory effectiveness aligns with actual outcomes—is crucial for long-term self-regulation success. Well-calibrated athletes are more likely to recognize when a chosen strategy is ineffective and replace it with a more suitable one, optimizing self-regulation over time (Brick et al., 2015). In this sense, self-awareness is not just the starting point of self-regulation but also the mechanism that ensures continuous refinement in sport and exercise contexts.

2.1.2. Strategy selection

Strategy selection is central to self-regulation, as athletes must continually assess not only which regulatory approach will be most effective but also when and how to implement it. The ability to select appropriate strategies is distinct from executing them—it requires evaluating past effectiveness, anticipating situational demands, and adapting in real-time (Nicholls & Polman, 2007; Aldao et al., 2015; Kalokerinos & Koval, 2024). Yet, there is something recognisable in people's self-regulatory patterns. For example, athletes' self-regulatory tendencies are partly predicted by stable traits such as conscientiousness, extroversion, neuroticism, perfectionism, spirituality, and attachment styles (e.g., Lane & Wilson, 2011; Noh & Shahdan, 2020; Rice & Van Arsdale, 2010; Trumpeter et al., 2006).

Nonetheless, rather than relying completely on fixed coping styles, in sport, athletes should adjust their strategies based on situational demands, past experiences, and perceived effectiveness (Frieze et al., 2024; Nicholls & Polman, 2007). This flexibility ensures that self-regulation remains dynamic and context-sensitive, rather than a rigid application of predefined techniques (Bonanno and Burton, 2013). In the case of emotion regulation, for example, effective regulation is not about rigidly applying the same strategy but about flexibility in strategy selection, meaning the ability to choose and switch strategies according to situational demands (Hu & Tamir, 2025). This concept, referred to as emotion regulation strategy variability, suggests that individuals who adapt their regulation techniques across different contexts experience better emotional and psychological outcomes (Aldao et al., 2015; Kalokerinos & Koval, 2024).

In this article, two key aspects of self-regulation strategies are distinguished: what they *aim* to achieve and the *means* by which they are executed. For instance, coping research differentiates between avoidance aims (e.g., I don't want to be scared) and approach aims (e.g., I want to be calm) (Nicholls & Polman, 2007). Meanwhile, goal systems theory emphasizes that a single aim (e.g., I want to be fit) can be pursued through different means, such as yoga classes or healthy eating (Kruglanski et al., 2015). I extend this perspective to self-regulation, suggesting that individuals often have the same regulatory goal but employ different strategies to achieve it—for example, an athlete aiming to calm down before competition may choose between controlled breathing or talking to a friend, or a combination of the two. In the present model, I distinguish between two primary self-regulatory means: mental control (e.g., self-talk) and self-regulatory behaviours. Within the latter, I further differentiate between behaviours that exert a direct effect (e.g., sitting down to relax) and those that operate through interaction with self-regulatory entities, such as people or tools (e.g., talking to a friend to gain perspective).

2.1.3. Self-regulatory aims

Self-regulatory aims refer to the psychological outcomes individuals seek to achieve through regulation, such as reducing distress, improving emotional stability, or optimizing performance. While theoretical models categorize these strategies differently, they can be broadly understood in terms of their underlying function—whether they aim to cultivate an internal state that supports adaptation, reframe the meaning of experiences, or disengage from experiences altogether.

Change-oriented strategies. Some self-regulation strategies focus on preparing oneself to face a challenge by shaping internal states so that individuals feel more capable of engaging with a situation. For example, athletes who struggle with performance anxiety regulate their emotions to feel calmer before stepping onto the court. Strategies from different theoretical perspectives—such as problem-oriented coping (Nicholls & Polman, 2007), emotion-oriented coping (Poczwadowski & Conroy, 2002), and response-focused emotion regulation (Lane et al., 2012)—all share the common aim of modifying internal experiences to overcome psychological barriers and improve external performance. These change-oriented strategies encompass a variety of techniques, including relaxation, self-talk, and goal-setting, which allow athletes to regulate

affective, cognitive, and motivational states in ways that enhance their ability to respond to performance-related demands in both sport and exercise contexts (Dohme et al., 2019).

Perception-oriented strategies. While some strategies focus on modifying internal states to prepare for engagement, perception-oriented strategies take a different approach—reassessing the challenge itself or one's emotional or cognitive response to it. When altering one's emotional or cognitive state directly is difficult, individuals may benefit from shifting how they perceive the external situation or their reaction to it. Attentional deployment—focusing on a neutral or positive stimulus—helps stabilize emotions before facing a stressor (Gross, 2015). Similarly, appraisal-focused coping involves shifting the interpretation of a stressor to make it feel more manageable. For instance, cognitive reappraisal modifies the emotional impact of an experience before it fully unfolds, making it one of the most effective forms of emotion regulation under pressure (Webb et al., 2012). At a more personal level, self-perception strategies such as self-acceptance and self-compassion help individuals separate their identity from transient emotional reactions. Rather than seeing nervousness before competition or intense physical activity as a sign of weakness, an athlete practicing self-compassion might acknowledge that such emotions are a shared human experience and do not define their competence or future performance (Neff, 2003; Doorley et al., 2022).

Avoidance-oriented strategies. Not all self-regulatory strategies, however, are aimed at adaptation or growth. Some focus on avoiding engagement with the stressor altogether or using it as justification for compensatory actions. Avoidance-oriented strategies manifest in both behavioural and psychological forms—individuals may physically remove themselves from a situation or disengage mentally through distraction or suppression (Nicholls & Polman, 2007). A step beyond avoidance, compensatory self-regulation does not attempt to resolve the stressor but instead repurposes it—turning it into a justification for engaging in unrelated behaviours that provide temporary relief. Rather than confronting the challenge, individuals may distract themselves with self-indulgent or impulsive actions, reinforcing patterns of disengagement rather than developing adaptive self-regulation. For instance, an athlete who struggles with pressure related to sport or exercise might not seek to regulate their anxiety but instead use the situation to justify excessive alcohol consumption or other forms of impulsive behaviour (Martens et al., 2003; de Grace et al., 2017). In these cases, the stressor is not managed but repurposed, often leading to further avoidance rather than resolution.

2.1.4. Self-regulatory behaviours

While self-regulatory aims define what an athlete seeks to achieve, self-regulatory behaviours describe how these aims are enacted through external actions and interactions. Athletes regulate their state using a range of behavioural, social, and environmental strategies, including movement, social support, and object use. These external methods help adjust psychological and physiological states before, during, and after performance, providing a complementary pathway to mental control, which relies solely on internal cognitive processes. Unlike mental control, which involves modifying aspects like emotions, thoughts, and attention without external intervention, self-regulatory behaviours depend on physical actions and environmental influences to achieve a desired state. Given their distinct role in self-regulation, self-regulatory behaviours and mental control are examined separately, with the following section focusing on the latter.

Overall, the model identifies four types of strategies involving self-regulatory behaviours: one category based on the direct effect of the behaviour itself, and three others that rely on interaction with external self-regulatory entities—namely, social support, object use, and substance intake. Behaviours with direct effects include actions such as physical activity (Clement et al., 2024), participation in high-risk sports (Woodman et al., 2008), or even self-harm (McKenzie & Gross, 2014), all of which can serve self-regulatory purposes by directly influencing

internal states. In contrast, other strategies work through external interactions. Social support strategies involve seeking assistance from others—for example, talking to a coach, sharing doubts with teammates, or asking for help from family (Johnson et al., 2020; Williams et al., 2013). Object use refers to employing physical or cultural tools, ranging from crutches to relieve pain or a jacket for warmth, to cultural products such as music, which has been extensively studied in sport and exercise settings (Karageorghis et al., 2018). Substance-based strategies include everyday consumables such as food and drink for hunger and thirst regulation (Martín-Rodríguez et al., 2024), sunblock and skin lotions for physical protection (Duarte et al., 2018), and psychoactive substances like caffeine or alcohol to modulate energy or mood (Grgic et al., 2020). In more performance-driven or maladaptive forms, nutritional supplements, drugs, or doping substances may also be used to enhance athletic output (Didymus & Backhouse, 2020). A key distinction between these strategies and mental control lies in their visibility: while behavioural strategies typically involve observable actions when others are present, mental control processes—such as inner dialogue or imagery—can occur privately, even in social settings.

2.1.5. Mental control

In the present framework, mental control and self-regulatory behaviours are conceptualised as distinct self-regulation processes. While self-regulatory behaviours adjust internal states through external actions or environmental interactions—such as walking to reduce stress or listening to music (Clement et al., 2024; Karageorghis et al., 2018)—mental control regulates aspects like emotions, thoughts, and attention entirely internally, without external aids (Gross, 1998; Lane et al., 2012). This process is crucial, for example, for managing emotions, sustaining focus, and adapting under pressure, enabling individuals engaged in sport or exercise to regulate emotional responses, override distractions, and refine performance routines (Birrer et al., 2010; Vealey, 2024). To better understand its role in sport and exercise, this section examines mental skills, the physiological mechanisms underlying mental control, and the debate on ego depletion as a potential limitation of self-regulation.

Mental skills used to exert mental control. Mental skills are learned, intentional psychological processes that allow athletes to control their aspects like emotions, thoughts, and physiological states to optimize performance and well-being (Dohme et al., 2017; Latinjak & Hatzigeorgiadis, 2021). These trainable mental control techniques support self-regulation, resilience, and adaptability, making them valuable in sport, military, and other high-pressure environments (Dohme et al., 2019; Thomas et al., 1999; Rodden-Aubut and Tracey, 2022).

According to Birrer and Morgan (2010) amongst others (e.g., Dohme et al. 2019; Thomas et al., 1999), several key mental skills contribute to self-regulation. *Goal-setting* enables athletes to establish realistic and structured objectives, enhancing self-efficacy and motivation. *Imagery* involves mental rehearsal techniques, such as visualization, to regulate arousal, strengthen confidence, and refine execution. *Self-talk* refers to the intentional control of internal dialogue, allowing athletes to regulate emotions, sustain focus, and reframe anxiety-related symptoms. *Relaxation techniques*, including conscious deep breathing and progressive muscle relaxation, help manage arousal and reduce stress. *Mindfulness*, as an intentional practice, fosters non-judgmental awareness and acceptance of present-moment experiences, enhancing psychological flexibility. *Cognitive restructuring* allows athletes to modify their interpretation of anxiety and confidence through deliberate reframing strategies.

However, these descriptions are functional definitions—they explain mental skills in terms of their outcomes rather than their intrinsic nature. A more fundamental perspective would examine how these skills operate at a cognitive and neurophysiological level, identifying the underlying mechanisms in brain function and self-regulation.

The physiology underlying mental control. Mental skills are not abstract psychological concepts but brain functions that emerge from

coordinated neural activity, particularly in the prefrontal cortex (PFC). The ability to regulate emotions, set goals, and control attention, for example, is not a supernatural power—these processes rely on specific cognitive functions that can be trained and strengthened.

The PFC is the central hub for mental control, enabling athletes to regulate emotions, override distractions, and sustain focus. It does so by modulating subcortical regions, such as the amygdala (which processes emotions) and the ventral striatum (which influences motivation and reward-based learning) (Kelley et al., 2019; Casey, 2015). As a concrete example, goal-setting—a core mental skill—engages the dorsolateral PFC, which is responsible for planning and maintaining effort toward long-term objectives (Kelley et al., 2019). Similarly, cognitive restructuring, which allows athletes to reinterpret stressful situations, is linked to left-lateralized ventrolateral PFC activity, with lower activation in this area correlating with higher chronic stress levels (Perchtold et al., 2018).

In sport and exercise psychology, researchers have examined how these brain mechanisms influence performance under pressure, decision-making, and stress regulation. For example, studies on prefrontal asymmetry show that athletes with greater left-PFC dominance exhibit higher approach motivation and better emotional resilience during competition (Haehl et al., 2022). Beyond cortical structures, stress regulation in athletes is influenced by glucocorticoid activity, which helps shape both immediate self-regulatory responses and long-term adaptation to stress. However, excessive activation of this system can impair resilience and disrupt self-regulation, leading to performance deficits (de Kloet et al., 2019).

By understanding mental skills as biological functions rather than just psychological techniques, sport and exercise psychology can develop more targeted interventions that align with the brain's natural regulatory mechanisms. Neurofeedback training can enhance self-regulation by increasing PFC engagement (Dupee et al., 2016), while mental skills training effectiveness should also be assessed through neurophysiological changes, such as altered prefrontal activation patterns (e.g., mindfulness effects; Bondar et al., 2024). Recognizing these mechanisms also clarifies why self-regulation sometimes fails—children, for instance, struggle because their emotional and reward systems develop faster than their self-control mechanisms, leading to impulsivity (Casey, 2015). Hence, understanding these developmental constraints highlights the importance of patience and supportive guidance from adults in fostering children's emerging self-regulatory capacities.

Ego depletion or mental fatigue created by exerting mental control. Mental skills training assumes that self-regulation can be improved not only in effectiveness but also in endurance. This implies that self-control is a limited resource that can become depleted with use, raising the question of how self-regulation fatigue operates. The concept of ego depletion was first introduced by Baumeister et al. (1994, 2018), proposing that self-control functions like a muscle—exerting self-control in one task temporarily reduces the capacity to exert it in subsequent tasks. This depletion effect, resembling mental fatigue, suggests that self-regulatory resources are limited and become exhausted with use.

In sport and exercise psychology, ego depletion has been studied in the context of endurance tasks, decision-making under fatigue, and sustained performance in high-pressure environments (Englert, 2016). Some findings suggest that athletes experience self-regulatory fatigue after prolonged emotional or cognitive exertion, impairing performance and increasing susceptibility to mistakes. However, there is debate over the underlying mechanisms of ego depletion. Some theories, such as the glucose hypothesis, proposed that self-control relies on glucose as a finite resource, but empirical evidence has failed to support this view (Dang, 2016). Instead, studies suggest that glucose rinsing (without ingestion) can improve performance, raising concerns about publication bias in the original glucose-based theories.

While early research supported the idea that self-control depletion affects effort, motivation, and fatigue (Hagger et al., 2010), alternative

explanations challenge the idea of a finite resource. For example, Vohs et al. (2021), in a large-scale, multisite, preregistered paradigmatic test, found no reliable evidence for ego depletion. However, it is worth noting that the experimental tasks and settings in that study bore little relevance to sport and exercise contexts. In sport and exercise research, some scholars suggest that mental fatigue may not reflect actual depletion but rather shifts in motivation and attention (Beedie & Lane, 2012). Additionally, belief systems may play a significant role: Job et al. (2010) showed that individuals who view willpower as a non-limited resource are less likely to show depletion effects, suggesting that subjective beliefs may moderate or even prevent ego depletion. These findings suggest that self-regulation training in sport should address not only the development of mental skills, but also athletes' capacity to sustain motivation, shape adaptive beliefs about effort, and manage cognitive workload under prolonged pressure.

3. Impact of self-regulation

Self-regulation plays a crucial role in emotional, cognitive, and behavioural adaptation, influencing performance, decision-making, and psychological well-being (Vealey, 2024). However, its impact is complex and depends on how it is engaged, sustained, and directed. While self-awareness is essential for initiating self-regulation, excessive self-focus can interfere with performance by increasing cognitive interference and emotional distress (Liao & Masters, 2002). Similarly, mental control enables individuals to regulate emotions, thoughts, and attention, but prolonged effort can lead to cognitive fatigue (Beedie & Lane, 2012). Beyond internal regulation, self-regulatory behaviours—whether on its own (e.g., walking, stretching) or involving external entities (e.g., seeking social support, using music or objects)—offer alternative ways to influence psychological and physiological states (Bishop et al., 2007; Edwards et al., 2018; Huong et al., 2025). Understanding the impact of self-regulation requires examining both its benefits and potential drawbacks, as well as how different forms of regulation interact to shape performance and well-being (Hagger et al., 2010; Vealey, 2024).

3.1. Self-awareness effects

Self-awareness enables individuals to monitor and adjust their cognitive, emotional, and behavioural states, but its effects are not always beneficial. While it supports adaptive regulation, excessive self-focus can disrupt performance, increase cognitive interference, and heighten emotional distress. One challenge is the *ironic effect of mental control*—attempts to suppress unwanted thoughts can make them more persistent, leading to self-regulatory failures (Wegner, 1994). In sport and exercise, heightened self-awareness can interfere with automatic motor processes, causing hesitation and anxiety, particularly in high-pressure situations (Liao & Masters, 2002; Gröpel & Mesagno, 2019).

The effects of self-awareness are also shaped by *attentional focus*. Since self-awareness involves directing attention inward, an excessive internal focus—fixating on movement execution rather than its effects—can disrupt well-learned skills (An & Wulf, 2024; Hill et al., 2017). This is particularly problematic when athletes become overly conscious of their actions under pressure. However, an internal focus is not inherently detrimental; in endurance sports, monitoring breathing and pacing can support self-regulation (Hill et al., 2017; Limmeroth et al., 2024; Schücker et al., 2014). The key is aligning self-awareness with task demands—when directed productively, it facilitates performance; when misdirected, it interferes with it.

Beyond attentional focus, the *quality of self-awareness* influences self-regulation. Self-criticism, often linked to fear of failure, heightens anxiety and impairs regulation, whereas self-compassion fosters resilience and adaptive adjustments (Kuchar et al., 2023). Ultimately, self-awareness aids performance when individuals engage with their

perceptions constructively but hinders it when self-focus becomes rigid or overly self-critical.

3.2. Controlling states

Mental control balances automatic and controlled processes—while habits and impulses drive automatic responses, controlled processes require cognitive effort and mental skills (Hofmann et al., 2009). For example, a confident athlete may appear composed automatically, reflecting high trait self-esteem, while another must actively regulate their state using self-talk, imagery, and breathing techniques. This distinction highlights how some individuals may rely more heavily on natural predisposition in certain situations, while in other circumstances, even naturally composed individuals must exert deliberate mental control to achieve the same outcomes.

Mental control can be applied to regulate a wide range of internal states that are critical for self-regulation in sport and exercise. For instance, *physiological regulation* can be achieved through instructional self-talk, which fine-tunes movement execution; motor imagery, which reinforces neuromuscular patterns; and breathing techniques, which help reduce physiological stress (Naderirad et al., 2023; Seiler et al., 2015; Hunt et al., 2018). *Emotional and affective states* can be modulated using self-talk to manage cognitive aspects of anxiety, meditation to foster emotional stability, and imagery to boost confidence and resilience (Fritsch et al., 2024; Edwards et al., 2018; Monsma et al., 2009).

Cognitive regulation may involve promoting positive and task-oriented thinking, where goal-directed self-talk supports the suppression of negative thoughts and facilitates reflective decision-making (Miles & Neil, 2013; Latinjak et al., 2014). Finally, *motivational control*—through motivational self-talk and controlled goal setting—plays a critical role in sustaining effort and promoting ongoing engagement in sport and exercise behaviours, while also supporting broader self-regulatory functioning (Fujita et al., 2024; Latinjak et al., 2020; Nicholls et al., 2016). While these examples highlight core domains influenced by mental control, they are not intended to be exhaustive.

3.3. Controlling external perception

Self-regulation is not only about managing internal states but also about shaping how individuals perceive and interpret their environment. Mental control allows individuals to direct their attention toward task-relevant information while adjusting their emotional and cognitive responses to external stimuli. Two core mechanisms in this process are attentional control, which determines what individuals focus on, and cognitive reappraisal, which influences how they interpret situational demands.

Attentional control ensures that individuals prioritize relevant cues while resisting distractions, particularly in high-pressure settings. Working memory capacity plays a crucial role in sustaining focus, helping athletes filter out irrelevant stimuli (Furley & Memmert, 2012). However, maintaining focus is cognitively demanding—prolonged attentional effort can lead to ego depletion or mental fatigue, increasing susceptibility to distractions (Gregersen et al., 2017). To counteract this, goal-directed self-talk serves as a regulatory buffer, reinforcing selective attention and sustaining cognitive efficiency under fatigue or external interferences (Gregersen et al., 2017).

Beyond attention, cognitive reappraisal allows individuals to reinterpret situations and regulate emotional responses accordingly. By adjusting their perspective, individuals can downregulate negative emotions or reframe stressors as challenges rather than threats (Ford & Troy, 2019). Imagery techniques enhance this process by reinforcing perceptions of control, boosting confidence, and reducing performance anxiety (Williams et al., 2010). Similarly, goal-directed self-talk helps individuals actively restructure their thoughts—shifting from negative ruminations toward constructive, solution-oriented thinking (Latinjak et al., 2020).

3.4. Controlling self-regulation

Self-regulation is not only about managing emotions, thoughts, and behaviours but also about ensuring that the regulatory process itself remains effective. Self-awareness functions as a monitoring system, helping individuals recognize when self-regulation is ineffective or misaligned with their goals (Snyder et al., 2011). However, once a regulation challenge is identified, mental control must be engaged to adjust self-regulation effectively.

While self-awareness serves as a monitoring tool, mental control determines how that awareness is processed and applied. Excessive self-monitoring can lead to performance anxiety, but mental control enables individuals to regulate the intensity of their self-awareness—for example, redirecting focus through mindfulness or self-compassion techniques (Noetel et al., 2019; Cormier et al., 2023). This means that self-awareness is not just a passive information-gathering process; it is an actively regulated mechanism that influences whether individuals overanalyse mistakes or use that awareness to adapt constructively.

Second, mental control optimizes strategy selection, ensuring that individuals do not default to maladaptive or habitual strategies. While past reinforcement may encourage automatic responses (Keech & Hamilton, 2022), controlled self-regulation enables individuals to override ineffective tendencies and adjust their approach based on current demands. Finally, mental control regulates itself, meaning that individuals can refine how they exert cognitive effort. This prevents mental fatigue from leading to regulatory disengagement. One example is goal-directed self-talk, which can reinforce task focus, cognitive reappraisal, and persistence, preventing mental control from deteriorating under stress (Latinjak et al., 2023). Ultimately, self-awareness signals when adjustments are needed, and mental control enables those adjustments across different layers of self-regulation—whether by fine-tuning awareness, adjusting strategy selection, or sustaining mental control.

3.5. Effects of self-regulatory behaviours

Self-regulation can be achieved not only through mental control but also through self-regulatory behaviours. While mental control focuses on internal cognitive adjustments, self-regulatory behaviours use physical actions, social interactions, or external aids to regulate thoughts, emotions, and physiological states. Some behaviours directly enact self-regulation, while others depend on interaction with external entities, such as people, music, or substances.

3.5.1. Direct effects of self-regulatory behaviours

Behavioural strategies play a critical role in emotional and physiological regulation, often working alongside mental control techniques. Physical activity, for example, disrupts rumination cycles, stabilizes mood, and reduces stress (Huong et al., 2025). However, its effects vary—some individuals find exercise calming, while others experience heightened anxiety due to performance pressure or compulsive tendencies. Walking, particularly when paired with mindfulness, provides an additional regulation mechanism by reducing cravings and stabilizing emotions (Taylor et al., 2006; Edwards et al., 2018). Therefore, while we examine and enhance how self-regulation influences sport and exercise behaviours—such as managing negative thoughts to avoid skipping a session—we should also remember that sport and exercise can themselves serve as self-regulatory behaviour for challenges outside the sporting context, for instance, going for a run to reduce work-related stress.

While most self-regulatory behaviours are adaptive, some serve as emotional escapes rather than constructive coping mechanisms. Activities like yoga integrate breath control, mindfulness, and physical engagement, reinforcing self-regulation through both movement and cognitive techniques (Cagas et al., 2022). In contrast, risk-taking behaviours—such as extreme sports—are sometimes used to suppress

distress rather than address its root cause. [Castanier et al. \(2010\)](#) found that individuals with high negative affectivity often seek intense sensory stimulation to override self-awareness, using thrill-seeking as an avoidance mechanism. At the maladaptive extreme, non-suicidal self-injury functions as a self-regulatory behaviour, triggering endorphin release and momentarily numbing distress but failing to resolve underlying stressors ([McKenzie & Gross, 2014](#)).

3.5.2. Indirect effects of the interaction with external entities

Self-regulation is often supported by external entities, including people, objects, and substances that individuals use to manage emotions, thoughts, and physiological states. These entities do not actively shape self-regulation in the way social support or coaching interventions do, but rather serve as tools that individuals strategically or habitually rely on to facilitate regulation. Among the many possibilities, three commonly used resources are social agents, music, and ingestibles, each offering distinct regulatory functions and varying degrees of effectiveness.

People can serve as useful regulatory resources, with individuals drawing reassurance, motivation, or focus from the presence of coaches, teammates, training partners, or significant others ([Eckardt & Tamminen, 2023](#); [Woodhead et al., 2024](#)). Unlike direct social support, where others actively provide help, these interactions are more self-initiated. For example, an athlete might seek out their coach to feel more composed simply because of their reassuring presence, or an exerciser might gravitate toward a calm workout partner in hopes of absorbing their composure under pressure. These effects are strongest when the relationship is positive, and the individual has previously associated that person with successful self-regulation.

Other external resources, such as music, provide structured sensory input that helps regulate mood, arousal, and attention ([Bishop et al., 2007](#)). Many athletes use energizing tracks to enhance motivation and focus, calming music to manage pre-competition nerves, or rhythmic beats to synchronize movement and maintain tempo. Beyond sport and exercise, music serves athletes as a self-regulation tool in daily life, used to reinforce, alter, or suppress emotions ([Thoma et al., 2012](#)). While some individuals engage with music in a constructive way, others rely on it to block out distressing emotions or thoughts, illustrating how external entities can be used both to achieve change and avoidance.

Similarly, ingestibles—including food, supplements, and pharmacological substances—play a role in regulating both long-term psychological stability and short-term performance states. Nutrients like omega-3 fatty acids and vitamin B12 support cognitive function, emotional balance, and neural health, playing a crucial role in psychological well-being ([Laborde et al., 2018](#)). Meanwhile, caffeine is frequently used to sustain attention, vigilance, and effort perception, particularly in high-pressure or fatigue-inducing conditions ([Guest et al., 2021](#); [Souissi et al., 2019](#)). These findings highlight the diverse ways in which ingestibles contribute to self-regulation, performance optimization, and cognitive resilience. However, not all forms of substance use are neutral—some athletes use painkillers beyond injury management to override discomfort and push through physical strain, and others turn to performance-enhancing stimulants that blur the line between regulation and dependency ([Holgado et al., 2018](#)).

4. Implications for self-regulation training

In this work, I have introduced the Integrative Self-Regulation Model for Sport and Exercise, which incorporates diverse theories and empirical findings into a cohesive framework for understanding and developing self-regulation. While research has extensively explored self-regulation mechanisms, interventions remain fragmented, with coping interventions, psychological skills training, and pressure training addressing only specific aspects of the process. Each of these methods contributes to key self-regulatory functions—self-awareness, strategy selection, mental control, and self-regulatory behaviours—but often

prioritize some components while neglecting others. This underscores the need for a comprehensive framework that ensures self-regulation training is adaptive and holistic, rather than limited to isolated techniques.

Coping interventions primarily strengthen strategy selection and execution, equipping athletes with tools to regulate stress and emotions through cognitive-behavioural training, emotion regulation techniques, and problem-focused coping ([Reeves et al., 2011](#); [Cupples et al., 2021](#)). These methods enhance coping self-efficacy but tend to focus on reactive rather than proactive self-regulation. *Mental skills training* takes a more comprehensive approach, incorporating techniques such as goal setting, self-talk, visualization, relaxation, and attentional control to develop self-regulatory skills across multiple domains ([Adler et al., 2015](#); [Ong & Griva, 2017](#); [Zhang & Werthner, 2025](#)). By fostering mental control and execution of self-regulatory behaviours, mental skills training promotes performance consistency and resilience. However, it often underemphasizes the dynamic interaction between self-awareness and strategy selection, which is critical for adapting self-regulation to different situations. *Pressure training*, by contrast, focuses on mental control under stress, exposing individuals to progressively increasing stressors to enhance cognitive appraisal, emotional regulation, and decision-making under pressure ([Van Rens et al., 2021](#); [Kegelaers et al., 2021](#)). This method improves confidence and stress resilience but relies on experiential learning rather than explicit strategy refinement, limiting its contribution to self-awareness and deliberate strategy selection.

Despite their benefits, these approaches remain incomplete, as none fully integrates all four components of self-regulation. To address this gap, I propose a comprehensive self-regulation training framework that incorporates proactive self-awareness development, flexible strategy selection, structured mental control techniques, and effective self-regulatory behaviour execution. This approach ensures that athletes can dynamically monitor, adjust, and refine their self-regulation across varying contexts. [Fig. 2](#) presents a practical checklist for sport and exercise psychologists, outlining 10 key components for developing well-rounded self-regulation training protocols and programs. The checklist can be used flexibly—to reflect on long-term self-regulation development plans, design shorter intensive training programs, or structure research on self-regulation interventions.

4.1. Improving self-awareness

Effective self-awareness training enhances clarity, promotes self-acceptance, and regulates self-focus when necessary ([Vealey, 2024](#)). While it improves cognitive and emotional regulation, excessive self-focus can lead to rumination, anxiety, and performance disruptions ([Liao & Masters, 2002](#); [Gröpel and Mesagno, 2019](#)). Training methods develop both attentional stability and insight into internal states (Point 1). *Mindfulness* fosters present-moment awareness, reducing judgmental thinking and enhancing focus ([Sappington & Longshore, 2015](#)). *Bio/neurofeedback* provides real-time physiological data, helping individuals recognize subconscious patterns and adjust self-regulation ([Dupee et al., 2016](#)). However, self-awareness alone is insufficient—self-acceptance and self-compassion ensure that insight leads to constructive adjustments (Point 2). The *Mindfulness-Acceptance-Commitment approach* cultivates psychological flexibility, while *self-compassion training* shifts responses to failure from self-criticism to self-kindness, promoting resilience ([Gross et al., 2018](#); [Kuchar et al., 2023](#)).

In high-pressure situations, reducing self-awareness can prevent performance disruptions. *Instructional self-talk* can shift focus outward, reinforcing task-relevant cues and minimizing cognitive overload ([Zourbanos et al., 2013](#)). Similarly, *flow training* promotes task absorption, enhancing automaticity and execution efficiency ([Goddard et al., 2024](#)). Striking a balance between internal reflection and external focus allows athletes to leverage self-awareness when beneficial while avoiding performance interference (Point 3).

Checklist for building self-regulation training protocols

The self-regulation training protocol ensures training in:

- ✓ **Enhancing the quality of self-awareness** – E.g., developing present-moment awareness through mindfulness training or increasing awareness of physiological and cognitive processes using bio- and neurofeedback.
- ✓ **Fostering self-acceptance and self-compassion** – E.g., using Mindfulness-Acceptance-Commitment training or self-compassion interventions to reduce self-judgment and foster a more positive attitude towards oneself.
- ✓ **Balancing self-awareness with external focus** – E.g., using cue-word training to shift attention externally or flow training to minimize excessive self-evaluation, preventing performance disruptions.
- ✓ **Refining motivation for change** – E.g., using Motivational Interviewing to enhance autonomous motivation, align goals with personal values, and foster long-term commitment to self-regulation strategies.
- ✓ **Facilitating flexible selection of self-regulation strategies** – E.g., teaching a range of coping strategies (e.g., problem-solving, emotion-focused, avoidance-oriented) and how to match them to different stressors, based on coping intervention principles.
- ✓ **Developing self-knowledge through structured reflection** – E.g., using PsychMapping or the Reflexive Self-Talk Intervention to analyse past self-regulation experiences, identify patterns, and refine strategy selection.
- ✓ **Enhancing self-regulatory behaviour execution** – E.g., providing skill-based training (e.g., effective help-seeking, nutritional supplements and music for self-regulation) to ensure self-regulatory behaviours are effectively implemented, not just understood.
- ✓ **Strengthening mental control skills** – E.g., training key psychological techniques such as self-talk, imagery, goal-setting, relaxation, and attentional control, ensuring they become automatic under pressure.
- ✓ **Building resources for mental control** – E.g., educating about healthy lifestyle habits (e.g., physical activity, sleep hygiene, and nutrition) to optimize cognitive functioning, stress resilience, and recovery from self-regulation demands.
- ✓ **Applying self-regulation strategies in real-world settings** – E.g., integrating self-regulation into practice and competition, using naturally occurring challenges or controlled pressure-training tasks to refine mental control and self-regulatory behaviours under realistic conditions.

Fig. 2. Developing comprehensive self-regulation training: a checklist for sport and exercise psychologists.

Sustainable self-regulation also requires autonomous (“want-to”) motivation, which fosters persistence and reduces reliance on effortful control (Point 4; Milyavskaya et al., 2015; Werner & Milyavskaya, 2019). *Supporting autonomy, competence, and relatedness* strengthens natural self-regulation (Deci & Ryan, 2000; Milyavskaya et al., 2014). *Social support* reinforces goal commitment (Koestner et al., 2020), while *aligning goals with personal values* enhances motivation and reduces perceived effort (Sheldon & Elliot, 1999). By integrating these strategies, athletes develop adaptive and sustainable self-regulation,

optimizing both performance and well-being (Werner & Milyavskaya, 2019).

4.2. Improving strategy selection

Effective self-regulation requires not only recognizing the need for regulation but also selecting the most adaptive strategy for the specific situational demands and applying it with sufficient flexibility to adjust when circumstances change (Friesen et al., 2024). While some responses

are habitual, training can enhance strategic flexibility, helping individuals assess stressors, choose appropriate responses, and refine their approach through self-reflection (Point 5). *Coping interventions* improve flexibility by reinforcing task-oriented coping (e.g., problem-solving) while reducing disengagement (Cupples et al., 2021). Matching strategies to stressor controllability—problem-focused for changeable stressors, emotion-focused for uncontrollable ones—enhances regulation and strengthens social support use when needed (Reeves et al., 2011).

Beyond structured interventions, self-reflection refines strategy selection by helping individuals analyse past regulation attempts and adjust accordingly (Point 6). *PsychMapping* and the *Educational Self-Talk Intervention*, for example, support this process by helping athletes understand their challenges, distinguish between more and less appropriate strategies based on context, and, in the case of the self-talk intervention, develop concrete plans for future self-regulation attempts (Latinjak & Mathas, 2024; Mathas et al., 2024).

Despite these advances, self-regulation training often overlooks the connection between self-regulatory aims and means. Future research should explore how different strategies—such as mental control vs. social support—can achieve the same self-regulatory goals, optimizing effectiveness while minimizing cognitive fatigue.

4.3. Improving self-regulatory behaviours

Enhancing athletes' self-regulatory behaviours requires education and habit development across various areas, such as sleep, nutrition, music use, and social support (Point 7). Educational interventions help athletes make intentional choices that optimize recovery, energy management, and emotional regulation. For instance, improving sleep hygiene—through strategies like consistent routines, screen time reduction, or caffeine management (Gwyther et al., 2022)—can enhance recovery, emotional stability, and cognitive function. Similarly, nutrition education can support informed dietary choices, reducing reliance on unverified supplements and lowering risks of disordered eating and unintentional doping (Bar et al., 2016; Gatterer et al., 2020). Structured programs also strengthen self-efficacy, helping athletes make strategic use of food for energy, recovery, and performance, alongside other personalized approaches to nutrition (Parks et al. 2016).

A variety of external self-regulatory tools can further support athletes, depending on individual needs. Music interventions, such as bio-synchronous or warm-up music, are one approach that can align rhythm with physiological states to reduce effort perception and optimize focus, motivation, and emotional regulation (Karow et al., 2020; Williams et al., 2020). Similarly, different forms of social support interventions can encourage help-seeking behaviours, increase awareness of available resources, and reduce stigma in contexts such as injury recovery and mental health (Jones et al., 2022; Martin et al., 2020).

4.4. Improving mental control

Mental control can be strengthened through *mental skills training*, which enhances the ability to regulate emotions, thoughts, and attention under pressure (Point 8; Vealey, 2024). Mental skills training develops trainable skills such as self-talk, goal setting, relaxation, imagery, and attentional control, which, with consistent practice, become more automatic and resilient to stress (Ong & Griva, 2017; Lochbaum et al., 2022). *Bio/neurofeedback training* further refines these skills by providing real-time physiological data, helping individuals recognize and regulate neural patterns linked to self-control (Dupee et al., 2016). Additionally, improvements in mental control can be tracked through changes in prefrontal activity, reinforcing the connection between psychological interventions and neurophysiological adaptation (e.g., Bondar et al., 2024).

Beyond mental skills training, *healthy lifestyle choices*, including nutrition, sleep, and physical activity, positively impact mental control

by supporting cognitive functions and self-regulation capacity (Point 9). Among these, physical exercise plays a particularly significant role by enhancing executive functions such as inhibition, cognitive flexibility, and attentional regulation (Audiffren & André, 2015). Supporting Baumeister's strength model of self-control, both acute and chronic exercise replenish cognitive resources, reducing mental fatigue and improving impulse regulation, emotional control, and sustained focus. Integrating exercise with mental skills training may enhance prefrontal engagement, optimize stress regulation, and foster more sustainable self-regulation.

In addition to all the above, self-regulation is a skill and as such it requires practice (Point 10; Baumeister et al., 2018; Birrer & Morgan, 2010; Vealey, 2024). Hence, *pressure training* complements previous approaches by exposing athletes to controlled stress, ensuring their skills translate effectively to real-world conditions (Van Rens et al., 2021; Kegelaers et al., 2021). There is also evidence that self-regulation skills developed through sport transfer to broader life domains (Sharp et al., 2013); however, athletes may benefit from explicit encouragement to apply these strategies beyond sport to fully complete the transfer process (Lebrun et al., 2019).

5. Future directions

The Integrative Self-Regulation Model for Sport and Exercise extends previous integrative frameworks (e.g., Achtziger & Gollwitzer, 2018; Friese et al., 2024; Inzlicht et al., 2021) by incorporating a broader range of regulatory processes, including emotional, behavioural, and neurophysiological elements. While the model's primary goal is to support applied practice, its breadth makes it too complex to test in full within a single empirical study. Nevertheless, it can guide future research in several ways. First, it introduces psychological mechanisms from general research that require contextual verification in sport and exercise—for instance, the distinction between autonomous (“I want to”) and controlled (“I have to”) motivation (Werner & Milyavskaya, 2019) for change, or the idea that different regulatory means (e.g., mental control vs. behavioural strategies) can be flexibly used to achieve the same regulatory aim (Kruglanski et al., 2015). Second, the model generates more specific, testable hypotheses—such as whether self-accepting self-assessment within self-awareness predicts greater flexibility in strategy selection, or whether combining multiple regulatory means reduces mental fatigue under prolonged pressure.

Beyond hypothesis testing, the model provides a structure for qualitative and applied research. It can inform the development of more comprehensive interview guides and serve as an analytic framework to explore how athletes and exercisers experience and describe self-regulation in different contexts. Given its applied orientation, the model also invites longitudinal investigations of its use in real-world practice—either by tracking practitioner and athlete experiences or by comparing it with traditional interventions like mental skills or mindfulness training, which typically target isolated segments of the regulatory process. Ultimately, I hope this model contributes to a broader shift in the field—from comparing disconnected techniques to designing and evaluating integrated, long-term self-regulation training protocols that reflect the full complexity of performance and adaptation in sport and exercise settings.

6. Conclusion

This work has introduced the Integrative Self-Regulation Model for Sport and Exercise, bridging fragmented perspectives from psychology to provide a cohesive framework for understanding and training self-regulation, especially in sport and exercise. The model underscores that self-regulation is a dynamic, multi-faceted process involving self-awareness, strategy selection, mental control, and the execution of self-regulatory behaviours. While mental control and self-regulatory behaviours provide distinct self-regulation pathways, they often

interact to optimize emotional, cognitive, and behavioural regulation. This model adds to a growing body of integrative efforts in the self-regulation literature (e.g., [Achtziger & Gollwitzer, 2018](#); [Fries et al., 2024](#); [Inzlicht et al., 2021](#)), while distinguishing itself through its applied focus and practical relevance to the sport and exercise domain. While the present model emphasises the functional components of self-regulation, future research should examine how these processes are shaped by individual characteristics (e.g., age, personality, neurological development) and contextual factors (e.g., cultural norms, environmental constraints), to support its adaptation to specific populations and applied settings.

By examining interventions that enhance these components, this article has outlined practical strategies for improving self-regulation in sport and exercise contexts. However, existing training approaches often emphasize isolated skills, highlighting the need for more integrated interventions that align with the full self-regulation process. Future research should focus on holistic training programs that improve functional self-awareness, cultivate flexible strategy selection, balance mental control and self-regulatory behaviours, and account for the cognitive costs of self-regulation, ensuring long-term resilience, well-being, and performance. With repeated use and training, elements of the self-regulation process—such as awareness, strategy selection, and execution—may become increasingly automatic. This transition toward effortless self-regulation ([Gillebaart & Schneider, 2024](#)) reflects how self-regulation can evolve through intentional practice and reflection into more fluent, less effortful responses under pressure.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author used ChatGPT 4.0 in order to improve the readability and language of the manuscript. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

CRedit authorship contribution statement

Alexander T. Latinjak: Writing – review & editing, Writing – original draft, Investigation, Conceptualization.

Declaration of competing interest

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

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