

Must stay in the game: self-regulation for performance optimization in professional ice hockey

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This study examines the subjective experiences, identification, and use of self-regulation strategies to optimise performance within the framework of multi-states (MuSt) theory. Participants were male ice hockey players competing at the highest level in Finland. Players (N = 20, M_{age} = 22.5) took part in an initial assessment of feeling states and core action components in relation to previous optimal and suboptimal performances, and self-efficacy in hockey-related strengths. Ten of them completed an intervention and assessment in four competition games, and took part in post-game evaluations involving awareness of their feeling states and effectiveness of the intervention. According to MuSt theory assumptions, results indicated that psychobiosocial states and core action components discriminated between optimal and suboptimal performances. Additionally, participants perceived the intervention as useful and effective in increasing awareness of own functional and dysfunctional feeling states related to their performance.

KEY WORDS: Emotion Regulation; Action regulation; Skill execution; Profiling; Self-monitoring.

Introduction

Subjective experiences play a major role in athletic performance (e.g., Janelle et al., 2020; Lane et al., 2016) and can either serve as a catalyst for optimal performance or act as a major barrier to success. These experiences influence several key components of sports performance such as attention, decision making, and intra- and interpersonal interactions (Tamminen et al., 2024; Vast et al., 2010). To optimize the likelihood of achieving peak performance, athletes should become aware of and effectively self-regulate their emotional states (Harmison, 2006; Ruiz et al., 2021a).

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A theoretical framework for self-regulation that conceptualizes different aspects of sport performance and athletes' subjective experiences is multi-states (MuSt) theory (Ruiz et al., 2021a). MuSt theory, which expands ideas from individual zones of optimal functioning (IZOF; Hanin, 2007) and multi-action plan (MAP; Bortoli et al., 2012) models, emphasizes the interaction between the athlete, task, and environment in leading to emotional experiences that exert either a functional or dysfunctional impact on performance. At the core of MuSt theory is the notion that athletes should be aware of their subjective experiences and use both emotion- and action-centred self-regulation strategies to reach optimal performance.

To self-regulate effectively, performers should first become aware of their experiences, which enables them to monitor and understand their impact on performance. To enhance awareness, individuals should recognize how their feeling states manifest in both optimal and suboptimal performances. Understanding the distinct patterns associated with optimal and suboptimal performances makes it easier for athletes to identify which type of self-regulation is needed in actual performance. Self-regulation is conceptualized as the process in which the individual aims to monitor, modify, or manage the type, quality, timing, and intensity of their states to attain their goals or deal with unfavourable experiences (Robazza & Ruiz, 2018). This process is crucial in the performance continuum, determining the athletes' feeling states before, during, and after performance.

The self-regulation process starts with the appraisal of an upcoming performance in which athletes assess their ability to meet environmental and task-specific demands (Ruiz et al., 2021a). This appraisal depends on how athletes evaluate their personal resources in relation to the environmental and task demands. A positive appraisal arises after perceiving resources as sufficient to meet the demands, viewing the task as a challenge rather than a threat. This challenge appraisal is associated with beneficial performance outcomes (Behnke & Kaczmarek, 2018; Hase et al., 2019; Moore et al., 2013). Conversely, a negative evaluation occurs when the performer feels that the situational demands exceed their perceived resources, leading to a threat appraisal with likely detrimental effects on performance. Whether the situation is appraised as a challenge or a threat influences individual emotional experiences and performance outcomes.

In MuSt theory (Ruiz et al., 2021a), emotion-centred self-regulation strategies focus on emotion-related psychobiosocial states or experiences, which draw from the IZOF model (Hanin, 2007). Psychobiosocial states are conceptualized as the feelings athletes experience with respect to their performance, which manifest in at least eight modalities: cognitive, emotional,

motivational, volitional, bodily, motor-behavioural, operational, and communicative (Ruiz et al., 2016). Athletes often shift between multiple states before, during, and after performance. Three different aspects of these experiences are distinguished: state-like experiences reflect how the performer feels in a specific moment; trait-like experiences represent recurring patterns of feelings; and meta-experiences involve reflections about these feelings based on past performances (Hanin, 2007). Meta-experiences are crucial to the self-regulation process; they are shaped by cognitive appraisals and facilitate the interpretation of specific state-like experiences, which over time may lead to more stable trait-like patterns.

MuSt theory also considers action-centred strategies of self-regulation in which athletes direct their attention to key tasks essential to performance (Ruiz et al., 2021a). Consistent with recommendations derived from MAP model (Bortoli et al., 2012; Robazza et al., 2016), athletes can enhance their performance by focusing on a select number of core action components while regulating their experiences, thereby promoting an effective, accurate, and automatic performance execution. The level of monitoring/control of core components of action adds a layer to the self-regulation process leading to a $2 \times 2 \times 2$ interaction of state functionality, valence, and action monitoring/control (see Ruiz et al., 2021a). Performer's shifts between states of different functionality and valence are associated with varying levels of action monitoring/control. For example, functional pleasant states are likely associated with lower levels of action monitoring as optimal performance can happen almost automatically. In contrast, functional unpleasant states under competitive pressure may require higher levels of action monitoring to maintain high performance levels.

Previous research in this area has mostly focused on the regulation of psychobiosocial states and core action components separately, demonstrating beneficial outcomes from interventions targeting feeling states self-regulation strategies (Middleton et al., 2017; Ruiz et al., 2021b), as well as awareness and regulation of optimal feeling states and core action components (Bortoli et al., 2012). An ice hockey specific application of MuSt theory was presented in a study by Ruiz et al. (2021b) where the use of core action components and psychobiosocial states for performance prediction was examined. Findings demonstrated that emotion- and action-based regulation was beneficial in high-level performance, and that athletes' experiences of their best and worst performances differed in terms of core action components and feeling states. The authors also noted that "focusing on core components of the action can help athletes attain good performance even when they experience nonoptimal states" (Ruiz et al., 2021b, p. 9).

MuSt theory tenets have also been tested in other studies. Morrone et al. (2023) examined the interplay between self-confidence, emotional arousal control, worry, concentration disruption, challenge and threat appraisals, psychobiosocial experiences, and self-evaluated performance in kickboxing. Their findings provided support to MuSt theory predictions and suggest that practitioners should encourage athletes to use both emotion- and action-based self-regulation strategies to reach functional states for optimal performance. Additionally, Viscosi et al. (2025) examined the effects of self-talk strategies on passing performance under pressure in elite football players. Results showed that MuSt-based self-talk significantly improved passing accuracy, decision-making speed, and emotional control, while also reducing anxiety and physiological stress. Action-focused self-talk (e.g., “see the pass, execute it”) was more effective than emotion-focused self-talk alone. Their findings suggest that structured self-talk training can enhance performance consistency and stress management in high-pressure situations.

Given the limited body of research on MuSt theory predictions and applications, the purpose of the current study was to examine the feasibility and perceived effectiveness of an intervention program designed to target pre-performance feeling states of athletes, with the goal of enhancing performance awareness and self-regulation in alignment with the principles of MuSt theory. Specifically, a first purpose of the study was to examine psychobiosocial states and core action components of ice hockey players in relation to their optimal and suboptimal performances. A second aim was to raise participants’ awareness of their emotional experiences, assist them in identifying and applying self-regulation techniques before and during performance, and enhance their perceived performance. The following hypotheses were formulated: (1) Psychobiosocial states and core action components would effectively distinguish between optimal and suboptimal recalled past performances (Hypothesis 1); (2) The intervention would increase ice hockey players’ awareness of functional and dysfunctional feeling states associated with their performances (Hypothesis 2); and (3) The intervention would enhance ice hockey players’ ability to implement self-regulation strategies enabling them to reach and maintain functional feeling states while executing core action elements optimally (Hypothesis 3).

Methods

PARTICIPANTS

Participants were 20 male players, aged 19 to 35 ($M_{\text{age}} = 22.5$, $SD = 4.86$) from an ice hockey team competing in the highest Finnish professional league. Ten players completed the

intervention from baseline through all performance assessments and post-intervention evaluation. Player attrition was primarily due to circumstances inherent to elite sport environment, with several players sustaining injuries during the intervention and others being contracted by different teams, which limited their availability to complete the study.

MEASURES

Psychobiosocial States

Participants completed the Psychobiosocial States scale (PBS-S; Ruiz et al., 2019) to assess their states. The PBS-S scale is based on an individualized profiling (Ruiz et al., 2016) to measure eight modalities of psychobiosocial states: cognitive, emotional, motivational, volitional, bodily, motor-behavioural, operational, and communicative. The list is comprised of 20 rows of items with three or four adjectives, totalling 74 adjectives. All aspects of the psychobiosocial states are assessed on two rows of items, one being functional (+), and the other dysfunctional (–) for performance. Examples of functional adjectives in the cognitive modality are “alert, focused, and attentive”, while “distracted, overloaded, doubtful, and confused” represent the dysfunctional cognitive modality. Participants select one adjective for each row to assess how they are feeling, and rate the intensity on a scale ranging from 0 (*nothing at all*) to 4 (*very much*) and functionality on a scale ranging from -3 (*very harmful*) to 3 (*very helpful*). The PBS-S scale has been successfully administered to assess feeling states in competitive sports, with acceptable reliability (functional states $\alpha = .742$, dysfunctional states $\alpha = .810$) and sound factorial structure (CFI = .932, TLI = .915, SRMR = .054) reported in a sample of Finnish athletes (Ruiz et al., 2019).

Core Action Components

A stepwise procedure was used to identify core action components (Bortoli et al., 2012; Robazza et al., 2016). First, the participants were asked to choose a recurring situation in their games where their performance is notably influenced by factors such as fatigue or pressure. Second, the participants were asked to identify the two most important visual and behavioural components of their chosen situation they needed to pay attention to in order to perform optimally. Finally, the accuracy of each of the four identified components was assessed on a scale ranging from 0 (*not at all accurate*) to 11 (*very accurate*). Previous research supports the applicability and usefulness of the assessment of core action elements in a sample of Finnish ice-hockey players (Ruiz et al., 2021b).

Cognitive Appraisals

Cognitive appraisals related to the upcoming performance were measured using the two items used by Moore et al. (2013) to evaluate perceived demands and resources of a performance situation. In particular, participants were asked to rate: (1) how demanding they felt the upcoming performance would be, and (2) how well they were able to meet those demands. Both responses were rated on a scale from 0 (*not at all*) to 6 (*extremely*). A demand-resource evaluation score was calculated by subtracting demands from resources, with possible values

ranging from -6 to +6. A positive score indicates a challenge appraisal while a negative score reflects a threat appraisal.

Self-efficacy

The team's coaching staff compiled a comprehensive list of specific skills that characterize optimal hockey performance in both defense and offense tactical scenarios. The list was then presented to each participant, who was then encouraged to select five qualities they considered as their strengths in defense and another five qualities they considered as their strengths in offense. This self-selection process was intended to enhance the reliability of the assessment by allowing athletes to personally identify and label their strengths. Participants rated each identified strength on a scale from 0 (very poor) to 11 (excellent), providing a quantitative measure of their perceived proficiency in various playing contexts. Self-efficacy assessment in this study was informed by guidelines provided by Feltz et al. (2008) to capture individually relevant and task-specific information.

Participant Evaluation of Intervention Easiness, Effectiveness, and Experience Awareness

At the end of the games, participants were asked to evaluate several aspects of their participation in the study. This included how easily they could identify their experiences, strengths, and core action elements, the perceived usefulness of the intervention, and the extent to which their self-awareness had increased. These evaluations were measured using Likert-type scales ranging from 1 to 5. Specifically, the scale for ease of identification ranged from 1 (*very difficult*) to 5 (*very easy*); the scale for perceived usefulness ranged from 1 (*not at all useful*) to 5 (*very useful*); and the scale assessing changes in awareness ranged from 1 (*not at all*) to 5 (*very much*).

PROCEDURE

Prior to starting the study, ethical approval was granted from the local University ethics committee. Participants were informed about the nature of the study and its procedures, as well as voluntary nature of their participation. Non-Finnish-speaking participants agreed to use English and demonstrated proficient language skills to take part in the study. The study was divided to three phases: (a) baseline, (b) actual games and self-regulation intervention, and (c) evaluation.

Baseline phase was started approximately one month prior to the start of the regular season. An initial meeting with the team was organized to provide participants information about the study and procedures. After this, 1-on-1 meetings were carried out with all players, in which participation in the study was discussed further with each player, and consent to participate was given. Those who agreed to take part in the study received a link to a baseline survey assessing study variables in relation to their previous optimal and suboptimal performances. To ensure anonymity and to match participants' responses throughout the different study phases, a code was randomly generated for each participant. Participants were asked

to identify one optimal and one suboptimal performance from the previous season. To help them recall these performances, the participants were encouraged to watch videos of the identified games on the team's video coaching platform SportContract. The participants were then asked to assess their psychobiosocial states and core action components in relation to their optimal and suboptimal performances. Next, the participants assessed their self-efficacy by identifying their five strengths in offence and five strengths in defense. After this, each participant received a profile handout, which included information regarding their individual psychobiosocial states and core action components profile in previous optimal and suboptimal performances, as well as self-efficacy qualities (i.e., identified strengths in defense and offense). An information session was held with the participants to explain how to interpret the profile handout and to indicate how they might use it. The participants were also encouraged to ask any possible questions at any time. While the participants were instructed to use the handout on their own (i.e., by identifying their most important psychobiosocial states linked to optimal performance and spontaneous self-regulation techniques to reach desired states), the handouts were also discussed in 1-on-1 meetings with participants who wished to do so.

In the second phase, a pre-game survey was administered to assess (1) participants' psychobiosocial states, (2) core action components, (3) cognitive appraisals, and (4) self-efficacy regarding their upcoming performances in at least four actual games. The intervention was individualized and spanned from October to January as not all participants played the same games. Individual profiles were created for each participant and made accessible on mobile devices, tablets, and computers.

First, pre-game profiles were developed where participants rated the accuracy of each of their core action components identified during the baseline phase. Next, they assessed their psychobiosocial states reflecting on how they felt in that moment, that is towards their upcoming performance. Participants then rated their appraisals of the upcoming game and their self-efficacy. After completing the pre-game survey, participants were encouraged to review their individual profiles, which displayed information from the baseline assessments, encompassing both optimal and suboptimal performances, as well as information related to their upcoming performance. Profiles were hosted on the same online platform for ease of access. At the top of the profile page, instructions guided participants in interpreting and utilizing the information, and what to focus on. For example, they were instructed: "Have a look at your individualized profile below. Pay attention to how you are currently feeling (dashed line) and how this compares to your optimal (solid black line) and suboptimal (solid grey line) feelings". Participants were also encouraged to write any comments regarding their thoughts or observations.

The profiles included participants' core action components to facilitate comparison between optimal and suboptimal performance assessments with current pre-game assessment of each core component. Similarly, participants were presented with the eight psychobiosocial states modalities and the specific adjectives they had previously identified for optimal and suboptimal performances for comparison with pre-game assessments. To facilitate comparison, in addition to graphic representations the information was presented in table format. This allowed for a more detailed view of which word had the highest and lowest ratings in terms of the feeling states' intensity and functionality. Participants were shown their identified strengths on defense and offense tactical situations to serve as a reminder, and they were also asked to reflect on the following questions: "How do I want to feel before performance?" and "What are the things I need to do to achieve that?". These questions were meant to encourage participants to reflect about their experiences and help them identify self-regulation strategies to reach desired feeling states.

A short post-game survey was administered to gather information about participants' performances. They were asked to rate how effective they were in playing with their defensive and offensive strengths during the game. Additionally, they were given the opportunity to write down any comments or observations about their performance. In the evaluation phase and upon completion of the actual games and self-regulation intervention, participants were invited to reflect on and evaluate their experiences about the study.

In summary, the procedure consisted of an initial assessment of: (1) psychobiosocial states, (2) core action components, and (3) strengths in offense and defence – self-efficacy. In the second phase, the same variables were assessed prior to actual games along with resource-demands perceptions. Self-efficacy was also measured after the actual games. Finally, participants evaluated their participation in the study.

DATA ANALYSIS

Data from participants who took part in all assessments – comprising the baseline, the intervention with a minimum of four actual game assessments, and the post-intervention evaluation – were included in the final data analysis. The data (i.e., individual profiles) were first examined through visual inspection both during and after the intervention. Visual inspection is a frequently used method in single-subject research (Horner et al., 2005; Wolfe et al., 2019), especially in studies involving elite level athletes (Kinugasa et al., 2004). At the individual level, each participant's profiles were utilised in the inspection of the data during the intervention. After the intervention, mean self-efficacy ratings for both defensive and offensive strengths were calculated for each participant. Additionally, changes in self-efficacy across actual games were calculated by subtracting the mean of post-game ratings from the mean of pre-game ratings for defensive and offensive strengths, respectively. The total mean difference across all four games was also calculated to examine changes in perceived self-efficacy ratings for each participant. At the group level, means and standard deviations were calculated on the accuracy scores of core action components, intensities of psychobiosocial states, demand/resource appraisals, and quantitative assessments of the post-intervention evaluation. Multivariate analyses of variance (MANOVA) were conducted to examine differences in mean scores of psychobiosocial states and core action components across performances (optimal vs. non optimal).

Results

FEELING STATES, CORE ACTION COMPONENTS, AND SELF-EFFICACY

Figure 1 illustrates a profile with intensities of psychobiosocial state and accuracies of core action component for a single participant in recalled optimal, suboptimal, and actual game performances. The participant's perceived emotional state generally fell within the range of their previously established optimal and suboptimal baseline experiences. For functional states (left side of the graph), the participant's intensity levels did not reach those of their recalled optimal baseline performance but remained above their suboptimal baseline levels. A similar pattern emerged for dysfunctional states, where

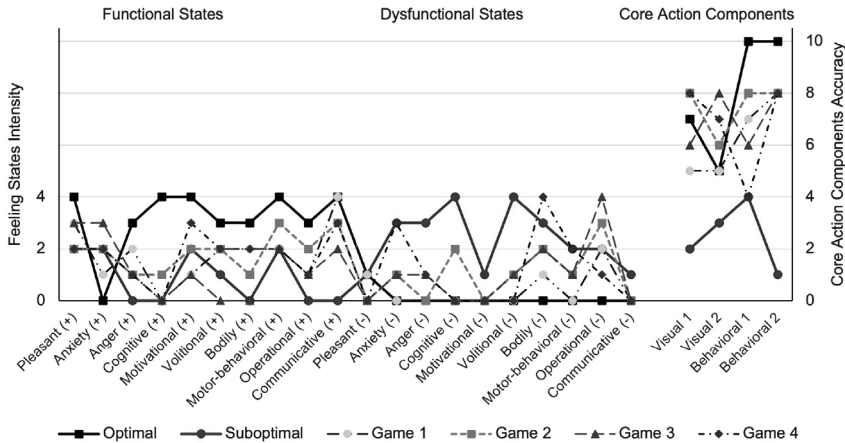


Figure 1. Individual profile of one player’s psychobiosocial feeling states and accuracy of core action components in recalled optimal, suboptimal, and actual game performances.

intensities were not as low as those reported for recalled optimal performance, except for the bodily and operational modalities, which exceeded the intensities reported for recalled suboptimal performance. In addition, the participant’s accuracy ratings for core action components surpassed those in nonoptimal performance, with accuracy for visual components even exceeding those in optimal performance. Individual profiles were presented to the participants and discussed during the intervention phase.

Accuracy scores of all core action component at baseline were high for optimal performances, in particular for behavioural aspects (see Table I). High intensity scores of functional psychobiosocial states, especially pleasant and motivational aspects, and low intensities of dysfunctional states were reported for optimal performances. The opposite was true for suboptimal performances. Significant differences were found in functional feeling states, Pillai’s trace = 0.978, $F(1, 9) = 92.170$, $p < 0.001$, $\eta_p^2 = 0.911$, and dysfunctional feeling states, Pillai’s trace = 0.803, $F(1, 9) = 36.778$, $p < 0.001$, $\eta_p^2 = 0.803$, across recalled optimal and nonoptimal performances. Significant differences were also found in core action components across optimal and nonoptimal performances, Pillai’s trace = 0.932, $F(1, 3) = 123.500$, $p < 0.001$, $\eta_p^2 = 0.932$. These findings support hypothesis 1.

TABLE I
Descriptive Statistics of Participants' Core Action Components and Psychobiosocial States for Recalled Optimal, Recalled Suboptimal, and Actual Game Performances (N = 10).

	Optimal		Suboptimal		Game 1		Game 2		Game 3		Game 4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Core Action Components												
Visual 1	8.7	1.8	3.7	2.4	7.5	1.5	7.2	1.7	7.2	1.4	7.8	1.0
Visual 2	8.3	2.2	2.7	1.7	6.9	2.0	7.1	1.1	7.6	1.3	7.6	1.3
Behavioral 1	9.3	1.8	2.1	1.2	7.4	1.4	7.4	1.7	7.1	1.0	7.2	1.9
Behavioral 2	9.4	1.4	2.5	2.1	7.1	1.8	7.2	1.8	7.0	1.4	7.6	1.3
Feeling states												
Pleasant (+)	3.7	0.5	1.0	0.9	2.8	0.6	2.8	0.8	2.6	0.7	2.3	1.1
Anger (+)	2.9	0.6	1.8	1.0	1.7	1.0	2.1	1.0	2.3	1.1	2.3	0.8
Anxiety (+)	1.6	0.8	2.4	0.8	1.1	0.9	1.4	0.7	0.8	1.0	0.9	0.9
Cognitive (+)	3.1	0.7	1.3	1.1	2.0	1.3	1.8	0.9	1.9	1.2	1.9	1.3
Motivational (+)	3.4	0.5	1.8	1.0	2.2	1.2	2.7	1.0	2.6	0.8	2.6	0.7
Volitional (+)	3.0	0.7	1.9	1.2	2.2	1.2	2.0	1.2	1.7	1.3	2.1	1.2
Bodily (+)	2.7	0.7	0.7	0.7	1.8	1.1	1.8	1.1	1.5	1.5	2.0	1.2
Motor-behavioral (+)	2.7	0.8	1.0	0.8	2.3	1.0	2.4	1.1	2.0	0.7	2.2	0.8
Operational (+)	2.8	0.8	0.7	1.1	1.9	1.0	2.2	0.6	1.7	0.8	1.7	1.0
Communicative (+)	2.7	1.3	0.8	1.1	2.3	1.1	2.0	1.3	1.8	0.6	1.9	1.0
Pleasant (-)	1.9	1.1	0.5	0.9	0.9	0.9	0.8	1.0	0.7	0.7	0.5	0.9
Anger (-)	0.7	0.8	2.6	1.1	0.5	0.9	0.6	0.8	0.7	0.8	0.5	0.7
Anxiety (-)	0.6	0.7	2.1	1.3	0.8	1.2	1.0	0.9	0.8	0.8	0.9	1.2
Cognitive (-)	0.3	0.5	2.8	0.8	0.4	0.5	0.9	0.9	0.5	0.7	0.5	0.5
Motivational (-)	0.0	0.0	0.9	0.7	0.0	0.0	0.2	0.4	0.1	0.3	0.0	0.0
Volitional (-)	0.3	0.7	2.3	1.1	0.2	0.4	0.4	0.5	0.5	0.7	0.3	0.5
Bodily (-)	0.8	0.8	2.6	0.8	1.0	0.8	1.2	1.0	1.2	1.3	1.1	1.3
Motor-behavioral (-)	0.2	0.4	2.4	1.0	0.5	0.7	1.1	1.1	0.8	0.8	0.8	0.8
Operational (-)	0.2	0.4	2.2	0.6	0.5	0.9	0.9	1.1	1.0	1.3	0.4	0.7
Communicative (-)	0.6	0.7	1.7	1.1	0.5	0.9	0.4	0.7	0.5	0.7	0.4	0.5

Note. (+) = functional; (-) = dysfunctional.

Table II presents the mean self-efficacy ratings for defensive and offensive strengths at baseline, as well as across all pre- and post-game assessments for each participant. Notable variations in players' self-perceived performance levels were observed across these assessments. For instance,

while Participants 1 (P1) and 2 (P2) reported similar ratings for defensive and offensive strengths at baseline, their subsequent game assessments were different. P1 consistently rated both defensive and offensive strengths below baseline levels across all pre- and post-game assessments. In contrast, P2 consistently reported defensive strengths meeting or exceeding baseline levels in every game, with offensive strengths above baseline in two games. Similar patterns of individual variability were observed between other participants, thus supporting our decision to take an intra-individual approach when analysing repeated game assessments.

As per post-game and pre-game self-efficacy differences in ratings, in

TABLE II
Mean Scores of Self-efficacy in Defense and Offense at Baseline (BL), Pre- and Post-Games (N = 10).

Player	BL	Game 1		Game 2		Game 3		Game 4	
		pre	post	pre	post	pre	post	pre	post
Defense									
P1	8.8	6.6	6.4	6.6	6.8	7.2	7.2	6.8	6.4
P2	8.6	9.6	8.6	8.8	9.2	9.2	9.6	9.2	9.0
P3	9.4	8.0	8.0	8.4	8.0	8.8	8.4	8.4	7.2
P4	9.2	8.2	7.8	7.8	9.2	8.0	9.2	8.2	8.6
P5	7.8	9.0	8.4	9.0	8.2	9.0	7.8	9.0	9.0
P6	8.8	8.4	8.2	9.0	7.2	9.4	8.0	9.8	8.8
P7	8.2	5.2	5.8	6.6	7.0	7.0	7.2	6.8	7.2
P8	7.8	7.6	6.0	6.8	6.8	6.4	7.0	6.2	6.6
P9	8.6	8.4	7.6	8.4	7.4	7.0	6.8	7.0	1.8
P10	7.8	8.0	7.0	8.4	9.0	8.2	9.4	8.4	6.0
Offense									
P1	9.0	5.8	8.4	6.4	6.4	7.0	5.6	6.6	6.0
P2	9.4	9.8	8.6	9.2	9.2	10.0	8.8	9.0	8.8
P3	8.8	8.8	8.6	8.8	8.2	8.4	7.6	8.6	7.0
P4	-	-	-	-	-	-	-	-	-
P5	8.2	9.0	8.0	9.0	7.8	8.2	7.2	8.6	8.4
P6	8.4	8.6	7.8	8.6	7.4	9.6	7.4	9.0	8.8
P7	5.8	5.6	5.6	6.4	6.6	6.6	6.8	6.4	6.6
P8	8.0	7.8	7.2	7.2	7.0	6.6	7.0	7.2	6.8
P9	8.4	8.4	7.6	8.2	7.6	6.8	5.8	6.8	1.6
P10	9.2	7.8	6.0	6.8	8.4	7.2	9.0	6.8	5.0

the first game, most participants reported decreases in defense and offense self-efficacy ratings compared to their pre-game levels, with only one participant (P7), reporting higher post-game ratings for all games (see Figure 2). Notably, players experienced overtime defeat in their first game. However, in subsequent second and third games, the majority of participants, except for P10, reported higher pre-game self-efficacy ratings in offense. In contrast, self-efficacy ratings in defense varied, with half of the players reporting higher rating post-game and the other half reporting lower ratings. These games resulted in victories for the players, except for P9 and P10, who experienced

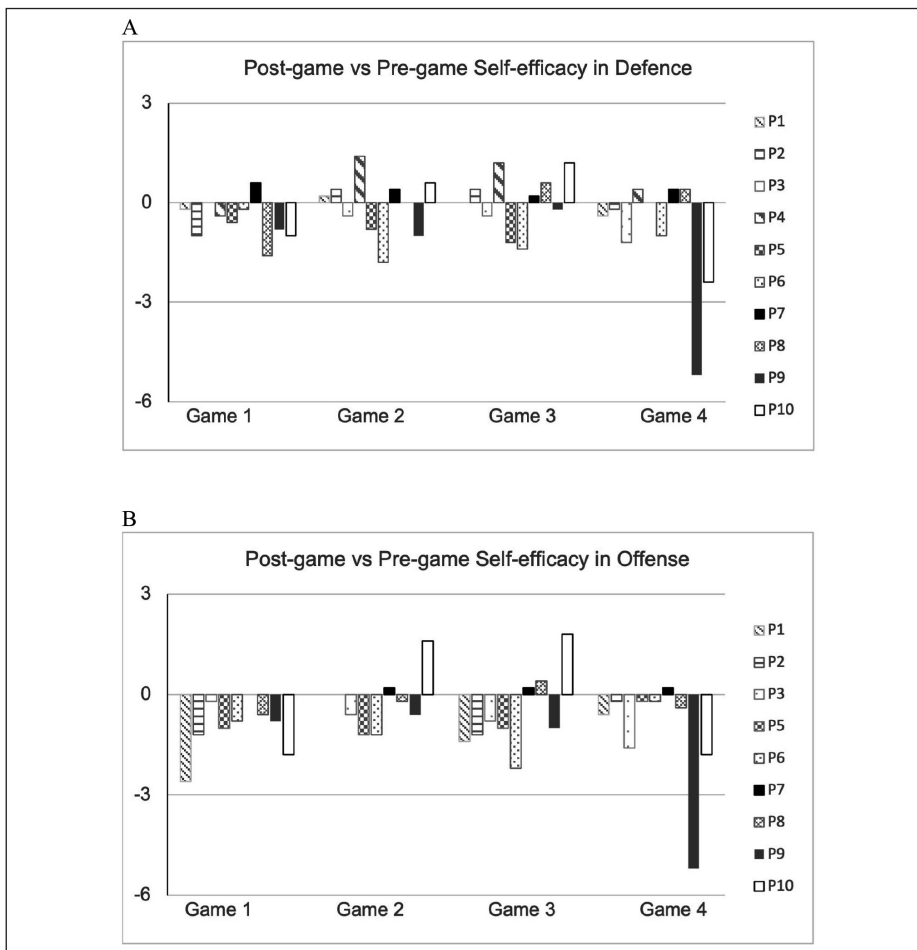


Figure 2. Changes in Self-efficacy Post-game versus Pre-game for Defense (A) and Offense (B). P = Participant.

significant losses especially in their third games. Interestingly, P4 (goalkeeper) reported higher post-game self-efficacy ratings in all games, except the first one.

Differences in post-game and pre-game self-efficacy ratings reflect participants' perceived appraisals of their resources compared to demands. As Table 3 indicates, prior to their first games most participants perceived their resources matching or exceeding competition demands. Participants' appraisals prior to their second and third games were mostly matching or exceeding their resources, while appraisals in their last games varied. At the group level, mean scores of perceived demands ranged from 4.60 ± 0.70 (first game) to 5.60 ± 0.52 (second game), whereas mean scores of perceived resources ranged from 4.70 ± 0.95 (third game) to 5.00 ± 0.52 (first game). These scores reflect players' high-level perception of both demands and resources for all games. It should be noted that resource-demand discrepancies were minimal, ranging from 0.10 (in the fourth game) to 0.70 (in the second game). Therefore, no distinct patterns emerged between perceived resources and demands and other constructs (e.g., psychobiosocial states, core action components). This restricted variability likely reflects a ceiling effect inherent to the elite professional context, where players consistently face maximal demands and possess well-developed coping resources. The two-item measure may lack the sensitivity to capture subtle appraisal variations in this population, suggesting the need for more nuanced assessment tools in future research with elite athletes.

TABLE III
Perceived Demand (D) and Resource (R) Scores Across Games (N = 10).

	Game 1		Game 2		Game 3		Game 4	
	D	R	D	R	D	R	D	R
P1	4	4	6	5	5	5	5	4
P2	4	5	6	6	5	6	5	6
P3	5	5	6	5	5	5	5	5
P4	4	5	5	4	5	4	4	5
P5	6	6	5	6	6	6	5	6
P6	5	5	6	6	6	5	5	5
P7	4	5	6	5	5	5	4	5
P8	5	5	5	4	5	4	5	4
P9	5	5	5	4	5	4	6	5
P10	4	5	6	4	4	3	5	3

Participant Evaluation of Self-regulation Easiness and Effectiveness

Participant ratings indicated that overall, they found it moderately easy to identify their states ($M = 3.20$, $SD = 0.63$), core action elements ($M = 3.00$, $SD = 0.82$), and own strengths ($M = 4.40$, $SD = 0.52$). They also reported a favourable usefulness of the study ($M = 3.70$, $SD = 0.82$). Participants ratings indicated an increase in their awareness during the study ($M = 3.20$, $SD = 0.92$), which supports Hypothesis 2. This finding was further corroborated by participants additional comments indicating that they had learned something valuable during the study, with three players mentioning the usefulness of identifying action components before and/or during performances and seven players mentioning the awareness and/or regulation of their emotional states as their most relevant outcome.

In regard to Hypothesis 3, at the group level, mean scores of functional states ranged from 1.99 ± 0.54 (last game) to 2.03 ± 0.53 (first game), whereas for dysfunctional states they ranged from 0.53 ± 0.31 (first game) to 0.75 ± 0.33 (second game). Mean scores of core action elements ranged from 7.23 ± 0.13 (second game) to 7.55 ± 0.25 (last game). This hypothesis was partially supported by pre-game measures and post-game evaluation. The lack of direct measures assessing participants' actual ability to reach and maintain functional emotional states as well as accurately execute core action components during the performance prevented conclusive support for Hypothesis 3. Although group-level inspection of core action component accuracies and psychobiosocial state intensities (Table 1) showed only one instance where the mean of a functional state (Anger + in game 1) was lower than baseline suboptimal performance levels, this limited evidence is insufficient to support the hypothesis.

Individual differences

Substantial individual differences emerged in participants' ratings of their ability to reach optimal performance, their appraisal of performance demands versus resources, and their psychobiosocial states and core action components before and after games. Consequently, data were analysed on an intra-individual level to understand how each participant's pre-performance assessment influenced their actual performance and post-performance ratings. Five illustrative cases are presented: three optimistic participants, one pessimistic participant, and one with mixed assessments.

The three optimistic participants consistently approached upcoming

performances with high confidence. They generally exhibited high self-efficacy, believing they could perform at or above their baseline optimal levels and across games, particularly in defensive skills. While their pre-game assessments for offensive skills were still largely positive, they were sometimes equal at or slightly below their baseline optimal levels. This pattern suggests a strong belief in their ability to achieve or exceed their typical best performance with minimal perceived obstacles. This optimism extended to their challenge/threat appraisals, with resources typically perceived as matching or exceeding performance demands. Unsurprisingly, their psychobiosocial states were generally near optimal, and they reported high accuracy in performing core action components. However, post-performance assessments revealed a gap between their high pre-game expectations and their actual performance in most games, especially regarding offensive skills. Despite this, comparisons to their baseline optimal levels showed they consistently achieved high levels of performance, often approaching or surpassing their personal best. This suggests their optimism, leading to optimal pre-performance states, positively impacted their ability to perform well, even if they did not meet their high initial expectations.

The pessimistic participant presented a contrasting narrative. Across all four games, pre-game assessments reflected their belief that they would not reach their optimal performance levels, averaging substantially below their baseline optimal for both offensive and defensive skills. While self-efficacy remained consistently low, their challenge/threat appraisals varied, with resources being perceived as adequate in two games but insufficient in the others. Feeling states aligned with their appraisals, showing more functional states during perceived challenges and more suboptimal states during perceived threats. Interestingly, they consistently felt their core action component accuracy was near optimal, regardless of the appraisal. Post-performance, they exceeded their low expectations in two games (one offensive, one defensive), but generally confirmed their pessimistic pre-game assessments. This highlights how some athletes may consistently underestimate their performance, potentially holding themselves to unrealistic low standards.

The participant with mixed assessments exhibited a blend of optimism and pessimism. He was consistently optimistic about his offensive performance, believing he would perform at or above their baseline optimal level. Conversely, he was pessimistic about his defensive performance. Challenge/threat appraisals remained relatively stable, mostly indicating a challenge state. Interestingly, his feeling states were generally optimal, except for one game where perceived offensive ability was lower, suggesting that offensive self-assessment might heavily influence overall feeling

states. Despite pre-game defensive pessimism, post-performance ratings showed improvement in both offensive and defensive aspects across all games, often exceeding pre-game expectations, particularly in defence. This suggests a tendency to underestimate his defensive abilities but also highlights his ability to self-regulate and achieve good performance on both offense and defence.

Discussion

This study tested the tenets and practical application of MuSt theory (Ruiz et al., 2021a). The first purpose was to investigate the psychobiosocial states and core action components connected with the participants' optimal and suboptimal performances. The second aim was to empower participants by helping them identify and use self-regulation techniques before and during performance, raise awareness of their subjective emotional experiences, and enhance their perceived performance. Overall, the findings align with the theoretical assumptions of MuSt theory regarding the discriminative function of feeling states and core action components. Additionally, the results provide further evidence supporting the feasibility of MuSt-based interventions for enhancing self-awareness and self-regulation in high-level athletes, positioning process improvements as a foundation for future research using objective performance measures.

As expected, participants' perceptions of optimal and suboptimal performances were clearly different, thus supporting the first hypothesis. Recalled optimal performances were characterized by higher intensities of functional feeling states and more accurate execution of core action components compared to recalled suboptimal performances. Conversely, participants reported higher intensities of dysfunctional states and lower core action component accuracies in recalled suboptimal performances compared to optimal performances. These results align with earlier research (Bortoli et al., 2012; Middleton et al., 2017; Ruiz et al., 2021b), which suggests that optimal performance is related with higher intensities of functional feeling states and accurate execution of core action components.

In line with the second hypothesis, the results suggest that the intervention was successful in raising the awareness of the participants' functional and dysfunctional feeling states. All participants felt they had learned something new, their awareness had increased, and the intervention was useful. Additionally, most participants reported having benefitted from the study by gaining a tool they can use in the future. These results reinforce MuSt theory

notion that awareness of optimal feeling states is an important step in the self-regulation process. This enhanced awareness provided participants with a valuable tool for ongoing self-regulation.

The third hypothesis, which stated that participants would achieve functional feeling states and execute core action components optimally through self-regulation, received partial support from pre-game assessments. Group level results indicate that most participants were able to achieve functional feeling states before actual games, suggesting that, in most games, participants were able to identify their optimal feeling states and use self-regulation strategies. Consistent with MuSt theory, these results suggest that the intervention positively influenced participants' awareness and self-regulation to reach optimal feeling states before performance and enhanced the possibility of achieving better performance. However, no quantitative data were gathered to confirm whether participants were able to successfully implement self-regulation techniques to enhance performance during games, nor whether pre-game states translated to objective performance improvements. Future research should incorporate objective performance indicators or coach ratings to triangulate subjective experiences with actual performance outcomes and establish whether achieving desirable pre-game states indeed translates to improved performance outcomes.

In contrast to the results showing that participants reported higher levels of functional feelings states compared to dysfunctional states before actual performances, task demand/resource appraisals indicated minimal differences. This restricted range likely reflects both measurement limitations and the elite level of the sample. The two-item appraisal measure (Moore et al., 2013), while used in previous research, may be insufficiently sensitive to detect meaningful appraisal differences in professional athletes who routinely perform under maximal pressure. Given the importance of challenge and threat states for optimal performance (Behnke & Kaczmarek, 2018; Hase et al., 2018; Meijen et al., 2020; Moore et al., 2012), researchers should consider using more nuanced assessment tools to capture appraisal processes in elite contexts, as well as involving more heterogeneous participants in terms of skill level to obtain a larger appraisal variability. Other factors, such as in-game performance metrics or qualitative feedback, could also be considered to fully understand the impact of participants' pre-performance states on their overall performance.

Examining participants intra-individually reveals distinct approaches to performance appraisal, even within the same team. Individual perspectives offer valuable insights for coaches. Optimistic athletes, while confident, might benefit from expectation management to ensure realistic self-assess-

ment. Pessimistic athletes might benefit from positive reinforcement and encouragement to counter their tendency to underestimate themselves. Athletes with mixed assessments could take advantage of strategies that help them view their performance as a whole, instead of focusing on perceived strengths or weaknesses in isolation. This information is valuable for coaches in helping such athletes develop more realistic performance assessments and fostering positive performance experiences.

PRACTICAL IMPLICATIONS

The results of the current study provide valuable insight for future interventions. The findings suggest that combining action- and emotion-centred self-regulation strategies is beneficial for enhancing self-awareness and preparation processes, as predicted by MuSt theory and supported in previous literature (Morrone et al., 2024; Ruiz et al., 2021b; Viscosi et al., 2025). This combination allows performers to address both the cognitive and emotional aspects of their preparation, which might subsequently result in improved performance outcomes. The study also provided additional support to the notion that feeling states discriminate well between optimal and suboptimal performances (Ruiz et al., 2021a). This finding underscores the importance of helping performers identify which feeling states are most beneficial for their optimal performance. For example, some participants might need to focus on emotional aspects of psychobio-social states, while others might need to regulate cognitive, motivational, bodily, motor-behavioral, operational, or communicative aspects. Furthermore, the results highlight the important role of core action components in achieving optimal performance states. Therefore, practitioners should not only help athletes recognize and elicit optimal feeling states, but also identify and incorporate the key action elements that accompany these states as part of their preparation routines. By taking a holistic approach that integrates both emotional and action-centred strategies, practitioners can provide athletes with a more comprehensive toolkit for achieving and maintaining optimal performance.

LIMITATIONS AND FUTURE DIRECTIONS

The study has several limitations that inform directions for future research. First, the absence of objective performance indicators. Performance-related outcomes relied on self-reported perceptions, which are the-

oretically meaningful but insufficient to support claims about performance enhancement. Future research should integrate objective indicators, such as time on ice, turnovers, pass completion rates, goalie save percentages, or coach ratings to compare subjective experiences with actual performance. This would enable stronger inferences about whether pre-game state optimization and self-regulation skill development yield measurable competitive advantages.

Second, the lack of quantitative measures linking perceived performance to psychobiosocial states, core action components, and the in-game use of self-regulation techniques limits conclusions about the intervention effectiveness. While participants assessed their optimal and suboptimal psychobiosocial states and core action components at baseline and before games, post-game assessments focused only on self-efficacy related to defensive and offensive strengths. Future studies should include post-game assessments of psychobiosocial states and core action components to directly compare with pre-game and baseline assessments. This would provide a more detailed and useful insight into how perceived performance influences these factors. Furthermore, future research should examine the implementation of self-regulation techniques during actual performance.

Third, the low variability in challenge-threat appraisal scores raises questions about measurement sensitivity in elite contexts. The two-item measure may be insufficiently nuanced to capture appraisal processes in professional athletes who consistently perform under maximal pressure. Researchers should consider using more fine-grained appraisal measures.

Fourth, the small sample size limits generalizability, reflecting the difficulty of accessing high-level performers and the attrition risks (e.g., deselection, injuries) inherent in intensive longitudinal designs. While the intra-individual approach mitigates this issue to some extent, a larger sample size could enhance confidence in the findings. Given the high stakes inherent to professional sports, a control group was not included limiting the causal inferences of the study. Future research might consider using a waitlist control design whenever this is ethically and operationally feasible. Research examining the relationship between self-regulation and performance would also benefit from including objective measures (e.g., game statistics). Furthermore, using MuSt-theory framework, researchers should involve participants from diverse sports and competitive contexts, explore the impact of individual self-regulation on team dynamics, and employ longitudinal designs to track changes in self-regulation strategies throughout a season or career.

Conclusion

The results of the current study indicate that the intervention was perceived as useful and increased participants' awareness of their emotional experiences related to optimal performance. The findings also suggest that the combined use of emotion- and action-centred self-regulation strategies is beneficial for achieving feeling states associated with optimal performance, though direct evidence of performance enhancement remains to be established. In addition, the results provide support to the assumptions of MuSt theory and its practical application in a real-world setting. Future research is needed to determine whether enhanced awareness of functional/dysfunctional feeling states and core action components and improved self-regulation translate into objective performance gains.

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