Expertise and the psychology of recovery among endurance athletes

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Dissertation Abstract

Expert sport performance is developed by engaging in large volumes of high-quality training, particularly among endurance athletes, which must be supported by recovery. Despite the importance of recovery for sustaining and enhancing training, the concept has been largely absent from sport expertise research due in part to a lack of identified athlete-led recovery skills. Moreover, research on recovery has focused on a limited range of modalities, informed by practitioners' perspectives, at the expense of more complex, athlete-centered perspectives of what recovery may involve. The overarching purpose of this dissertation was to explore and describe the psychology of recovery in relation to sport expertise, and in doing so answer, "What might it mean for an endurance athlete to be *skilled* at recovery?". This purpose was addressed in four articles, organized in an exploratory, sequential, mixed-methods design.

Article 1 explored what recovery means to a sample of 13 elite endurance athletes with experience at multiple World Championships/Olympics. Each athlete participated in two semi-structured interviews, separated by an intervening week of keeping an activity journal of their recovery-related thoughts/actions. Using inductive reflexive thematic analysis, the findings portrayed recovery as encompassing a wide range of potential approaches that spanned multiple dimensions of feelings, levels of focus, and personal solutions. Further, the athletes assigned meaning to recovery in a particular time and context based on processes of 'defining short and long-term purposes', 'breaking and engaging', and 'negotiating and prioritizing'. These findings suggested that recovery is highly complex and individual, and that athletes define recovery according to personal and contextual conditions.

Article 2 described the process of implementing recovery from the perspective of elite endurance athletes, using data from the same interviews as Article 1. Through inductive reflexive

thematic analysis, I found that these athletes felt recovery was athlete-led: it involved processes of self-knowledge and planning (captured in the theme of ‘Knowing my body’), self-awareness and interpretation (‘Listening to my body’), and self-control and adjustment (‘Respecting my body’), all connected in on-going development (‘Learning my body’). During reflexive analysis, I further found that recovery self-regulation was integrated with people and places in the athletes’ environments in ways that supplemented, facilitated, and provided for aspects of recovery. I integrated the athlete-led themes and environment-influenced themes in the Athlete Recovery Regulation Model, a heuristic model outlining how athletes shape their recovery using a set of athlete-led skills of recovery self-regulation.

Article 3 aimed to describe how 22 elite cyclists and triathletes implemented certain recovery self-regulation skills between two key workouts, placed 2-3 days apart in their planned training. Using experience sampling methods, participants reported their momentary use of certain self-regulatory processes, as well as states of recovery and stress, up to eight times per day, leading up to and between the workouts. These processes were strongly correlated but differed in frequency, intensity, consistency, and predictors of use, which suggested that the processes represent synergistic yet unique competencies. Greater use of recovery self-regulation processes was associated with higher perceived stress and, to a lesser extent, lower perceived recovery, but there was no association with the time remaining to or elapsed after the key workouts. These findings indicated that elite endurance athletes self-regulate their recovery frequently and dynamically, largely in response to multidimensional feelings of stress.

Article 4 refined the methods of Article 3 into a more controlled, representative task to assess and describe recovery between two key workouts. Using that task, planned analyses aimed to (a) describe the patterns of recovery self-regulation employed by 16 non-elite endurance

athletes, and (b) assess those patterns in relation to the recovery of performance between successive workouts. Sixteen recreationally competitive cyclists participated remotely in two prescribed workouts, 48 hrs apart, on the Zwift virtual cycling platform. Between workouts, they participated in the same experience sampling design as Article 3. Findings showed that the non-elite cyclists also self-regulated their recovery frequently and dynamically. In contrast to the elite athletes in Article 3, this sample made greater use of self-regulatory processes specifically when experiencing physical stress, following the first workout, and use declined with time between the workouts. The recovery of performance in workout 2 relative to workout 1 was associated with more frequent use of certain self-regulatory processes, although overall, various characteristics of recovery self-regulation were not associated with performance recovery. These findings indicated that non-elite athletes engage in recovery self-regulation, albeit in potentially simpler and more reactive patterns compared to elite athletes.

This dissertation makes several contributions. It proposes that an athlete's role in recovery may be conceptualized through athlete-led skills, as described in the Athlete Recovery Regulation Model. Further, it suggests that recovery may be understood in relation to various processes and perspectives of self-regulated learning. Methodologically, this dissertation advances a proof of concept that recovery can be examined in a traditional expertise paradigm, using experience sampling methods employed around a representative task in the context of inter-workout recovery. Finally, this dissertation advances an athlete-centered and skills-based understanding of recovery, which provides an alternative avenue for applied practitioners and sport organizations to address recovery with endurance athletes. Overall, this dissertation centers recovery on the athletes who engage in it by describing skills they can own and hone to shape their recovery.

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This dissertation is the product of the combined contributions of many people over the past five years. First and most fundamentally, this research was only made possible through the time, effort, and patience of the participants in each of the studies that it contains. You cannot have "athlete-centered perspectives" without the honest engagement of those athletes, and so to them, I am incredibly thankful.

Most prominently, I want to acknowledge the incredible investment of my supervisor, Dr. Bradley W. Young, in this research and myself as a researcher. To borrow from a few familiar theories/frameworks, learning takes challenge and effort, but also passion and enjoyment. I came to work with you because I wanted to push myself to be better. You challenged me and my work, encouraged me to push back, and let me make my mistakes. You showed me how much effort and care it takes to do good work that we can be proud of (and I am very proud of the work we have done). You added fuel to the fire when I was discouraged and set me loose when I was excited. You gave me opportunities to enjoy the process of research with new people and places (Germany, CSI-P, Poland) that I would not have ever had otherwise. This document is a better dissertation because of your investment in it; I am a better scholar because of your teaching; I am a better man because of our time together. I look forward to many more years working together.

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Statement of Contributions

I, Stuart Wilson, was primarily responsible for (a) conceptualizing this doctoral research, (b) designing all studies and collecting the data, (c) analyzing the data, and (d) writing the four articles that comprised this dissertation. Given my primary role in all phases of all articles in this dissertation, I am the lead author on all four articles.

Dr. Bradley W. Young, in his role as my doctoral supervisor, was responsible for (a) providing guidance and feedback as I conceptualized this doctoral research, (b) providing further guidance and feedback during the design, data collection, and data analysis of all articles, (c) specifically acting as a critical friend, challenging my coding and interpretations, during the process of analyzing data for Articles 1 and 2, (d) editing and providing feedback during the writing of all four articles and the accompanying material of this dissertation. Given the contributions of Dr. Young, he is a co-author on all four articles in this dissertation.

Regarding Article 3, Dr. Sharleen Hoar provided guidance on the study design, co-led the participant recruitment, facilitated data collection, and provided feedback and editing on the resulting manuscript. Given the contributions of Dr. Hoar, she is a co-author on Article 3.

Drs. Culver and Durand-Bush provided conceptual feedback during the thesis proposal, as well as during our annual meetings where I updated them on the progress of my dissertation. All research procedures were examined and approved by the University of Ottawa Research Ethics Board, Office of Research Ethics and Integrity, prior to each phase of data collection in the current dissertation (Appendices A–C). This research was supported by a doctoral research award from the Social Sciences and Humanities Research Council of Canada, an Ontario Graduate Scholarship from the Ontario Ministry of Training, Colleges and Universities, and a Sport Participation Research Initiative Supplement from Sport Canada.

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GENERAL INTRODUCTION

The development of expert sport performance depends on the effective implementation of recovery. Expert performance is defined by the reliably superior execution of a variety of domain-specific physical, mental, and perceptual-cognitive skills (Ericsson & Smith, 1991). These expert skills are developed by engaging in large volumes of high-quality practice that targets and challenges an athlete's capabilities (Ericsson et al., 1993; Hodges & Lohse, 2022). In sport, expert athletes engage in more practice of a higher quality as a requisite part of talent development (Baker & Young, 2014; Young et al., 2023).

High-quality sport practice demands high levels of effort that should be matched with corresponding recovery. Recovery entails the process of restoring performance capability following stress (Kellmann et al., 2018). Adequate recovery will compensate for stress to spur adaptation and continued practice, while inadequate recovery allows stress to accumulate and may lead to negative training and health outcomes (Kellmann, 2002). Approximately 29% of developing athletes and 30% of elite athletes experience overtraining during their careers (Birrer et al., 2013; Matos et al., 2011), which indicates that a general understanding of the importance of hard work in training is not being matched with corresponding understanding or implementation of recovery.

While sport performance in training and competition can be understood and examined in terms of skills that athletes can practice and 'perfect', recovery from training has not been considered in similar terms of skills or skillful implementation. Instead, recovery is generally presented in terms of modalities administered by external practitioners and not as a property of the athlete. With this omission in mind, the overarching question of this dissertation asks, "What might it mean for an athlete to be 'skilled' at recovery?"

Literature Review

Expertise and Sport

Expertise research aims to examine and explain what separates the performance of outstanding individuals—experts—from lesser-skilled individuals in a domain (Ericsson & Smith, 1991). In sport, the development of expert performance capabilities is influenced by a variety of factors that are beyond the control of the athlete, ranging from broad sociocultural and/or geographic influences (e.g., when and where an athlete is born) to specific heritable qualities (e.g., an athlete's height; Baker & Horton, 2004). However, expertise development is also influenced by factors within the athlete's control, most notably by their sustained engagement in high-quality training.

The deliberate practice framework (DPF; Ericsson et al., 1993) provides a psychological explanation of the relationship between quality practice and performance. Specifically, the DPF assumes that individual differences in skilled performance are attributable to individuals' accumulated volume of deliberate practice, a particular form of high-quality training. Deliberate practice describes activities that require high cognitive or physical effort and are performed to improve performance, without promise of immediate reward. Ericsson et al. (1993) compared the accumulated lifetime amounts of practice meeting these characteristics between three skill-level groups of student violinists. They found that the highest-skill group had accumulated significantly more deliberate practice by age 18 than the mid-skill group, who in turn had accumulated significantly more than the lowest-skill group. While the DPF was outlined in relation to expertise in music and memory, subsequent sport research has consistently found that expert athletes accumulate more hours of deliberate practice than less-skilled athletes (e.g., Casado et al., 2020; Young & Salmela, 2010; for reviews, see Baker et al., 2020; Baker &

Young, 2014). A meta-analysis found that deliberate practice explained 18% of the variance in sport performance level (Macnamara et al., 2016), which affirms that high-quality training is necessary, but not sufficient, for the development of expert performance.

The DPF proposed that the accumulation of deliberate practice is constrained by the resources, sustained motivation, and, most relevant to this dissertation, the effort required to engage in it (Ericsson et al., 1993). Specifically, the *effort constraint* suggested that the demanding nature of deliberate practice meant it could only be performed in limited bouts that must be balanced with corresponding recovery. Ericsson et al. (1993) asked the same three skill-level groups of violinists as previously described to record the amounts and patterns of nighttime sleep, naps, and leisure time over a week of practice. The high- and mid-skill groups reported sleeping and napping longer than the lowest-skill group. The high-skill group also reported more uniform patterns of sleeping and napping (e.g., a consistent mid-afternoon nap period) compared to the two lower-skill groups. Violinists in the high-skill group were also more accurately aware of how many hours they spent engaged in leisure activities, as determined by comparing their estimations of a typical week with actual hours recorded in a diary. Altogether, this preliminary evidence suggested that experts engage in unique patterns of recovery behaviours to support their practice efforts. Considering their relationship with the larger predictions of the DPF, these patterns of engagement in recovery could enhance the accumulation of high-quality training, and therefore, the long-term development of expert performance. However, despite the promise and importance afforded to recovery by Ericsson et al. (1993), purposeful exploration of recovery has been largely absent from sport expertise research (Baker et al., 2020; Baker & Young, 2014).

This dissertation aims to initiate an intentional investigation of recovery in relation to expertise in sport. While performance on a task will be influenced by a variety of domain-general and/or inherited factors, Ericsson and Smith (1991) argued that expertise could be empirically defined by characteristics of performance that are relatively stable/repeatable by the export performer, specific to the task or domain of expertise, and are largely acquired through practice. In this dissertation, I will refer to these characteristics as *skills*. Ericsson and Smith outlined the *original expertise approach* (OEA) as a methodological framework for investigating the skills of expert performance, which comprised three steps (see also, Baker et al., 2020; Ford et al., 2009). Step 1 involved observing expert performance in its natural environment to identify key characteristics of expertise in that domain. This step is used to inform the design of constituent, representative tasks that allow experts to reproduce these characteristics of their performance under controlled conditions. Step 2 of the OEA involved examining the cognitive mechanisms that may mediate performance on these representative tasks and, by extension, explain the nature of the experts' superior performance. The external validity of these tasks is often established by demonstrating superior representative task performance by a more-expert group relative to a less-expert group. Step 3 involved determining the experiences and practice/learning activities associated with the development of these perceptual-cognitive mechanisms over time.

As an example of these steps, in study 2 of their investigation of deliberate practice, Ericsson et al. (1993) drew on observations of expert pianists to design several representative tasks of piano performance (i.e., OEA Step 1). These tasks assessed the speed and accuracy of repeated keystrokes across several increasingly complex patterns, progressing from tapping with one finger, to alternate fingers, to multiple fingers on one hand, to multiple fingers on two hands simultaneously. They then compared performance on these tasks between expert and amateur pianists and found that (i) the expert pianists were faster than the amateurs at all tasks, and (ii) the gap between groups grew as tasks became more complex (i.e., OEA Step 2). Finally, they found that representative task performance could be predicted by an individual's cumulative lifetime deliberate piano practice (i.e., OEA Step 3).

In this dissertation, I will draw on steps 1 and 2 of the OEA (Ericsson & Smith, 1991) to examine the naturalistic use of recovery skills by expert athletes, design a representative task of recovery expertise, and then use this task to examine the skills and processes that may confer an expert advantage in recovery. In order to use the OEA to examine expertise in recovery, we must first identify what constitutes performance and skills in that domain. While the performance criteria and skills of pianists, for example, are relatively clear, those characteristics are less obvious for recovery.

Conceptualizing Recovery

Recovery is an umbrella term encompassing many processes on different temporal scales that describe the return to baseline following some type of disturbance. For instance, research in physiology often refers to recovery as the time it takes performance (or a correlate like cortisol) to return to baseline (Bishop et al., 2008). This dissertation will specifically explore recovery between training sessions in a training cycle, which differs from recovery during a training session or between intervals within a training session, or recovery from a traumatic incident or injury (Bishop et al., 2008). From this perspective, training recovery is the process of restoring performance capability in response to stress (Kellmann et al., 2018).

Stress is the ongoing transaction between stressors, defined as the environmental demands a person encounters, and stress responses, defined as their reaction to those demands (Lazarus & Folkman, 1984). Athletes encounter stressors from a variety of physical (e.g., training loads), psychological (e.g., personal expectations), and social or organizational sources (e.g., teammate interactions; D. Fletcher et al., 2006). Similarly, they experience varying stress responses on psychological (e.g., pre-performance anxiety) and physical dimensions (e.g., neural, hormonal, or muscular changes; Blascovich, 2008). Therefore, stress is accumulated and experienced on a variety of dimensions, which is why the same training session may be simultaneously described in terms of both physical and mental fatigue (Kölling et al., 2015).

The transaction between stressor and stress response is mediated by various personal characteristics and processes. For instance, this relationship is cognitively mediated by an individual's appraisal or evaluation of the demands they encounter in relation to their perceived personal resources and perceived coping abilities (Lazarus & Folkman, 1984). Such cognitive mediation also typically incorporates moderating factors such as personality and relevant experiences (Blascovich & Tomaka, 1996). Physically, the stressor-response relationship is further moderated by biological factors (e.g., genetics) and physiological processes (e.g., maturation) that interact with the appraisal process (Blascovich & Tomaka, 1996). For example, a specific training session will result in certain levels of physical stress (i.e., physical fatigue, muscle damage), depending on the athlete's training status, which will be individually perceived and appraised by the athlete, which causes further physiological responses. As such, stress involves complex and reciprocal interactions between different dimensions, and one stressor can result in varying responses between individuals or within an individual over time.

The scissors model of recovery-stress states (Kellmann, 2002, p. 17) describes how recovery and stress are interrelated processes. The model assumes that stress requires matching recovery. Adequate recovery will maintain or reduce stress to allow adaptation. With inadequate recovery, stress continues to accumulate and eventually surpasses the individual's personal capacity, leading to negative outcomes of injury, illness, overtraining, and/or burnout. This model therefore asserts that levels of stress or recovery are not inherently good or bad—the value of each is defined relative to the other.

Following its interconnected relationship with stress, Kellmann and colleagues conceptualized recovery as correspondingly multi-faceted and individual (Kellmann, 2002; Kellmann et al., 2018; Kellmann & Kallus, 2001; Kellmann & Kölling, 2019). According to this conceptualization, recovery is a gradual and cumulative process that provides a break, reduction, or change in the stress experienced. Notably, they described recovery as specific to (a) the type and duration of the stressor, (b) the context in which it is presented, and (c) the individual, based on the interaction of their appraisals, needs, and preferences. To summarize, recovery encompasses states, mechanisms, and activities on multiple dimensions (e.g., psychological, physiological, social) that are employed to compensate for stress accumulated from training and non-training sources. Further, we may interpret that what constitutes 'optimal' recovery is defined by characteristics of the individual and their current context.

Measuring Perceived Recovery-Stress States

To measure this novel, multidimensional conceptualization of recovery, Kellmann and colleagues developed three questionnaires that assess an athlete's recovery-stress state as an intermediary marker of the recovery process: The Recovery-Stress Questionnaire for Sport (RESTQ-S; Kellmann & Kallus, 2001), the Acute Recovery and Stress Scale (ARSS; Kellmann & Kölling, 2019), and the Short Recovery and Stress Scale (SRSS; Kellmann & Kölling, 2019). The SRSS will be the primary measure of perceived recovery and stress in this dissertation because it is the shortest and most acutely focused of the group. This survey contains eight items that respectively assess an athlete's *current* state of physical, mental, emotional, and general (labelled 'overall') recovery and stress. As the SRSS was created from the RESTQ-S and the

ARSS and has been largely justified and validated against those two surveys, I now present the development of these surveys.

The RESTQ-S is the original and most comprehensive measure of the recovery-stress state as conceptualized by Kellmann and colleagues. This survey describes a respondent's state of perceived recovery and stress over the past three days/nights using 76 items across 12 general and seven sport-specific scales. The RESTQ-S provides a more balanced, multi-dimensional perspective compared to similar surveys (e.g., Profile of Mood States; McNair et al., 1992) that describe fewer dimensions of the recovery state and focus more on negative states (Mäestu et al., 2005). Extensive research has shown that, in comparison to objective markers of recovery, the RESTQ-S is more sensitive to changes in training load (Saw et al., 2016), and can be a better predictor of overtraining (Coutts et al., 2007). While the RESTQ-S has been the predominant measure of perceived recovery-stress states, the length of the survey and the three-day anchor it employs means it cannot effectively describe an athlete's *current* recovery-stress state.

Kellmann and colleagues developed the ARSS and the SRSS as shorter alternatives to the RESTQ-S that are anchored to an athlete's *current* perceived recovery-stress state. The ARSS comprises 32 adjectives across eight subscales—four assessing dimensions of recovery, and four assessing dimensions of stress. Confirmatory factor analysis supported this factor structure (two dimensions of four subscales each; Kölling et al., 2020). The ARSS further demonstrated concurrent validity with corresponding RESTQ-S scales and criterion validity with objective recovery markers around training (e.g., levels of creatine kinase and immunological markers; Kellmann & Kölling, 2019). Drawing on the factorial structure of the ARSS, the SRSS condenses the eight ARSS subscales into respective single items, or dimensions; each item is represented by the four corresponding ARSS adjectives. For example, for the item for mental recovery, respondents are asked how well the “attentive, receptive, mentally alert, concentrated,” apply to their current state, from “Not at all” to “Fully applies”. The measure’s authors specifically recommend that the SRSS items *not* be combined into mean recovery or stress scores, to respect the unique characteristics of each dimension (Kellmann & Kölling, 2019). Even as a shorter assessment instrument, the SRSS has demonstrated concurrent validity with the RESTQ-S and criterion validity with objective recovery markers (Kellmann & Kölling, 2019). Overall, the SRSS represents a very short assessment of momentary recovery-stress states with theoretical, psychometric, and criterion validity.

The SRSS has been used to monitor changes in recovery-stress states in relation to a variety of training stimuli (Hitzschke et al., 2017; Pelka et al., 2018; Perkins et al., 2022; Roberts et al., 2022; Wiewelhove et al., 2016) and recovery methods (Loch et al., 2020; Pelka et al., 2017; Wiewelhove et al., 2018). For example, Kölling et al. (2016) used the SRSS daily to monitor changes in the recovery-stress states of national team rowers during a 4-week training camp preparing for the junior World Championships. Loch et al. (2023) used the SRSS to compare the effects of two mental recovery strategies (powernap versus systematic breathing) during a 75-minute break between rounds of an air rifle shooting competition. The combined evidence of these examples demonstrates that the SRSS is a valid tool for measuring short-term changes in recovery-stress states around training and performance.

While some of these studies illustrate recovery-stress states in relatively ‘expert’ samples of athletes (e.g., Kölling et al., 2016), these states are not markers of expertise: States are precursors to or outcomes of skills, not skills themselves. To understand expertise in recovery, one must examine athletes’ decisions, processes, and actions to identify the potential skills they use to shape and respond to recovery-stress states.

Investigations of Recovery and Expertise

The majority of sport research considering recovery in relation to correlates of expertise has focused on differences in strategies of recovery between performance levels. For example, in a survey of 264 endurance athletes from 11 sports, those who reported finishing top three overall in competition during the past year also reported using more recovery modalities than athletes who did not report a top-three finish (Braun-Trocchio et al., 2022). In contrast, a survey of 322 triathletes from 39 countries found no significant differences between novice and competitive athletes in the frequency of recovery modalities used (Leabeater et al., 2022). Among similar large-scale survey studies with mixed-sport or team-sport athletes, higher-skilled athletes generally use recovery strategies more frequently than lower-skilled athletes (Crowther et al., 2017; Tavares et al., 2017; Venter et al., 2010).

Although these studies show precedent in contrasting performance levels, conclusions about the relative use of recovery strategies may be confounded by environmental and methodological factors. First, existing research frequently notes that the use of specific recovery strategies may be highly related to an athlete’s access to the relevant resources. Tavares et al. (2017) found that players from an elite rugby union team used more recovery modalities, more often, than players from an amateur team. However, considering that both groups rated recovery as highly important, they greatly attributed these findings to relative differences in access to recovery modalities. For example, inequitable access could explain how 91% of the elite team used massages, compared to only 23% of the amateur team, and why 78% of the elites used mechanized compression pants compared to 0% of the amateurs. Crowther et al. (2017) also specifically noted that relative access likely explained differences in the use of massage by athletes at international (100% use) and national (63% use) levels compared to those at lower competitive levels (32% state level, 45% regional level, 22% local level). In qualitative interviews, coaches have described accessibility as a key factor in determining which recovery strategies they prescribe to or implement with their athletes (e.g., Simjanovic et al., 2009). In summary, greater engagement in certain recovery strategies may be characteristic of athletes performing at elite competition levels, yet it is highly influenced by environmental affordances present at those levels. Therefore, strategy use is not a reliable property of the (expert) performer and is a poor characteristic of an *athlete's* expertise in recovery.

Studies of the use of recovery strategies also offer a limited perspective of how an athlete might engage in recovery. These studies typically survey athletes for their use of a pre-determined inventory of evidence-based recovery strategies. Listing options in a survey favours strategies that can be described in discrete, packaged interventions, such as modalities targeting physiological outcomes. For example, among their list of potential recovery strategies, Braun-Trocchio et al. (2022) asked athletes to indicate whether they used three different types of water immersion strategies ("cryotherapy", "ice baths", and "contrast baths") and seven different treatments specifically applied by a physical therapist (e.g., "cupping", "ultrasound", "dry needling"). Alongside these detailed approaches, athletes were also asked to indicate whether or not they used "socializing" or "relaxation" for recovery (e.g., Braun-Trocchio et al., 2022), without any understanding of the nuanced characteristics (e.g., what, how, where, why, with whom) that determine the scope and effectiveness of these strategies. Crowther et al. (2017) justified excluding these types of "lifestyle choices" (e.g., sleep, nutrition, fluid intake; (Crowther et al., 2017, p. 6) because they may be performed for non-recovery-related reasons. As such, extant investigations of recovery strategies fail to capture the breadth and complexity of athletes' recovery experiences.

While the broader literature on expertise and recovery demonstrates these limitations, a subset of recovery research focusing on sleep characteristics provides evidence for expertise-related differences. Sleep is a highly important and accessible form of recovery (Walsh et al., 2021). Several studies report that elite, international-level athletes sleep for longer durations and demonstrate more consistent sleep scheduling and durations than lower-level athletes (Alves Facundo et al., 2022; Caia et al., 2017; Teece et al., 2023; Wilson & Baker, 2021). Further, preliminary evidence indicates that elite athletes engage in specific sleep-related behaviours that are more conducive to better sleep outcomes, such as reducing light exposure before bedtime (Teece et al., 2023). This body of evidence indicates that elite athletes engage in specific patterns of (sleep) behaviours that likely benefit their recovery, although sleep is but one among many potential approaches to recovery.

A final consideration when reviewing recovery research is that the methods used often favour practitioner perspectives over athlete ones. Sometimes the practitioner bias is explicit. For example, some studies report on *athlete* recovery strategies based on what coaches say they “apply” to athletes (Simjanovic et al., 2009, p. S22) or what medical staff believe that athletes do during their time at home, away from practice (Altarriba-Bartes et al., 2021). Sometimes the practitioner bias is more implicit. Recovery research is dominated by accounts of recovery monitoring and recovery modalities, domains of practice that are generally the responsibility of practitioners who work with high-performance athletes (e.g., doctors, mental performance consultants, physiologists, coaches). If monitoring and modalities are properties of the practitioners, skills are the property of the performer. Currently, perspectives of the performer—the athlete—are noticeably absent from research on recovery.

Based on the available evidence, I advance that recovery has been underexamined as a skill-related quality of sport expertise because appropriate recovery skills have not been identified. Further, athlete-centered recovery skills have not been identified because research has focused almost exclusively on the practitioners and resources in the athletes' environments and not on the athlete's role in recovery. This absence of investigation leaves a lack of clarity in *how* to investigate recovery expertise. For example, whereas few would debate that expert performance in basketball involves scoring a lot of points using a variety of shooting skills (e.g., free throws, three-point shots, layups), the equivalent characteristics and processes have not been outlined for recovery from training. To engage in the steps of the OEA and examine the skills and processes of expert performance, research must complete a preliminary step of identifying and describing the characteristics of expert recovery and the skills involved, necessarily by engaging with the perspectives of the athletes who live that recovery.

Athlete-Centered Recovery

At the outset of this dissertation, two key lines of research had begun to support the notion that competitive athletes play an active role in shaping their recovery. First, Balk et al. (2017) examined how perceived recovery was influenced by an athlete's ability to create detachment from practice. Originating from research in organizational psychology, detachment describes the extent to which an individual "switches off" from their job after work (de Jonge et al., 2012, p. 324). Greater detachment reduces activation of bodily systems and promotes recovery across multiple dimensions (e.g., physical, mental, emotional); the effect is strongest when detachment is aligned with dimensions of demands and recovery (de Jonge et al., 2012). For instance, Balk et al. examined detachment in sport in a daily diary study by asking athletes to report their perceived level of demands each morning and their perceived level of detachment and state of recovery each evening. They found that when athletes reported higher sport-related emotional demands, they felt significantly less emotionally recovered at bedtime when emotional detachment was low. Importantly, detachment may be achieved using varying situational strategies. Therefore, these findings demonstrate that an athlete's state of recovery is mediated by the effects (i.e., detachment) created by their thoughts/behaviours during the day.

In a second line of research, Eccles and Kazmier (2019) illustrated the athlete's role in managing recovery as described from the athletes' perspectives. The authors used semi-structured interviews to ask members of a university field hockey team what rest means to them. The players characterized being well rested as a psychological state of feeling fresh, and valuing, enjoying, and being motivated towards one's sport. The players achieved this state by engaging in specific activities within specific physical and social environments to minimize "deleterious psychological experiences" (that impair restfulness; Eccles & Kazmier, p. 93) and seek out or create positive experiences. For example, they minimized the experience of "thinking about [field] hockey all the time" (Eccles & Kazmier, p. 93) by engaging in activities like watching television or seeking to spend time with friends outside of their team. Although mental rest is only one aspect/dimension of recovery (Kellmann, 2002), these findings indicate that athletes actively shape what might have been assumed to be a simple or inactive phenomenon. Further, this study demonstrates how examining recovery-related processes from the athletes' perspective afforded a more complex description than might have been previously understood.

These two lines of research demonstrate an active involvement in recovery that shares parallels with processes of self-regulation. Self-regulation involves self-generated thoughts, feelings, and actions that are enacted and refined in pursuit of personal goals (Zimmerman, 2000). This definition adopts a social cognitive perspective, which advances self-regulation as the interaction between personal, behavioural, and environmental processes. As such, self-regulation involves not only the behavioural skill to shape or navigate one's environment, but the personal processes (e.g., self-efficacy) to situationally employ those skills. Applied to the learning context, Zimmerman (2000) modeled self-regulated learning (SRL) as a cyclical series of metacognitive and motivational strategies implemented by an engaged learner before, during, and after a learning task. While SRL was developed to describe learning in school-related settings, it can effectively describe learning during and across sport practices. For example, an athlete may plan how to approach a specific drill, self-monitor as they perform it, and reflect afterward to inform how they approach their next practice.

SRL represents a set of mental skills that athletes may use to enhance their practice outcomes (Durand-Bush et al., 2023). In task-level research, high school girls who used process goals and/or self-recorded their efforts during practice demonstrated greater improvement in dart throwing than those who used product/outcome goals and/or did not self-record (Zimmerman & Kitsantas, 1996). Similarly, Cleary and Zimmerman (2001) compared the self-regulatory strategies adopted in practice by high-performing high school varsity basketball players (i.e., >70% free throw success in games) to groups of lower-skilled and novice players. The skilled group set more specific goals, used more technique-oriented strategies, made more strategy attributions, and demonstrated higher levels of self-efficacy than the lower-skilled and novice groups. In more macro-scale research, greater use of SRL processes has been consistently found to differ and distinguish between higher-level athletes from those performing at lower competitive levels across multiple sports (Reverberi et al., 2021; Toering et al., 2009; Young et al., 2023). In the language of the original expertise approach, SRL represents a set of cognitive mechanisms that appears to explain superior practice engagement by experts. Considering their utility as skills to describe processes *during* training, I propose that SRL frameworks may be useful for understanding how athletes manage their recovery *between* training sessions.

Dissertation Purpose

To summarize, expert performance is developed through large volumes of high-quality training, and demanding training requires corresponding recovery. However, recovery has been underexamined for characteristics of expertise that athletes may leverage to improve their training and long-term performance. Specifically, studies investigating recovery in relation to correlates of expertise (e.g., between performance levels) have focused on a limited selection of recovery strategies that are largely resource-dependent and biased towards a practitioner-oriented perspective of recovery. No studies have identified specific skills of recovery that fit the characteristics of repeatable, domain-specific, and developable properties of the athlete.

The purpose of this dissertation is to explore and describe the psychology of recovery in relation to sport expertise by addressing the overall question, “What might it mean for an endurance athlete to be skilled at recovery?”. Specifically, this dissertation will address three separate research questions with corresponding objectives:

1) “What does *recovery* mean to elite endurance athletes?”, which involves describing the meanings, experiences, and processes of recovery from the perspective of elite endurance athletes (Obj1).
2) “What athlete-led skills are involved in the process of implementing recovery?”, which involves identifying potential skills of recovery that could be validly examined as a characteristic of athlete expertise (Obj2).
3) “How are these skills implemented to effectuate expert recovery?”, which involves:
    a) Examining the skills of expert recovery in their natural environment (Obj3A)

b) Developing a representative task to assess whether these skills are reproduced and reliably executed under more controlled conditions (Obj3B).

I addressed these objectives in four articles in this dissertation. In Article 1, I described what recovery means and involves from the perspective of elite endurance athletes (Obj1). In Article 2, I described elite endurance athletes' perspectives on the process of implementing recovery to identify a set of potential skills of recovery framed in terms of self-regulatory learning processes (Obj2). In Article 3, I described how elite cyclists and triathletes engaged with the identified recovery skills during a naturalistic recovery-intensive scenario (Obj3A). In Article 4, I refined that recovery-intensive scenario into a representative task of recovery and used it to examine how non-elite competitive cyclists engaged with the identified recovery skills (Obj3B).

Methodology

The four articles in this dissertation were produced through three phases of data collection, organized in a sequential exploratory mixed methods design (Creswell & Creswell, 2018). In this section, I will describe the methodology used in this dissertation in order to contextualize, organize, and supplement the specific methods described in each article. Specifically, I will present the over-arching philosophical paradigm and structure of data collection for the dissertation, lay out the three phases of data collection implemented within this structure, and describe how these phases built on each other and translated into the four articles comprising the body of this dissertation.

Philosophical Paradigm

Critical realism contends that ontology—what is real—cannot be reduced to epistemology—what is known. This premise allows two seemingly opposing assumptions to be reconciled: (a) that humans construct their reality through knowledge, and (b) that "human knowledge captures only a small part of a deeper and vaster reality" (A. J. Fletcher, 2017, p. 182). Critical realism stratifies reality into three domains: the real, actual, and empirical domains (A. J. Fletcher, 2017). The *real* domain involves underlying mechanisms or structures that generatively cause events in the actual and empirical domains, such as the concept of expertise. The *actual* domain describes events that occur regardless of whether or how they are observed or experienced, such as biochemical stress processes in the body or movement during training. The *empirical* domain encompasses our experience or interpretation of actual events, which may differ between individuals for the same event. While critical realism does not advance the view of multiple independent realities, it does support the idea that there are multiple valid *perspectives* on reality (Wiltshire, 2018). Empirical observations from any research method are limited to the empirical domain, yet critical realism acknowledges that phenomena act beyond our knowledge of them (Wiltshire, 2018).

The philosophical framework of critical realism allows diverging narratives and lines of research on recovery and expertise to be philosophically integrated. In this dissertation, I assumed that expertise was a *real* property of individuals, which could produce actual events with an effect on recovery. I assumed that recovery would involve real social and biological phenomena that interact with actual physiological processes and behaviours to impact an athlete's actual state. I assumed that athletes individually perceive, interpret, and react to those processes and events, which reciprocally impact further processes and behaviours with real and actual consequences for recovery and training. Finally, I assumed that the varied methods used in this dissertation would provide me and my co-authors with an empirical understanding of these underlying/actual phenomena. The results of this dissertation represent my interpretations of those empirical approximations.

Population

This dissertation will focus on recruiting samples representing the population of endurance sport athletes, defined as those competing in time- or distance-to-completion events lasting over 75 sec (McCormick et al., 2015). I chose to focus on endurance sport because these athletes engage in very high workloads, even at non-elite levels (Priego Quesada et al., 2018), meaning that recovery should be a highly important and poignant experience. To understand and examine the nature of expert performance, in Phases 1 and 2 I recruited samples of elite athletes. Ericsson and Smith (1991) did not define who constitutes an ‘expert’, so I drew on the criteria for elite athletes proposed by Swann et al. (2015). In Phase 1 (informing Articles 1 and 2), I purposefully recruited endurance-sport athletes from nine sports who had demonstrated sustained international-level performance. Athletes in this sample would be defined as competitive-elite or successful-elite on Swann et al.’s (2015) scale. In Phase 2 (informing Article 3), I recruited cyclists and triathletes training with Canadian National Teams in various disciplines. Swann et al. (2015) would describe athletes in this sample as semi-elite to world-class elite. In Phase 3 of data collection (informing Article 4), I recruited a sample of recreationally competitive cyclists who compete at non-elite levels in virtual cycling races as a comparator for the findings described with the elite samples.

Data Collection

This dissertation employs three phases of data collection in an exploratory sequential mixed methods design. In this structure, initial qualitative research is used to explore participants’ understanding of a phenomenon to inform the design of subsequent quantitative research (Creswell & Creswell, 2018). In Phase 1, 13 elite endurance athletes participated in two semi-structured interviews—separated and enhanced by an intervening week of keeping an activity journal—that explored their perspectives on what recovery means and how they implement it. In Phase 2, I used experience sampling methods to capture a naturalistic assessment of the momentary use of recovery skills by 22 national team cyclists and triathletes, between two hard workouts in their planned training. In Phase 3, I used experience sampling methods to assess the momentary use of recovery skills by 16 non-elite, recreationally competitive cyclists between two prescribed hard workouts in a controlled, representative recovery task.

All three phases of this dissertation involved samples of endurance-sport athletes, defined as those competing in time- or distance-to-completion events lasting over 75 sec (McCormick et al., 2015). I chose to focus on endurance sports because athletes in this population generally engage in very high workloads, even at non-elite levels (Priego Quesada et al., 2018), which means that recovery should be a very important and poignant experience for them.

While these phases use differing methods, they are philosophically compatible. Phase 1 provided expert participants' perspectives and understanding of their recovery on an empirical level, which I used to describe the nature of recovery experiences and recovery skills and to make inferences about recovery skills in relation to expertise (i.e., actual, real levels). Phase 2 examined those inferences to provide an empirical description of actual skill use. Phase 3 extended that empirical description of actual skill use in a sample of non-elite athletes, which allowed me to further reflect on recovery skill use in relation to expertise and workout performance, which I assume to be operating at a real level.

Below I provide a summary of the methods used in each phase of data collection, to complement the descriptions provided in the individual articles. The results of Phase 1 are presented in Articles 1 and 2, which were formatted for submission to academic journals. As such, they each provide a partial understanding of how data collection was conducted, and how their respective analyses fit with each other. For clarity and transparency, I have therefore described the procedures and analyses of Phase 1 in greater detail below, and how they translate to the respective articles. Phase 2 data collection corresponds directly with Article 3, as do Phase 3 and Article 4. Therefore, those phases are summarized in relation to how they fit within the dissertation.

Phase 1: Qualitative Multi-Interview Design

Phase 1 was designed to describe recovery from the perspective of elite endurance athletes. It involved a three-part qualitative design where each participant was interviewed twice, separated by an intervening week of activity journaling. I purposively recruited Canadian athletes currently competing in endurance sports at a consistently elite level (i.e., multiple World Championships and/or Olympics). This population engages in particularly high training loads, so I assumed the experience of recovery would be especially poignant. I recruited athletes by contacting representatives at national sport organizations (e.g., administrators, coaches), through public social media profiles, and through snowball sampling. I stopped recruitment when I felt the difficulty of recruiting further participants within this highly elite population outweighed the depth of understanding that might be added through further interviews (i.e., "informational or meaning sufficiency"; Braun & Clarke, 2022, p. 17). Athletes signed up for the study by completing an online screening survey. Athletes provided informed consent for the full study (Appendix D) on page 1 of the screening survey (Appendix E), and then again verbally at the start of each interview as confirmation they had read a consent form sent to them by email (Appendix F). Participants who completed the screening survey and met the inclusion criteria were contacted to schedule both interviews at once. This recruitment process resulted in a full sample of thirteen athletes (six women, seven men; aged 25-31 years) from nine sports, as described in Article 1.

I chose to use two interviews in concert with a modified activity journal to explore recovery on multiple levels and encourage reflection by participants. Interview 1 (Appendix G) focused on ‘big picture’, conceptual questions about recovery, while Interview 2 (Appendix H) was focused on asking the athletes about more specific processes and conditions of implementing recovery. For instance, interview 1 centered around the question, “What does recovery mean to you?”, with further main questions exploring the athletes’ perceptions of why they recover, how they like to recover, and how they know when they are recovered. Interview 2 centered around the questions, “Is recovery a priority for you?” and, if so, “What determines how important or how much of a priority recovery is?”. Further main questions explored the times (i.e., of the day, week, phase, year) and situations (i.e., social, physical contexts) that influenced the athletes’ perceptions of how they implement recovery.

To help transition between the broad focus of interview 1 to the specifics of interview 2, I asked participants to complete an activity journal each day between interviews as a method of bringing awareness and reflection to the patterns of their recovery (Appendix I). The journals were introduced and explained at the end of interview 1 and returned by participants a few hours before interview 2. The journal involved recording what they did for each 15-minute block of the day, along with notes about any thoughts, feelings, or behaviours related to stress, fatigue, or recovery. I specifically explained that the activity journals were meant to prompt reflection and discussion during interview 2, so their entries would not be counted or measured as data.

I used inductive thematic analyses of the interview transcripts to address the exploratory and descriptive aims of both Article 1 (i.e., describe what recovery means to elite endurance athletes) and Article 2 (i.e., describe the process of implementing recovery). I coded all transcripts (i.e., both interviews for each participant) in two rounds. The first round of coding focused on meanings: I noted any passages that answered or informed, “What is recovery?”, which were developed into themes for Article 1. The second round of coding focused on processes: I noted passages that described how athletes managed or implemented recovery, which were developed into themes for Article 2. Therefore, codes from both interviews 1 and 2 were used to develop themes in each of Articles 1 and 2. Further, the same interview text could be coded multiple times to represent different relevant ideas in different articles. I developed the themes and wrote the results for each article separately and sequentially, Article 1 then Article 2. The results of these articles are therefore distinct but informed by each other.

Phase 2: Quantitative Observational Design

Phase 2 of data collection was designed as a naturalistic assessment of findings based on Phase 1 data collection (Articles 1 and 2) in the ecologically valid environment of their use. Specifically, I used experience sampling methods to assess the momentary use of recovery skills by 22 national team cyclists and triathletes, between two hard workouts in their planned training. This study centered on the period between two hard workouts because the findings of Article 1 indicated that this inter-workout period represents an important, recovery-intensive scenario that elite endurance athletes must consistently navigate. I employed the experience sampling method to assess repeated self-reported measures of recovery-related self-regulation because the findings of Article 2 indicated that these processes represented recovery skills that athletes use to purposefully shape their recovery from moment to moment. The methods and results of Phase 2 are presented in detail in Article 3; the appropriate appendices are referenced therein.

Phase 3: Quantitative Quasi-Experimental Design

Phase 3 of data collection was designed to refine the methods of Phase 2 into a defined, representative task that would allow recovery skills to be examined under more controlled conditions. This phase of data collection was again informed by Phase 1, in that it built directly on Phase 2. Phase 3 was similarly designed around two hard workouts, between which I employed experience sampling methods to assess the self-reported, momentary use of recovery self-regulation skills by 16 non-elite, competitive cyclists. Notably, for this phase, I standardized the conditions of the recovery-intensive scenario from Phase 2 so that it represented a representative task of recovery expertise. Specifically, the content of the hard workouts and the duration between them was standardized and prescribed to participants using an online virtual training platform, so that recovery skill use could be compared with the participants' ability to restore their performance from Workout 1 to Workout 2. The methods and results of Phase 3 are presented in detail in Article 4; the appropriate appendices are referenced therein.

ARTICLE 1

Revisiting Recovery: Athlete-Centered Perspectives on the Meanings of Recovery from Elite Endurance Training

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Abstract

Effective recovery, the process of restoring performance capability in response to training, is essential for improving sport performance. Though recovery is theoretically complex, dynamic, and athlete-determined, it has often been operationalized in a limited scope centering on perspectives that are external to the athletes. The purpose of this study was to explore what recovery means to elite endurance-sport athletes by characterizing the experiences, processes, and purposes of recovery. Thirteen Canadian elite athletes (six women, seven men; aged 25-31 years; from nine sports), each a participant in multiple Olympics/World Championships, completed two semi-structured interviews discussing their perspectives on recovery, between which they kept a week-long activity journal of their recovery-related actions and thoughts. Through inductive reflexive thematic analysis, we created two overarching themes supported by six themes. First, athletes described how recovery encompassed a wide range of potential approaches, which spanned multiple dimensions of feelings, levels of focus (i.e., a focus dial), and personal solutions. Second, several processes shaped how the athletes acted on or experienced recovery within those potential approaches, as described in themes of ‘defining short and long-term purposes’, ‘breaking and engaging’, and ‘negotiating and prioritizing’. These results expand on previous recovery research by adding the detail and nuance of athlete perspectives on how they engage with and experience recovery states and approaches. Athletes play a central role in defining and shaping their recovery, and these findings hold implications for how theories of self-regulation and expertise may contribute to further understanding athlete-centered recovery in high-performance endurance sport.

Keywords: Sport; Performance; Development; Expertise; Endurance

Revisiting Recovery: Athlete-Centered Perspectives on the Meanings of Recovery from Elite Endurance Training

Superior sport performance is developed through hard training, and hard training requires recovery. As opposed to ‘recovery’ from a specific injury or between intervals within a practice, this study sought to better understand recovery as a process of restoring performance capability *between training sessions throughout a season* (Kellmann et al., 2018). In this context, matching training with corresponding recovery helps stimulate adaptation and improvement, while inadequate recovery can lead to negative outcomes of injury, overtraining, and/or burnout (Kellmann, 2002). Recovery is often examined through specific lenses, such as its relationship with indicators of burnout or training (Saw et al., 2016) or the use of recovery modalities (Dupuy et al., 2018). These lenses effectively represent the work of practitioners who service competitive athletes, but they miss the perspectives of the athletes who are engaging in and experiencing recovery.

Recovery and Stress in Relation to Sport Training

Kellmann and Kallus (2001) conceptualized recovery in sport as “an inter- and intraindividual multilevel (e.g., psychological, physiological, social) process for the re-establishment of performance abilities” (p. 22), specifically in response to stress. Stress is an ongoing transaction between stressors, the environmental demands a person encounters, and stress responses, their reaction to those demands (Lazarus & Folkman, 1984). Athletes face a wide variety of physical (e.g., training), psychological (e.g., pre-competition anxiety), and social (e.g., conflict with teammates) stressors from performance-related or organizational sources (Fletcher et al., 2006). The relationship between stressor and response is mediated by a person’s cognitive appraisal or evaluation of the demands they encounter compared to their personal resources and perceived coping ability (Lazarus & Folkman, 1984). The results of this evaluation are associated with specific neural and hormonal responses (Blascovich, 2008), meaning that stressors of all types and sources contribute to the experience and accumulation of physical/mental fatigue. Further, appraisals are moderated by intrapersonal factors (e.g., personality traits), while responses are moderated by biological factors (e.g., genetics) and physiological processes (e.g., maturation; Blascovich & Tomaka, 1996). As such, one stressor can result in many different responses between individuals or within them over time.

Kellmann and Kallus (2001) conceptualized recovery as an umbrella term encompassing both restorative processes and outcome states, with several key characteristics (see also Kallus & Kellmann, 2000; Kellmann, 2002). For instance, recovery occurred on multiple levels, with varying physiological, psychological, behavioural, social, and environmental inputs/effects. It was gradual and cumulative, providing a break, reduction, or change in current stress. It was specific to the type of stressor, to the duration and context of the stressor, and to an individual's appraisals, needs, and preferences. Finally, recovery could be passive (i.e., biological restoration with time), active (engaging in restorative action), or proactive (anticipatory activity). This complex, contextual, and athlete-specific conceptualization now underpins the consensus understanding of recovery in sport (e.g., Kellmann et al., 2018).

Representations of Recovery in Sport Research

Recovery is commonly represented in research as a state to be monitored, or as the process of using specific modalities. Monitoring involves assessing an athlete's state of stress or recovery through various objective or subjective measures, often in relation to markers of training (e.g., training load; Saw et al., 2016). Effective monitoring is associated with the use of a few, short measures (e.g., Hooper & Mackinnon, 1995) to provide insight into an athlete's recovery status, which can be valuable for those supervising or interacting with the athlete (e.g., the coach). However, monitoring does not address the full, complex experience according to the athlete and reduces recovery into a few simple items or markers of recovery risks. As such, while research on recovery monitoring is often used to infer how training load is associated with states of recovery (Saw et al., 2016), the mediating roles of an athlete's situational appraisals, intentions, or actions have not been examined.

Research on the process of recovery predominantly focuses on the forms or modalities of recovery that athletes might use. Extensive work has examined the validity of various modalities (e.g., ice baths, compression garments; Dupuy et al., 2018), and surveyed their relative use and perception by different populations of athletes (e.g., Bezuglov et al., 2021). Research that has established best practices for the use of recovery modalities (e.g., Crowther et al., 2017; Venter, 2014) is valuable, but it is limited by *what* content is reported by *whom*. Selection bias may favour the assessment of more readily measurable forms of recovery, such as discrete modalities (e.g., cold-water immersion), over less packaged “lifestyle choices” (Crowther et al., 2017, p. 6) which may be more difficult to isolate experimentally. Such methodological choices arguably favour more medicalized, physiological, modality-based recovery perspectives (e.g., Doherty et al., 2021) over more complex, experiential ones.

Overall, strong research traditions around monitoring and modalities mean perspectives on recovery favour what researchers/practitioners do, see, and measure, failing to capture athlete-centered complexities of engaging in recovery. Thus, the extant literature risks framing athletes as compliant machines to be tinkered with, largely devoid of agency (Denison et al., 2017). For example, recovery has been operationalized as what coaches report “applying” to athletes (Simjanovic et al., 2009, p. S22) or what medical staff believe athletes engage in (Altarriba-

Bartes et al., 2021). Coaches and staff can reasonably comment on what athletes overtly do or share with them around training sessions, but hold little understanding of athletes' intentions, motivations, or actions during the "other 22 hours" of the day outside practice.

Athlete-Centered Recovery

Integrating athlete perspectives into conceptual understanding can improve the relevance and application of associated research. For example, Eccles and Kazmier (2019) interviewed players and coaches on a university women's field hockey team to understand their perspectives on what constitutes, drives, and results from the experience of mental rest. They presented these findings in a descriptive model of the psychology of rest, which identified five deleterious psychological experiences and seven restful ones. This model was subsequently used to inform practical recommendations for promoting mental rest grounded in an athlete-centered perspective (Eccles et al., 2022). Though mental rest is only one part of recovery (Kellmann, 2002), this work illustrated how an athlete-centered approach can embrace the complexity of restorative processes around high-performance training.

To summarize, primary evidence describing athletes' perspectives on recovery is remarkably lacking from current sport research. A bias towards researcher- and practitioner-based perspectives has contributed to an incomplete understanding of recovery, composed of menus of modalities or reductionist monitoring. To provide a more fulsome narrative, our study aimed to explore what recovery from training means to elite endurance-sport athletes. Specifically, we sought to describe how these athletes characterize the experiences, processes, and purposes involved in their recovery.

Methods

Participants

We purposively recruited elite Canadian endurance athletes, selected because their sports and competition level involve characteristically high training loads where recovery should be important. Endurance athletes were defined as training for performance in time- or distance-to-completion events over three minutes. To be ‘elite’ (Swann et al., 2015), athletes had to: (a) be from an Olympic sport, indicating its global relevance; (b) have competed in a major global championship (MGC; Olympics or Senior World Championships) in the past two years, indicating current high performance; and (c) have competed in at least two MGCs in their career, indicating sustained success. We recruited participants through National Sport Organizations, social media, and snowball sampling, aiming to maximize the number of sports represented and maintain an approximate gender balance. We stopped data collection at a point resembling Braun and Clarke's (2022) description of "informational or meaning sufficiency" (p. 17) when we felt little depth could be added with further interviews, while acknowledging the difficulties of recruiting further participants within our limited pool of highly elite participants.

Thirteen athletes participated (six women, seven men; aged 25-31 years) from biathlon (*n* = 3), cross-country mountain biking (2), track cycling (2), marathon running (1), rowing (1), triathlon (1), long-track speed skating (1), flatwater kayaking (1), and swimming (1). All had competed in a MGC in 2019 or 2020; after the study, 11 competed in a MGC in 2021. Pre-interview, they had competed in 2-13 total MGCs in their careers (*M* = 5.1, *SD* = 3.0) and multiple other global championships (e.g., junior, U23, Commonwealth Games), had been training competitively for 8-23 years (*M* = 13.0, *SD* = 3.8), and had been part of the senior National team for 3-11 years (*M* = 6.5, *SD* = 2.5).

Philosophical Position

We approached the research aim with a philosophy of critical realism, which asserts that ontology (i.e., what is real) cannot be reduced to epistemology (what is known) and instead stratifies reality into real, actual, and empirical domains (Fletcher, 2017). The *real* domain involves underlying causal mechanisms and biological processes of stress which produce *actual* events, occurring regardless of whether or how they are observed or experienced (e.g., an athlete's physical movement during practice). The *empirical* domain encompasses our experience or interpretation of actual events, which may differ between individuals for the same event (e.g., athlete's experience of fatigue, researcher's interpretation of an interview). We assumed that recovery involves underlying biological processes of stress and regeneration which lead to changes in an athlete's state or performance that are experienced and interpreted individually. The understandings of recovery presented herein are the researchers' interpretations of those experiences, co-constructed in conversations with the athletes.

Design and Procedure

We employed a three-part qualitative design where each participant was interviewed twice, separated by an intervening week of activity journaling. We followed recommendations to consider looking beyond the traditional one-off interview (Smith & Sparkes, 2016) as a way of moving beyond hypothetical discussions to richer, more specific examples. Using two interviews allowed the time to explore both conceptual and practical questions, build rapport with each athlete, and encourage a more open conversation about the realities of their recovery. The activity journal encouraged the athletes to reflect on their recovery and brought specificity and context to interview 2. We obtained ethical approval from the host institution (Appendix A). All participants provided informed consent (Appendix D) and completed an initial online screening form (Appendix E) to collect demographic information and verify they met inclusion criteria for performance level.

Interviews 1 and 2 used semi-structured interview guides of focused but open-ended questions to give participants the agency and flexibility to shape conversation (Smith & Sparkes, 2016). All interviews were conducted and audio-recorded using videoconferencing software (Zoom, n.d.). We used four pilot interviews with collegiate/national-level athletes to shape and refine these guides, removing questions that were too theoretical or too closed. The interview 1 guide was built around main questions addressing our research aims (Appendix G). After opening questions asked athletes to describe their history and experience of training for competitive sport, four main questions explored the meaning ("What does recovery mean to you?"), purpose ("Why do you recover?"), experience or sensation ("What does it mean/feel like to (not) be recovered?"), and behaviour of recovery (e.g., "How do you like to recover?"). Each main question was meant to explore a different way that athletes might make meaning of recovery, and the interviewer (the PI) used follow-up questions to probe meanings which seemed to elicit greater engagement from each athlete. Interview 1 lasted 31-77 minutes (*M* = 49).

The activity journals served as elicitation devices for interview 2 (Smith & Sparkes, 2016), informing discussion by representing patterns and examples of (non-)activity (Appendix I). Following interview 1, athletes were asked to complete an electronic or printed version of the journal; both versions resembled activity logs used in time-use studies (Deakin et al., 2006) with extra space provided for personal notations. They were asked to record what they did for each 15-minute block of the day, for seven consecutive days, noting any thoughts, feelings, or behaviours related to stress, fatigue, or recovery. We explained that the journals were meant to prime them to think about recovery and prompt further reflection during interview 2 and that there would be no quantitative categorizing or measuring of activities noted. Athletes returned their journals by email 1-3 hours ahead of interview 2 so the interviewer could review them and make notes in preparation.

Interview 2 explored the processes involved in the implementation of recovery (Appendix H). The PI began with a form of member reflection, by summarizing his notes from that athlete's interview 1 and asking each athlete for feedback. The athletes were then asked to familiarize the PI with their journal by reviewing the week and highlighting anything notable, and the PI asked follow-up questions as these points related to recovery. The interview 2 guide was centered around the question, "What determines how important/meaningful recovery is to you?" with specific questions pertaining to the social (who?), temporal (when?), and environmental (where?) conditions influencing how the meaning of recovery may have changed across context. The athletes were encouraged to use the journals to illustrate (non-)examples (e.g., "here I did *this*, but normally I'd do *that*"). The PI then had the opportunity to explore anything yet to be discussed that he had noticed when reviewing the journal (e.g., the consistency or not of bedtimes, clarification on whether the athlete considered a documented journal activity part of their recovery or not). The final question asked what the athlete had learned about recovery over their career. Interview 2 lasted 44-103 minutes (*M* = 70). One athlete chose not to complete the second interview due to circumstances related to their sport but gave permission to include their first interview as data.

Analysis

We used an inductive reflexive thematic analysis to describe the characteristics and experience of recovery, guided by the six-phase process outlined by Braun and Clarke (2020). Interviews were transcribed verbatim into 379 pages of single-spaced text. Transcripts from both interviews were collated by participant, and both authors read all transcripts, making notes to familiarize themselves with the depth and breadth of the data. The PI analyzed each transcript line by line and created codes comprised of words, sentences, or paragraphs conveying an idea related to recovery, fatigue, stress, or training. The same text could be coded multiple times to represent different relevant ideas. Coding and theme development used a combination of semantic and latent approaches depending on what best answered the research questions. While most coding and some theme development involved relatively explicit meanings of recovery (e.g., recovery can be characterized by physical and mental feelings), most theme development involved creating latent meaning that tied together differing experiences, processes, or examples of recovery. After the PI coded four initial transcripts, both authors met to discuss initial codes and patterns. The PI continued coding additional transcripts and began to develop low-order subthemes, which were re-grouped, defined, and labelled into larger themes. The authors met again after the eighth and after the final transcripts were coded to discuss the coherency of all subthemes and themes, the supporting evidence for each, and to ensure they addressed the research question. The second author served as a ‘critical friend’ (Smith & Sparkes, 2016), inviting the PI to consider alternate interpretations and perspectives, and strike a balance between the variability of experiences and coherency across individuals.

Methodological Rigour

Quality reflexive thematic analysis comes from “the researcher’s reflective and thoughtful engagement with their data and … with the analytic process” (Braun & Clarke, 2019, p. 594), and critical realism describes empirical reality as our subjective understanding and explanation of real events. Thus, we ensured participants and researchers had opportunities to reflect on and contextualize their experiences. For athletes, the interview 1 lead-in located discussion in their past and present training, the activity journal promoted their reflection on "actual" recovery, and interview 2 began with intentional member reflection. As researchers, we did a bracketing exercise of writing and discussing our experiences/views of training and recovery entering the study. We noted our experiences as coaches and athletes in endurance sports, our shared professional interest in psychological characteristics of phenomena, and our research-informed beliefs that there are better and worse ways to engage in recovery. We acknowledged how our interpretations would be influenced by prior research on rest (e.g., Eccles & Kazmier, 2019) and recovery (e.g., Kellmann, 2002). Finally, we acknowledged the cultural-relational ethic whereby athletes likely perceived the PI as being an 'insider' because of his experience in high-performance endurance sport, being an 'outsider' from their specific sport and/or performance level, and being the representative of 'science' or 'research' in the conversation. We perceived this positionality through, for example, some early defensiveness by the athletes (e.g., "I don't know what science says, but I think...") that dissipated as the PI developed familiarity with them and displayed an understanding and appreciation of their experiences in their sport.

Transparency and Openness. All methods are appropriately cited in the text, and no additional external code or data were used. This study's design and its analysis were not pre-registered. The raw data on which these conclusions are based (i.e., verbatim transcripts) are not available for access because ethical approval for the study was contingent upon maintaining the anonymity of our participants, who represent a very small and select group and are easily identifiable through their full transcripts.

Results

We found that athletes' descriptions of recovery represented two somewhat paradoxical themes. On one hand, (1) Recovery was *potentially* broad, meaning that athletes described recovery approaches according to a wide array of potential behaviours and experiences. That said, (2) the athletes sought certain recovery approaches/experiences depending on the time and context, as guided by their personal aims and appraisals. The results are organized into two overarching themes, each supported by three themes with respective subthemes. First, we outline how the athletes characterized the breadth of what recovery *can be*, variably according to (a) multiple dimensions of feelings, (b) a range in levels of focus, and (c) a variety of personal solutions. Second, we describe how the athletes shaped recovery to their context through processes of (a) defining short and long-term purposes, (b) breaking and engaging, and (c) negotiating and prioritizing. Understanding training was not a study aim, however, we found that the athletes generally grounded their understanding of recovery in their perspectives on training, often explaining the former in relation to experiences of fatigue/stress. A preliminary section presents this context before the main results. All athletes have been assigned pseudonyms.

Preliminary: Perspectives on Training Demands, Fatigue, and Stress

The athletes attributed a *specific purpose* to each training session, week, or phase/block, such as achieving a standard of performance or movement "quality," experiencing a certain feeling or effort level (e.g., feeling "relaxed"), or taxing a specific training characteristic (e.g., volume, strength endurance). They then defined their training using *specific parameters* which either accomplished or embodied that training purpose, often speaking first in terms of volume (e.g., hrs or km per week), then qualifying it with a measure of intensity, whether objective (e.g., watts, speed, heart rate) or subjective, like perceived effort, importance, or the "degree of mental sharpness and engagement" (Zoe) demanded from a session. Finally, training was defined through the *specific demands* it created, like fatigue or stress.

The athletes described fatigue in nuanced detail. They distinguished between the muscular ("tightness"), metabolic ("burning"), and performance ("no easy miles") aspects of physical fatigue, or between the cognitive ("zombie-like"), emotional (e.g., moody), and motivational ("I just don't want to get off the couch") facets of mental fatigue. High volume training caused "dull or deadened" feelings, while high intensity training elicited "anxious, stressed" feelings of arousal (Zoe). Further, the "totally spent, on hands and knees, destroyed feeling" (Charlie) of acute fatigue differed from the persistent exhaustion of chronic fatigue. Fatigue was a central experience of being an endurance athlete, but as Fiona stated, not an enjoyable one: "I spend most of my days just feeling not good on a bike." Despite this, Ryan explained that "fatigue is an indication that you're working hard, that there's going to be a payoff.… like, 'I'm supposed to be tired'." The athletes coped with negative experiences of fatigue because of its perceived importance to the training process.

The athletes spoke mostly in terms of fatigue but described it within a larger concept of stress which included non-training sources: "Stress is stress. It doesn't matter if it's relationship, or logistical, or training-derived, it's a stress" (Zoe). Just as training fatigue expanded to take time and energy from other activities, demands outside of sport compounded to "create stress that doesn't allow you to recover. You have a big fight with your friend, or somebody cuts you off when you're [cycling] and you're just stewing in it" (Charlie). The athletes had to account for stress from all sources because "your body just interprets it as stress, it doesn't know what it is. It's just load. Load is load" (Zoe), and they felt that all load impacted training.

Every athlete reinforced that performance was built on high-quality training, and training depended on recovery. Olivia said, “It doesn’t matter how hard you train, if you don’t recover properly it’s not gonna work. I would say having good recovery is as important as training itself.” The athletes differed in weighting the relative importance of training and recovery—some valued training more, some valued recovery more, some valued them equally— yet all described them as interdependent. Charlie explained, that with his volume of training, “it’s a lot of wear and tear on the body, so the more consistent you are, the more training you can do at a high level. So definitely, your ability to train and succeed is a function of your recovery.”

Recovery Encompassed a Wide Range of Potential Approaches

The athletes described a wide array of experiences, behaviours, and states involved in recovery. We characterized this variety using three themes, capturing the range of feelings, levels of focus, and personal variations that recovery could encompass.

Recovery Was Experienced across Multiple Dimensions

Athletes characterized recovery as the presence or absence of specific feelings across physical and mental dimensions, interpreted as degrees of relative readiness. These feelings could be experienced in distinct dimensions or holistically.

Physical Feelings. The athletes described physical feelings of recovery with a similar nuance to those of fatigue. They associated feeling recovered with specific feelings in their body or muscles, such as “lightness,” “suppleness,” or “freshness,” and the absence of feeling “bogged down” or “beat up”. They also described performance-related feelings; when they felt recovered, “the [training] efforts are just lighter … there’s that easy speed” (Fiona). Similarly, James noted, “I feel like I can execute the moves with quality. Things that were more challenging five days ago become less challenging, just because of how my body feels”. The athletes were so used to feeling physically fatigued that recovery was strongly defined by its absence. James noted that feeling highly physically recovered was so unfamiliar that when it did happen, he could be extra sensitive to those feelings and how to interpret them.

Mental Feelings. Feeling recovered included some cognitive elements (e.g., feeling "sharp" in the absence of cognitive fatigue) but athletes focused more on emotional characteristics. Zoe felt "the goal of the rest day is to enjoy it and feel good, and I've done a successful rest day if I'm able to go to sleep feeling content." Along with feeling happier and more relaxed, Theo described a strong optimism associated with recovery, while James noted a greater emotional depth with recovery that contrasted with the dullness or irritability of fatigue. Athletes associated these emotions of recovery with feeling "reinvigorated", with a strengthened motivation to "want to go to practice. Wanting and [being] able to be there in the right headspace" (Eva).

Holistic Feelings. Although the athletes often explicitly described distinct physical or mental feelings of recovery, sometimes they combined these dimensions into feelings beyond the sum of their parts. Zoe described recovery as a feeling of "freshness" or "readiness," explaining that her main goal was just to finish a recovery activity "feeling better than when I entered it, … [which involved] all sorts of different variables beyond mental, emotional, physical. It's just this all-encompassing thing that I don't know if I could describe, but you know it when you feel it." Athletes wove various physical and mental feelings together to create their fulsome recovery picture. For example, Zoe experienced recovery as feeling:

> An absence of muscle soreness, but [also] a sense of muscle engagement, like a little bit of tension in the legs almost. …I'm energized and I have like enthusiasm for what I do. Recovery brings a sense of optimism that I don't often have when I'm fatigued. Like,

> optimism in my [athletic] potential, or for life in general. Feeling recovered also comes with a lot of perspective. So when I feel recovered, I'm generally excited to race, but I'm also like, 'well, I can't control what happens, but [racing's] gonna be fun either way'.

This quote shows the complex meaning of recovery, as it combines the presence of certain feelings (e.g., "muscle engagement") with the absence of others (e.g., "muscle soreness"), and combines physical and mental feelings into holistic characterizations.

A Focus Dial of Recovery

Beyond the sensory dimensions, approaches to recovery varied in the level of focus and effort required, which some athletes described as being more/less "dialed in." We adopted this metaphor of a dial (e.g., on a control panel) to describe how the focus level towards recovery could vary for both what athletes did and how they did it.

Dialed In. Dialing in recovery represented approaches that were more deliberate, detailed, and geared towards optimizing short-term performance. It generally focused on recovery with more direct benefits suiting immediate training demands. For example, Ryan explained that, during a high training load week, "I'm not going to really do a whole lot of anything else in my spare time. … not a lot of [time with] friends, not gonna visit family. … I'm training, recovering in-between, and just getting myself ready for the next day." Eva described how a narrowing focus often meant sacrificing other parts of her life:

> When you're very tuned into that 'dial', you're only tuned into that. …Your mind is solely focused on like, 'What is the next day going to look like? What are the things that are important right now?' This is definitely that time where you gotta really take care of yourself and worry less about all the other factors that you might normally do.

Dialing in recovery often required greater discipline and focus on executing details. Being dialed in did not mean recovery was more important, just that “I have to be more deliberate about the practices that I’m using. …Very dialed in with nutrition, willing to nap in the middle of the day, stretching, foam rolling, getting out for an evening walk” (Zoe), or as Eva characterized, doing “all those little things that definitely make a difference.”

When the athletes spoke about “good” recovery, it was often in reference to variations of a dialed in approach. For example, Quinn wanted to “be better at recovery”, which he felt meant, “instead of standing and like baking or whatever, like actually sitting down in the compression pants and recovering.” Recognizing this trend, the PI asked subsequent athletes why they would not always take a deliberate, disciplined approach, to which Fiona responded, “Because it’s time consuming. And taxing. So it takes away from other things you could be doing.” Dialing in recovery was potentially more effective in the short term, but it seemed to place greater self-regulatory demands and time demands on the athlete. Olivia described that dialing in recovery “takes planning, and organization, and time, and being diligent, which adds a mental stress, just doing that. By being focused on that [type of recovery], you are using mental energy.” Because of these extra demands, Charlie noted, “on a recovery day, I’m not going to do a whole lot of like crazy recovery modalities. Because mentally, that takes a lot of work as well”, while Zoe explained, “when I’m mentally fatigued, it would make it worse to like sit in the [compression] pants or foam roll, or add more active recovery techniques, because that just feels like more training.” The athletes conveyed a limit to how much and how often recovery could be dialed in.

Dialed Out. Dialing out recovery was more person-focused, and less deliberate or detailed. It addressed more general, long-term sustainability and well-being, involving approaches that were more emotional or spiritual (not necessarily religious). To Fiona, "everything is recovery. Because it's like, you as a person have to be able to get up the next day and do your training." She explained:

> A lot of people are like, 'Stay off your feet!' [Whereas] I think, just get outside and do something, find what makes you happy. …We make good coffee every morning, recovery rides are to somewhere [fun], go watch the surfers. …Go for a swim, go to the beach, do some things just to kind of create a bit more balance.

These examples embodied a broader sense of restoring and fulfilling the athlete as a person, which supported the motivation to sustain sport engagement. Fiona related, "there's just a big piece that I have to enjoy what I'm doing. … I've been doing it too long to not enjoy it." Logan added, "some people go a whole season and they're dry [no alcohol] and they just let it loose [post-season]. I kind of like rewarding as you go, kind of enjoying the process." Dialed out forms of recovery avoided using parameters similar to training (e.g., volumes, intensities) and instead targeted qualities that could indirectly benefit performance by sustaining training over time.

Dialing out recovery involved a less demanding, disciplined approach to common forms of recovery. James juxtaposed dialing in nutrition in-season, where "[it] gets boiled down to this, like, meal-by-meal, day-by-day, changing [with] what the needs are," with the off-season, where he might "do a two-hour bike ride and [not] eat right after, and I won't worry about it." Talking about dialing out her sleep, Olivia noted that "not having to focus on all the small things—like being hyper-vigilant about, like, going to bed exactly on time and doing this and that—part of that is mental recovery." The athletes traded in the incremental benefits of better sleep or nutrition when a relaxed approach brought greater benefits. Olivia highlighted this during her off-season, when "I'm not focusing on recovery strategies, but it's still the recovery month. By doing nothing you're recovering, but you're not emphasizing doing recovery things."

Recovery Was Personalized

Recovery was personalized to suit each athlete’s preferences, personality, and body. The athletes identified personal characteristics that shaped how they experienced and addressed recovery. For instance, Zoe described her personality as “definitely a little bit neurotic,” which increased her mental recovery needs, but also meant that, “I’m very detail-oriented and determined to do things properly. If my coach says, ‘you shouldn’t be [cycling] for this number of hours, or the dietitian gives me a macronutrient breakdown for a post-[training] meal, I will do that to the letter.” Athletes also noted how their recovery was impacted by social preferences, often in reference to control over schedules of training/recovery or casual non-training situations. Olivia said, “I am fun and outgoing. So having social aspects and having things outside of training for me is important”; whereas others prioritized having time alone, especially when travelling or training with a team. Finally, some athletes noted their individual capacity for engaging and/or maintaining certain recovery approaches. For example, James described his capacity for an “emotional tolerance for [recovery]. … [I] can do all the [prescribed] stretching and it doesn’t seem to take a lot of energy from [me], whereas some people just can’t even bring themself to do it.” Physically, athletes felt their recovery needs were dictated by characteristics of their body, such as resilience to training load, injury history, and sleep needs. Zoe used the metaphor of certain athletes being “Ferraris,” who “are like pure rocket fuel athletes. They need so much sleep and recovery between sessions, and they operate on lower volume,” versus “Diesels,” who “can handle a lot higher volume physically and [they] just don’t get quite as smashed.” For Sean, the need to manage the residual effects of an extensive injury history had catalyzed his greater commitment to recovery, while Olivia felt that “having a body that somehow hasn’t been prone to injury has made me less …hyper-focused on recovery as a prevention of future injury,” allowing her to focus on other forms of recovery instead.

The athletes emphasized how the content and process of their personal recovery differed from those of other athletes, and how developing that individuality was key to athletic growth. Eva related how, when she started on the National team, “you're told so many different things—you’ve got to do this, got to do that—but it's how you grow, evolve, and learn what's best for you that’s more important for your recovery. As opposed to [following] what everyone else does.” Nonetheless, many athletes struggled with how what worked for them contrasted with pre-conceived, popular, or prescribed notions of recovery. Eva exemplified this internal debate – she identified herself as “bad” at recovery because she *assumed* that “lots of people would be like, ‘you're not good at it … you don't sit down enough to take the time for recovery’,” while countering, “but I also don't think that [sitting down more] is ideal recovery for me. …I think what I do [activities outside sport] is what’s good for me.” Athletes gradually optimized what worked for them by comparing their approach to recovery with other athletes and norms.

Recovery Was Contextually Specific

Within the broad range of options that recovery could involve, several distinct but concurrent processes shaped how the athletes acted on or experienced recovery. The athletes sought recovery according to three different processes depending on time and context, as described in the following three themes.

Recovery Was Shaped by its Purposes

Recovery was a goal-oriented process, as the athletes viewed it with short-term purposes of absorbing and preparing, couched within the long-term goals of sustaining and accumulating.

Athletes focused most of their energy on short-term recovery goals, trusting that doing so consistently would lead to achieving long-term recovery goals.

Absorbing and Preparing. The short-term purposes were to *absorb* the previous training session and *prepare* for the next one. As opposed to negating or erasing the stress of a prior session, recovery was the process of “allowing your body to process what you’ve done” (Logan) to “absorb all of the training from the big weeks” (Olivia). Absorbing meant adapting to useful parts of stress (e.g., fatigue to stimulate growth), while minimizing the residual effects of unhelpful parts of stress (e.g., excessive lingering pain/soreness): “If I’m uncomfortable on the bike or [a muscle] is tight, then I’ll do those recovery processes. …You just want to be able to do your six hours [of training] the next day without being in mad pain” (Quinn).

Beyond absorbing, the athletes framed recovery as the process of preparing for the next session, which they discussed three ways. Sometimes, preparing meant *restoring* the capability to train, where athletes used recovery to “recharge,” “recoup,” or “remain functional.” Logan said, “Why do I recover? So I can do the same thing I did yesterday, tomorrow.” A step up from restoring, preparing could mean *maximizing* outcomes in the next session. Charlie explained that “you need to do stuff like [using] a foam roller, doing stretches, to make sure you have the range of motion to get the most out of your running stride the next day.” Zoe discussed how keeping recovery rides easy allowed greater investment in a subsequent hard session, while going too hard on easy rides limited the next effort. While assuming that all his elite competitors were “out there smashing themselves” and training hard every session, Charlie felt that those “who aren’t putting that time and effort in [to recover], they’re losing out because they’re just not getting the most out of their body” (Charlie). Recovery prepared athletes to get more out of an equal effort.

Finally, preparing could involve *managing* unhelpful outside stressors (i.e., those not leading to beneficial adaptations) so they did not interfere with training-focused processes. To James, much of recovery was about “[doing] my best to take care of stuff that needs to be taken care of as a person. Stupid stuff, like calling FedEx about my package. Things that wear on you if you don’t do them.” Managing these stressors better prepared athletes for training, while also preserving the quality of other recovery experiences like rest days. Zoe avoided filling her rest days with chores as a way of "protecting [her] recovery," and pointed out that all the zoom meetings and errands in her activity journal were placed on training days as a way of grouping stressors. Anna recognized the negative impact of minor stressors, which prompted her to “look for [recovery] in different scenarios throughout the day. … Even on our travel day, we almost missed our flight, but I felt that I had [the psychological] tools so I didn’t get stressed out and waste energy.” Saving “energy” by avoiding unhelpful interactions throughout the day helped Anna feel better prepared to engage with her next training session.

Absorbing and preparing are somewhat paradoxical goals: absorbing meant appreciating how stress stimulated adaptation, while preparing meant minimizing stress. The athletes balanced these goals by seeking a state of being *recovered enough.* Gabrielle explained that “our recovery goals are to try to be ready to ride [cycle] the next day, but not necessarily to perform every day. … Ready to ride, but not like at a racing standard.” Zoe described how this balance shifted over a training year, where “being tapered for a World Championship, that would be like a 10 [out of 10] on the scale of feeling like recovered and energized, but it would be counterproductive to shoot to be that recovered most of the year because you need the stress to improve,” so most of the time “we’re maybe aiming for feeling like 6 to 7.5 recovered … and there are periods of the year where you want to be like in the hole a little bit, if you feel like a 4, that's OK, we're doing it right." Feeling recovered enough represented a level of optimal recovery: fatigued enough to promote adaptation, while prepared enough to train effectively.

Sustaining and Accumulating. Executing short-term cycles of absorbing and preparing led to achieving longer-term purposes of maintaining *the sustainability* of training while *accumulating* the capacity for greater future training. Ryan explained:

> If you don't undertake proper recovery, …then you don't perform as well in your next workout, which impacts the next workout and it's like this cascade of events … [where] eventually you get to the end of a training block and you might be super dead tired. … If you're not doing the proper recovery, you're missing out on that extra little bit that, you know, over the course of an entire season probably adds up to a significant amount of training hours that you're not capitalizing on.

Quinn echoed this pursuit of incremental advantages, viewing training and recovery as a daily challenge of "how much can you load into yourself, and then can you recover from that to sustainably load the most into yourself again, and then again, the most." He engaged in that challenge because "the [more elite] you get, the more you have to load in [during practice], which means the more you have to recover to stay competitive." Daily recovery was often motivated by the promise of long-term benefit and supported by trust and faith that "I'm doing all of these [recovery] things because I think they will help, I just can't guarantee when" (Anna).

By using recovery to manage stress and avoid setbacks, the athletes believe they gained an advantage in sustaining training. Athletes used different metaphors to convey this, such as "riding a fine line" (Logan), just trying to "keep your head above water" (Gabrielle), or likening fatigue to a "physical debt accrued after a hard workout" (Ryan) that you have to pay off on time, "so that it doesn't hit you super hard at the end of the [training] week." Inadequate recovery equated to mismanaging the accruing stress, which resulted in mental and physical setbacks. Sean felt that without focusing on his recovery, “I definitely wouldn’t be able to train at the level that I’m training right now, … I’d definitely have more shoulder or back injuries,” while Zoe attributed having a “major breakdown” to realizing that “the [COVID-19] pandemic just added a lot of weight to the stress side, and I didn’t balance that properly with recovery.” Sustaining required that the athletes manage the direct stress of training, but also its indirect costs. For example, Olivia explained that in biathlon:

> It takes so long to get to the top, that if you’re so serious when you’re 18 that you never hang out with your friends, never have a little bit of fun in the summer, then you’re never gonna make it to being 26. You’re gonna burn out. … It’s mental recovery in a sense, like making sure you’re still part of your peer group and you’re still having fun and doing other stuff [outside sport], so that from a longevity point of view, you’re not gonna be tired of just taking a nap every afternoon and feel like a grandma by the time you’re 26.

Athletes recovered in the short term to ensure that physical and mental setbacks did not develop into longer-term issues that might impair the sustainability of their training.

Breaking and Engaging

Recovery often involved taking a break from specific demands to engage in something restorative. Ineffective recovery was characterized by an insufficient break and/or engaging in an inadequately restorative activity. Athletes described these processes on three levels, detailed below.

Breaking from Demanding Training to Engage in Easy Training. Athletes took a break from physically, mentally, or structurally *demanding* training to engage in *easy* training, which was characterized as less mentally/physically taxing or more self-directed. This “switch” was often facilitated by a change in location, social group, or form/parameter of exercise. They identified certain workouts, days, weeks, or training blocks as recovery because these provided an opportunity for alternative engagement. Ryan explained how in a recovery week:

> Training hours are really low, but you also just have the freedom to kind of do whatever you want. That's to give us a break, physically and mentally … so that when you come back you're mentally refreshed, and eager and motivated to get back into training.

Recovery provided relief from the physical and the self-regulatory/motivational demands of a prescribed, expansive training plan and its associated activities (e.g., dialed in recovery).

Breaking was more than an absence of demands; athletes engaged in easier training by intentionally altering features of their training task or environment. For example, Zoe got a break from training structure through an off-season period of "training freedom" described as, "pure autonomy. It's not coach driven or directed, … you can do whatever you feel like and there's no stress associated with it." Other athletes altered their task by engaging in enjoyable cross-training (e.g., cycling for speed skaters), or by placing boundaries on their main sport. For example, Fiona had a rule that when cycling for recovery, "[my] cadence matches watts. It's like 90-90, so it's a very chill day for me." Athletes altered their social environment to promote recovery by recruiting certain teammates for training or, depending on their preferences, going alone. They also engaged with specific physical environments. Logan pointed out in his activity journal that he sometimes took the time to drive to a specific location for a recovery run, instead of just running from his house. He explained that, "[on] easy days, I love getting out into the mountains or forest and hitting a single-track trail, not worrying about pace, and just running. [That] helps my body physically and mentally." Overall, athletes recovered by purposefully engaging in training characterized by easier or rejuvenating mental and physical characteristics.

Getting Out of the Sport Bubble to Engage with Other Meanings. Many athletes described taking a break from their *sport bubble*, the life sphere associated with being an elite athlete pursuing peak performance in that sport. Charlie described how:

> Training for triathlon is fucking time heavy. It's very consuming, and you can just get stuck in the weeds of things. So part of my recovery is getting out of my like, 'bubble'. I like to read about what's going on in the world, I like to explore different things. … A form of recovery for me is just removing myself from my [sport] world.

While this description represents a *mental* break, Theo sought a *physical* break on his days off by "[going to] do something else, like going for coffee and just really [doing] something completely unrelated to training." Eva sought a *social* break by "[trying] really hard to not talk too much rowing when I'm away from rowing … because sometimes it's just way too much. So I'm very much surrounded by people that don't know very much about rowing."

Breaking from the bubble represented relief from features related to the identity of being an elite athlete, and a chance to "not just necessarily [be] 100% athlete-Anna all the time" (Anna). For instance, Gabrielle valued a full day off over having a recovery workout because it allowed her to "just be able to feel like you're not an athlete, and do stuff like, whatever, anything, that's not cycling related". Without such breaks in identity, athletes risked constantly thinking of how to improve and perform. Sean described an internal dialogue of "'I need to push, I need to keep pushing, pushing'. You get sucked into that vortex … and you go down that hole of just 'going' all the time." Recognizing this risk, Ryan described that part of recovery "[is] taking your mind off whatever you did earlier that day … If you're constantly always thinking of biathlon, biathlon, biathlon, all day, all night, you're going to burn out." Successfully taking a break from the identity and thought cycle of elite training meant that “when you come back, you remember how much you’re enjoying this, why you’re doing it, and it’s like a reset” (Theo).

Athletes recovered by seeking specific meanings outside their bubble. They sought activities that provided enjoyment and “peace” (Fiona) and pointed out examples in their activity journals such as baking, reading, sewing, making paper snowflakes, or other creative projects. They engaged in non-sport activities they found interesting, which also satisfied a need to feel accomplished, “useful”, or “productive” (Zoe), so that “at the end of the day it’s not like, I did a 1.5-hour recovery ski and like had a massage, but what else? [Instead], it’s, oh, I did some schoolwork, or I read a book, versus just being a potato” (Olivia). School or work were major sources of meaning that almost every athlete engaged in, usually on a very part-time basis (i.e., one class, one weekly shift). School helped Sean recover because “I can shut my mind off from school and go to swimming, and then shut off from swimming and go back to school.” School also helped “remove that element of pressure that comes with being a one-trick pony” (Zoe), providing security because “if cycling goes to shit, then you’ve got something else to think about. Or just to feel like your life is moving forward” (Gabrielle). Having interests and prospects outside of sport helped athletes manage the stress of investing and sacrificing so much to participate in training at an elite level.

Many athletes described valuing relationships with friends and family as a source of normalcy outside their sport bubble. Logan noted how engaging with people who “[aren’t] hyper-aware of what I’m doing is refreshing, in that it gives me a nice perspective that… I’m the one building this all up in my head… everyone’s got their own ‘marathon’ they’re working towards.” Likewise, Charlie enjoyed getting a “whole different perspective” by “just talking to other people, about their day and what they're doing. It's so important for my recovery to be engaged with my network of friends, family."

Checking Out to Engage in the Right "Non" Demands. Zoe explained, "there's checking out of cycling and checking into something else, and then there's checking out of like active or productive brain usage, *like period.*" This type of break minimized cognitive, emotional, and physical demands from all sources, in and out of sport. Quinn said that during his hardest training, "I occupy most of my day on the bike, and then sit like a vegetable on the couch for like three hours before I have enough energy to make dinner." Some athletes checked out of all demands when very fatigued, while others featured it more routinely in their recovery.

Although these approaches could be casually described as doing "nothing", athletes always accompanied the break by engaging in "something". Ryan clarified that "you don't have to just lay in bed and do nothing", instead specifying that "you just don't want to be *busy*…. You need a small window to just let yourself relax, switch off, play video games, something to give yourself a chance to calm down and let your body actually recover." "Switching off" was accomplished by engaging in something perceived as "non-demanding", such as watching TV, napping, easy reading, or passively relaxing on the beach, which filled the attentional vacuum left by the break from larger stressors but did so in a non-stressful way.

The importance of selecting these activities is seen juxtaposed against athletes' descriptions of bad breaks. Zoe described being deliberate in how she checked out, because "[surfing social media] can feel like I'm mentally checking out, but it's actually another source of stress." Several athletes specifically avoided the routine of "just coming back from [training] and watching Netflix all day," which cause stress because that type of recovery pattern made them feel "lazy" (Gabrielle). For many athletes, intentions to do nothing—lie on the couch, scroll through their phone—may have provided a physical break, but served as poor recovery because of unintentional mental stress. Successfully checking out involved removing most stressors but relied on engaging in the right non-demanding activity to provide recovery.

Negotiating and Prioritizing

To engage in recovery in a given situation, the athletes had to negotiate all the potential recovery options to prioritize what they felt to be the best solution. The following subthemes describe this process in relation to two of the previous themes characterizing recovery.

Negotiating the Dimensions of Feelings. The athletes aligned their recovery with the dimension of stress/fatigue they experienced, addressing physical stress with physical recovery and mental stress with mental recovery. For example, physical alignment meant ensuring nutrition matched the demands of a training block or going for a lie-down when muscularly fatigued. Demonstrating alignment of mental stress and recovery, Logan's workouts required him "to be so focused mentally a lot of the time, just to be pushing and pushing, or staying relaxed at an uncomfortable pace," that in response, he "[liked] to emphasize that my easy runs just be very fluid, like I'm almost zoned out. …It's giving your body and your mind that contrast to what you're doing during the hard efforts." Instead of finding one ideal recovery solution, the goal was to best match the stress experienced with the right recovery to address it.

Seeking recovery on one dimension sometimes conflicted with recovery on the other, so athletes often had to prioritize one for the greatest overall recovery benefit. Ryan explained how his teammates used to enjoy frisbee golf between practices, but that he was pushing his training group to understand when to prioritize activities for fun and social time (i.e., mental recovery), and when to prioritize staying off your feet (i.e., physical recovery). Priorities, and the solutions to these negotiations, shifted with context. For instance, Zoe explained how, "the taper before

World Championships is very mentally difficult for me, but the priority is making sure that my body is ready, and I know that it only has to last for like a week or two." Zoe prioritized physical recovery to maximize short-term performance, but implied that she had different priorities in longer-term contexts. Olivia rationalized her decision to "sometimes hang out with friends in the evening 'cause it's really important for mental recovery. Maybe you have a drink or whatever, which some could argue isn't the best for physical recovery. But like, it's a balance." Among the many potential recovery options available, conflict between different approaches meant that the athletes were constantly negotiating the relative consequences of their priorities.

Negotiating the Focus Dial. The athletes also negotiated degrees of dialing recovery in or out, differentially seeking periods of low or high focus on recovery depending on situational appraisals. Anna related how:

> [Some evenings] I'll be like, 'OK, I had [specific recovery] things I wanted to do, like do my stretching, my mobility, and this and this', but I'll just be super tired and I'll just make the call like, 'OK, the best decision is to like lay on the couch right now and watch TV for a few hours before bed'. … If I get home late from training and I'm super tired and I just wanna chill, then sometimes that's better [than following her detailed routine].

Zoe described similarly negotiating on an annual scale, where during the "general preparation phase, I think about [recovery] pretty minimally," focusing only on basic logistics of getting enough sleep at night, food in the house, and time between training sessions. In contrast, leading into World Cup competitions, "the day is structured around when I'll be on my bike, and then how I'm going to recover from that. … There's a much higher intensity focus on nutrition, sleep, active recovery practices and arranging other obligations."

Some athletes described negotiating the focus dial as seeking “balance”. For example, Olivia tried to find “balance between doing enough [non-sport activities] so I don’t just feel like I’m living the ‘eat, sleep, train life’, but not doing too much so that I feel like at the end of the week like my brain is gonna blow.” She qualified that balance was contextual, because: “Like, I enjoy going dancing at the bars, but that’s good in [the off-season], right? It has its time, but at other times, it’s not so good.” Athletes sought balance between many characteristics of recovery, including high and low discipline, person versus performance orientations, and situations in and out of sport. Being “balanced” was not a given proportion but referred to satisfying goals on both sides, as Charlie explained:

> Say 10-15% of my time is just being fucking out of it, and then 85% of my time is being in it [his sport/training bubble]. That’s enough of a balance for me. … Because, in my opinion, you can’t be 50/50 and train at a high level and try to be the best in the world.

What constituted balance was personal, shifted throughout the year, and was defined not by an equal division of time/effort but by what promoted sustainable training at a high level.

The athletes articulated personal hierarchies of recovery to help prioritize their efforts, where certain approaches were deemed essential, and others were only used as needed or when time/energy permitted. Fiona listed how she’s “probably not one to do all the stretching, all the [foam] rolling, that I should, day in, day out. But at the same time, [nighttime] sleep, recovery eating, they’re kind of my basic fundamentals.” Beyond these fundamentals, Ryan added:

> It’s also good if I could have a nap, like that’s a small plus. And then it’s good if I can just kind of hang out and not have to go to work, that’s a small plus. I want to just do whatever I want ’cause that will help me relax, that’s a small plus. But [these extras are] not as important as physically doing a cooldown and having proper nutrition.

While additional recovery approaches could be seen as incrementally beneficial, some approaches existed further down the hierarchy alongside more highly marketed recovery tools (e.g., ice baths, electrical stimulation). For instance, Gabrielle said, “if you can’t do [sleep and nutrition] well, I just don’t see the point of starting to invest into like, whatever, getting [compression pants] or all that crap.” Zoe similarly summarized that:

> Those [tools/modalities] are all marginal gains. They’re like a 0.2% each in my books, and there’s so much more low-hanging fruit [recovery approaches] we could be going after. … You only have so much time in a day, and those recovery [tools] take time, and for me, they're just not as fruitful. … I’m still chasing 10%, and I’m not worrying about those infinitesimal small bits of a percentage that come with specific modalities.

Discussion

We aimed to explore what recovery means to elite endurance-sport athletes by specifically characterizing the experiences, processes, and purposes involved. We found that recovery encompassed a broad range of potential approaches and experiences, but that several processes guided what athletes sought from recovery for a specific time and context. The results illustrate the complexity of athlete-centered meanings and experiences of recovery, supporting yet expanding on existing conceptualizations of recovery. We discuss each of the six main themes in relation to predominant conceptualizations of recovery and related literature, before concluding with potential directions for future athlete-centered research.

The themes of multiple dimensions of feelings and levels of focus characterized the range of *types* of recovery experiences and approaches the athletes described. Our findings extend longstanding descriptions of recovery as a multi-dimensional experience (Kellmann, 2002;ענttä & Hassmén, 1998) but also evidence a high level of nuance and specificity to athletes’ feelings of fatigue and recovery. Discussing recovery in terms of levels of focus is a novel characterization that came from noting how recovery varied beyond physical and mental dimensions. For example, deep breathing protocols and going to the beach both constitute ‘mental recovery’, but the athletes described how they required different types of engagement and addressed different recovery needs. Kellmann (2002) categorized recovery by the degree of physical action (i.e., active, passive, or pro-active recovery), but the metaphor of a ‘focus dial’ represents levels of cognitive, motivational, and regulatory investment. This evidence for variation in the self-regulatory effort required by different recovery approaches supports suggestions that recovery may be characterized using theories of self-control or self-regulation (Balk & Englert, 2020). For instance, dialed in recovery involved greater self-discipline/control, and the athletes felt they had a limited capacity for engaging in that type of recovery before they needed to balance it with more dialed out recovery. This notion that athletes feel they need ‘recovery from recovery’ mirrors aspects of self-control ‘fatigue’ (Balk & Englert, 2020). These elements of self-control within recovery appear to represent testable claims deserving of future research. Further, categorizing different types of recovery along orthogonal continua of dialed in to dialed out and mental to physical recovery may create a more nuanced scaffold for how we study a greater range of recovery possibilities that are meaningful to endurance athletes.

Within the characteristics of multiple dimensions and levels of focus, the athletes had personalized their recovery by choosing preferred approaches corresponding to their self-perceptions. These findings parallel Kellmann’s (2002) description that recovery depends on athlete appraisals, leading to wide variation in the forms of recovery athletes may choose in addressing a specific stressor. While we identified common goal-oriented processes shaping the athletes’ engagement in recovery, each athlete pursued them through personal solutions matching their individual constraints. Such personalization is in contrast to prevailing narratives in research. Much research often asks athletes to respond to (i.e., list, rate, count the use of) a menu of common recovery solutions (i.e., modalities; e.g., Venter, 2014), assuming they apply to the individual contexts and desired outcomes of the athletes. This type of methods-first perspective appears to contrast with the potential variability in individual meanings of and preferences for recovery suggested by our findings. Recovery may be better understood by appreciating this inter-individual variability, and examining *how* athletes select and implement these personal solutions, rather than where specific recovery approaches may be applied.

Considering the elite level of the athletes involved, the described purposes of recovery resembled those advanced in the deliberate practice framework (DPF; Ericsson et al., 1993) account of sport expertise development. In the DPF, skilled performance is a function of the performer's accumulated hours of deliberate (i.e., high-quality, challenging) practice, which is constrained by the high level of mental and physical effort required to engage in this quality of practice. Effective recovery enables the performer to engage in subsequent deliberate practice at a sufficient intensity, and to repeat and accrue such engagement over the years needed to reach expert performance levels. This description fits with our findings that recovery was largely geared in the short term towards preparing to optimize the next practice, while also being guided in the long term by processes oriented towards sustaining training engagement and accumulating training capacity. Recovery as a corollary to deliberate practice has been underexamined over the years (Eccles et al., 2022; Young et al., 2021); indeed, very little work has examined recovery in the explicit context of deliberate practice and expertise development (c.f., Wilson & Baker, 2021; Young & Salmela, 2001). Our findings unpack characterizations, processes, and purposes that may help to frame this line of inquiry.

The theme of taking a break to engage with restorative meaning involved processes which mirrored several recovery-related concepts. For instance, the process of taking a break may afford recovery in part by facilitating psychological detachment, which denotes the experience of ‘switching off’ after work hours by ceasing to engage with or ruminate on work-related topics (Sonnentag & Kruel, 2006). Among competitive athletes, greater detachment following practice has been positively associated with perceived recovery (Balk et al., 2017). In addition to their potential regulatory functions, discussed earlier, dialed out recovery approaches may also encourage psychological detachment from sport-related cues and demands by helping athletes to focus on non-sport aspects of life. However, psychological detachment does not address why engaging in specific meanings is required for effective recovery.

In their model of the psychology of rest, Eccles and Kazmier (2019) identified negative deleterious psychological experiences and the corresponding restful ones that addressed them. They reported several characteristics that paralleled elements of breaking and engaging in this study. For instance, one category of restful experiences, the reduction of thinking about one’s sport, entailed getting physical and social distance from it (i.e., getting out of the sport bubble) by seeking non-sport related environments (i.e., engaging in other meanings). A second category, the reduction in effortful thinking more generally, entailed seeking out activities and environments with low cognitive demands (i.e., checking out) that may be relaxing or enjoyable (i.e., engaging in non-demands). There is obvious synergy between these corresponding subthemes, suggesting that rest and recovery shared some key experiences/processes. However, we found recovery to also be much more than these two subthemes, incorporating more active goal-oriented processes of prioritization across a greater variety of dimensions.

Whereas the processes of ‘breaking and engaging’ and ‘short and long-term purposes’ respectively described the ‘what’ and ‘why’ of recovery, ‘negotiating and prioritizing’ addressed ‘how’ athletes navigated various personalized approaches. The athletes aligned stress on one dimension with corresponding recovery approaches, which represents what multiple sources (Balk et al., 2017; de Jonge et al., 2012; Kenttä & Hassmén, 1998) have described as the process of matching stress and recovery. The athletes’ responses suggested that any implementation decision involved prioritization: matching on one dimension could conflict with another; picking one recovery approach took time and energy from alternatives. Prioritizing recovery dimensions or approaches in this way implies that athletes make important decisions around recovery implementation. These findings invite greater recognition of an elite athlete’s decision-making role in recovery, which to date has been an under-examined facet of recovery research.

Limitations and Future Directions

Our research should be contextualized by certain limitations. All participants were living and training primarily within the Canadian amateur sport context, locating their perspectives on work and recovery within a Canadian-centric lens. They were all highly elite, so their experiences may differ from those training at other levels or earlier points in a career. Whereas our results noted how negotiating the recovery-fatigue balance was central to the sporting lives of these endurance athletes, athletes in other sports (e.g., more skill-focused sports) may have different relationships with recovery.

The nature of our questioning may have biased the athletes' conversations toward recovery as a consequence of hard training and sport-specific stressors, thereby possibly constraining the amount of dialogue on non-sport-related recovery and lifestyle matters. For example, we asked opening questions to explore what “hard training” meant and felt like early in interview 1, on the assumption that hard training requires recovery. Despite this, themes about taking a break and dialed out forms of recovery proved integral to our results, so we believe a balance was struck. Finally, our design featured two interviews separated by one week of activity journaling. Considering how the meaning of recovery was tied to training contexts that shifted over different training periods (e.g., year, phase, week), future research should explore how processes and implementation may change between time points in a season/career, and as a function of performance level.

Conclusion

Recovery involved a wide array of experiences and approaches characterized by dimensions of feelings and levels of focus, each considered in individual terms. Recovery was dependent on time and context, taking on specific meanings shaped by short and long-term purposes, guided by processes of breaking and engaging, and enacted through processes of negotiating and prioritizing. The athletes played a central role in recovery by defining these experiences and enacting these processes according to their individual appraisals. Their perspectives expand upon previous conceptual descriptions of recovery by introducing greater nuance and complexity, particularly around the self-regulatory demands imposed by the athlete's active role in recovery. Practitioners should try to contextualize and vary their language around motivations for recovery, as their interests (e.g., injury prevention) may differ from what drives recovery for athletes. Researchers should consider how recovery methods/modalities fit the situational needs of athletes, instead of how athletes fit the methods/modalities, Further, research practitioners should consider the role athletes play in the process of sorting through potential recovery solutions to identify and implement the approach that best meets their needs. Athletes lie at the heart of the recovery process, and any discussion or design of recovery interventions should begin with their meaningful perspective.

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ARTICLE 2

Self-Regulating Recovery: Athlete Perspectives on Implementing Recovery from Elite Endurance Training

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Abstract

Recovery is the process of restoring performance capabilities between training sessions. Recovery strategies must be implemented to meet contextual demands, yet this process is not well-understood from an athlete perspective. Drawing on previous descriptions of self-regulation in learning, this study aimed to describe the process of implementing recovery from the perspective of endurance athletes. Twelve elite Canadian endurance athletes (6 women, 6 men; 25-31 years-old; each had competed in multiple Olympics or World Championships) participated in two semi-structured interviews, separated by one week of recording their thoughts, feelings, and activities of recovery in an activity journal. Through reflexive thematic analysis, we found that recovery was athlete-led; they used self-regulatory processes pertaining to self-knowledge and planning (the theme of ‘Knowing my body’), self-awareness and interpretation (‘Listening to my body’), and self-control and adjustment (‘Respecting my body’). The athletes’ described their recovery as integrated with their environment; various people and places supplemented, facilitated, and provided aspects for their recovery. Our results suggest that recovery can be effectively understood as a series of athlete-led skills, supported and enhanced through specific environmental interactions, which we summarize in a novel heuristic called the Athlete Recovery Regulation Model. These findings advance a new perspective on recovery as a product of skills that athletes can develop to hone the effectiveness of their recovery from training.

Keywords: self-regulated learning; sport performance; sport practice; mental performance.

Lay Summary

We asked elite endurance athletes to describe their process of implementing recovery around training. This process was primarily athlete-led, involving a set of self-regulatory skills, integrated with the support of people and places in their environment. Recovery should be considered in terms of skills that athletes can own and develop.

Implications for Practice

- Elite endurance athletes describe taking responsibility for and shaping their approaches to recovery using self-regulatory skills that they develop with practice and experience.
- They rely on people and places in their environment to supplement, facilitate, and/or supply provisions for their efforts to self-regulate their recovery.
- Recovery should be examined for skills similar to the mental and perceptual-cognitive skills that define superior training and performance in athletes.

Self-Regulating Recovery: Athlete Perspectives on Implementing Recovery from Elite Endurance Training.

Athletes develop superior sport performance by engaging in repeated practice balanced with corresponding recovery (Ericsson et al., 1993). Recovery is the multifaceted (psychological, physiological) process of restoring performance capability following training (Kellmann et al., 2018). Effective recovery compensates for stress to restore performance and spur adaptation, while inadequate recovery allows stress to accumulate, potentially leading to overtraining, injury, or burnout (Kellmann, 2002). Stress is the equally multifaceted interaction between the environmental demands a person encounters (e.g., training) and their individual response to those demands (D. Fletcher et al., 2006). Thus, if recovery is to effectively match stress, it must be adapted to various individual experiences and environmental contexts. This study aimed to explore the processes athletes use to implement recovery across those shifting conditions.

Sport Research on Recovery

Much of the research on athletic recovery has focused on establishing the validity of various modalities (e.g., cryotherapy, compression garments; Dupuy et al., 2018) without considering how and why athletes choose to engage in recovery. This work shows that recovery modalities are effective in addressing specific forms of stress, which makes them tools that must be implemented in the right context at the right time. While research exists to inform how practitioners should implement recovery (e.g., Haller et al., 2022), recovery extends far beyond the few hours that an athlete might spend with coaches or therapists each day. For example, in recent qualitative work, elite athletes described traditional modalities as a relatively lower priority in their recovery (Wilson & Young, 2023). Further, they sought recovery from abstract, person-centered experiences such as meaningful hobbies or “peaceful” time in nature, which would be difficult for practitioners to decompose, validate, and prescribe. Altogether, a more complete understanding of recovery relies on better understanding the athlete's role in implementing it.

Some prior descriptions of recovery imply that athletes play an active role in guiding it. Kellmann and Kallus' (2001) proposed that recovery involves an action-oriented component, where "self-initiated activities (proactive recovery) can be systematically used to optimize situational conditions and to build up and refill personal resources and buffers" (p. 22). Interviews exploring the meanings of recovery with international-level endurance athletes described a similar action-oriented notion (Wilson & Young, 2023). Specifically, the athletes described recovery as a wide array of potential approaches and experiences spanning multiple sensory dimensions and degrees of personal investment, with individual variation. Instead of fixating on any one approach, they focused on what would fit the goals, demands, and priorities of their current context. Recovery thus involved an individualized process of sorting through potential approaches to identify and execute the right approach at the right time. Research with collegiate field hockey players found they took a similarly active role in their recovery (Eccles & Kazmier, 2019). The players created mental rest by reducing psychological experiences that impaired it (e.g., constant thinking about sport) and seeking those that promoted it (e.g., distancing oneself from the training location). Compared to how recovery has been presented, this literature suggests that athletes take a more active role in implementing their recovery—one that could be described through self-regulation (Beckmann & Kellmann, 2004).

Self-Regulation and Recovery

Self-regulation has been infrequently examined in relation to recovery. In seminal work, Beckmann and Kellmann (2004) explored the association between an athlete's state of recovery and perceptions of their dispositional self-regulation. They found that a higher perceived state of current recovery was associated with higher ratings of volitional self-regulation, such as an athlete's dispositional tendency to deliberately think of pleasant things under stress. While the findings supported a connection between recovery and self-regulatory predispositions, their framing of self-regulation does not explain how an athlete may engage with and manage their recovery according to the demands of specific situations.

Individuals can intentionally influence their functioning and circumstances around recovery. In a brief overview of relevant theories of self-control and recovery in occupational settings, Balk and Englert (2020, p. 274) defined recovery self-regulation as "identifying one's current state, one's desired future state and undertaking actions *to minimize the discrepancy* between both states during the recovery phase" [italics added]. They advanced a model of recovery self-regulation for sport involving a recurring cycle of three psychological skills: (1) *self-monitoring*, to detect discrepancies between one's current and desired state; (2) *regulation of emotion and cognition*, to create cognitive and emotional detachment from training; and (3) *self-control*, to resist immediate urges and initiate unappealing behaviours in service of recovery.

Balk and Englert's (2020) proposal is an intriguing entry-point that leaves certain complexities of recovery self-regulation unexplored. For instance, it framed recovery predominantly as a reactive, short-term process prompted by discrepancies in the recovery state. While Wilson and Young (2023) found that elite athletes used recovery to absorb training from previous sessions (i.e., discrepancy-reduction), the athletes also described it as a process of preparing for subsequent sessions to accumulate training long-term. These approach-oriented functions support Kellmann's (2002) suggestion that athletes may engage with recovery proactively, in anticipation of stress. Further, a discrepancy-reduction view of recovery does not sufficiently address the cognitions or motivations involved in *doing* the regulation: What defines one's desired state of recovery and how do they know when they have achieved it? Do athletes seek to close every discrepancy in their recovery state? If not, how do they decide which ones to address? Finally, a discrepancy-reduction model focuses on the individual without considering the influence of their environment. This is a relevant omission, as athletes train and recover in purpose-built social and physical environments (e.g., teams, training centers). It is thus preferable to adopt a perspective that affords athletes the agency to be motivationally, metacognitively, and behaviourally engaged in managing their recovery.

Zimmerman (2000) defines self-regulation as "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" (p.14). In this sense, self-regulation is both the source and consequence of learning. This social cognitive perspective describes self-regulation as the ongoing interactive processes of observing and adjusting one's behaviours, cognitions, emotions, and environmental conditions (Zimmerman, 2000). These processes involve a combination of metacognitive competencies and motivational beliefs, employed proactively and reactively across three cyclical phases: (1) *forethought*: pre-task gauging of one's strategic approach and beliefs towards a goal; (2) *performance*: self-observation and self-control during pursuit of the goal; and (3) *self-reflection*: post-task self-reactions and judgements that can inform approaches/beliefs towards subsequent goal pursuits. This framework was developed to describe how students engage with successive individual tasks in pursuit of larger learning goals—like studying daily in the lead-up to a final exam like a final exam (Zimmerman, 1998)—and it has since been effectively applied to describe self-regulated learning (SRL) in sport practices. For instance, higher-skilled athletes make greater use of certain SRL processes (e.g., reflection, maintenance of self-efficacy) to optimize engagement in training

(Wilson et al., 2021). Elite athletes have similarly described recovery as a series of smaller tasks, like stretching and eating certain foods after a workout, in service of larger goals of being prepared for their next workout (Wilson & Young, 2023). However, no work has explored how athletes might apply self-enhancing self-regulatory processes to recovery.

Taken together, this literature supports the importance of self-regulation for recovery but begs empirical exploration. This study aimed to describe the process of implementing recovery according to the athletes who engage in it. Guided by social-cognitive perspectives of SRL, we asked the research question, “How do elite athletes self-regulate their recovery?”. Pursuing this question meant exploring the processes and roles attributed to the athletes and delineating them from those of their environments.

Methods

This study was part of a larger project exploring the psychology of recovery from the perspective of elite endurance athletes. The data for this study were collected through the same participants and procedures presented by Wilson and Young (2023). This study addressed a separate research question using separate analytic procedures. Ethical approval was granted by the Office of Research Ethics and Integrity at the University of Ottawa (H-08-20-6017; Appendix A).

Philosophical Position

Critical realism assumes that humans construct reality through knowledge *and* that “human knowledge captures only a small part of a deeper and vaster reality” (A. J. Fletcher, 2017, p. 182). Instead of reducing ontology (i.e., what is real) to epistemology (i.e., what is known), critical realism stratifies reality into real, actual, and empirical domains (A. J. Fletcher, 2017). The *real* domain involves underlying causal mechanisms which produce *actual* events that occur regardless of whether or how they are observed. The *empirical* domain represents how each person experiences and assigns meaning to those actual events. In line with this philosophical position, we assumed that real biological processes of stress and recovery cause actual changes in training performance. Athletes individually perceive, interpret, and react to those processes and changes, which leads to behaviours with real physiological consequences. The results of this study represent our interpretations of how the athletes communicated their experiences, co-constructed through our conversations with them.

Participants

We recruited participants using a combination of criterion-based purposive sampling and maximum variation sampling (Sparkes & Smith, 2013). After receiving institutional ethical approval, we contacted Canadian endurance athletes through social media, their National Sport Organizations, and snowball sampling. Specifically, we sought elite athletes, 18 years of age or older, from Olympic endurance sports, competing in time- or distance-to-completion events lasting over three minutes. Endurance sports involve very high training loads at elite levels, which we assumed would make recovery familiar and poignant to these athletes. Following recommendations from Swann et al. (2015), 'elite' meant athletes had competed in at least one major global championship (MGC; Olympics or Senior World Championships) in the prior two years, and two or more over a career. Within these criteria, we sought maximum variation in the endurance sports included. Guided by Braun and Clarke's (2022) description of "informational or meaning sufficiency" (p.17), we halted data collection when we felt that the challenge of further recruiting members of this limited pool of elite athletes meeting our criteria outweighed the potential conceptual depth that could be added through further interviews. Our final sample of 12 athletes included six women and six men, 25-31 years old ($M = 27$) from biathlon ($n = 3$), cross-country mountain biking (2), track cycling (2), swimming (1), marathon running (1), rowing (1), long-track speed skating (1), and flatwater kayak (1). They had been training competitively for 8-23 years (*M* = 13), including with the senior National team for 3-11 years (*M* = 7). Career-wise, they had competed in 2-13 MGCs (*M* = 5), including at least one in 2019 and/or 2020, along with many other major events (e.g., junior/U23 World Championships, Commonwealth Games). During/after the study, 10 of 12 competed in a further MGC in 2021.

Data Collection

Each athlete participated in two semi-structured interviews separated by a week of activity journaling. All were screened to verify inclusion criteria and provided informed consent to start each interview (Appendix D, E). All interviews were conducted and audio-recorded using videoconference software. We used two interviews to separate conceptual and practical questions, build rapport, and allow time for athletes to reflect on patterns in their recovery (Smith & Sparkes, 2016). Interview 1 lasted 31-77 minutes (*M* = 50). Interview 2 lasted 44-103 minutes (*M* = 70).

Both interview guides were developed using guidelines by Sparkes and Smith (2013). We refined them through four pilot interviews with sub-elite athletes, removing questions that were too abstract. Interview 1 (INT1; Appendix G) explored recovery as a concept, with questions asking athletes to describe what recovery involves and feels like, and its forms. Interview 2 (INT2; Appendix H) explored processes and factors influencing how they implemented recovery. Questions focused on, “What determines how important/meaningful recovery is to you?”, and follow-up probes explored the influence of temporal, situational, and social factors. Before each athlete’s INT2, the PI listened to their INT1 recording and made notes. INT2 opened with a form of member reflection, where the PI summarized their INT1 notes and asked the athlete to reflect on them. Closing questions in INT2 asked whether/how recovery had changed over their career.

The activity journal served as an elicitation device for INT2 (Smith & Sparkes, 2016). It contained an instruction page, a filled-in sample page (Appendix I), and seven pages for entry, each representing one day broken into 15-minute increments. At the end of INT1, the PI explained the journal's purpose as a reflective device, gave the athletes online and printable copies, and asked them to use the template to record their general activities each day, along with any thoughts, feelings, or behaviours related to stress, fatigue, or recovery. The athletes returned their journals ahead of INT2 for the PI to review. In INT2, athletes used their activity journal to highlight anything notable in the past week and were encouraged to use the journals to illustrate their responses around recovery during the intervening week. The journal design was inspired by activity logs in time use studies (Deakin et al., 2006) to represent temporal patterns in activity, with extra space added for personal reflections. Participants could fill out the log how and when they wanted, and the information were not treated as data.

Analysis

We performed a reflexive thematic analysis (Braun et al., 2016). Reflexive thematic analysis can be helpful for understanding people's perspectives on the processes and factors underlying certain phenomena (Braun et al., 2016). During analysis, data corresponding to the focus of this study—the process of implementing recovery—were separated from that used in Wilson and Young (2023). Because of the questions asked in each interview, this meant that data from INT1 were the focus of that article, while data from INT2 were the focus of this study, although responses from each informed and contextualized the other. All interviews were transcribed verbatim. Both authors read all transcripts, making notes to familiarize with the depth and breadth of the data (Sparkes & Smith, 2013). The PI inductively coded passages representing processes, characteristics, or examples illustrating the implementation of recovery. To fit this descriptive focus, coding was generally more semantic, and the same text could be coded multiple times. The PI used inductive reasoning to create candidate themes representing codes with shared meaning, and then ordered/related these themes to each other through reasoning informed (but not determined) by conceptualizations of SRL. Both authors then worked together to discuss and revise the framework of themes, with the second author serving as a 'critical friend' (Sparkes & Smith, 2013), inviting the PI to consider alternate interpretations.

We initially focused on the athlete's processes in recovery. The interview guide had one planned question specifically asking, "How much is recovery [the athlete's] responsibility, versus the responsibility of others?". However, when coding, we found that people and places in the athletes' environments were woven into their responses. Instead of ignoring these responses, we reflexively added a secondary research question asking, "How do the athletes' environments influence their implementation of recovery?". Correspondingly, we inductively coded for the ways people and places influenced how an athlete implemented recovery.

Braun and Clarke (2022) recommend that reflexivity be evident throughout reflexive thematic analysis. Before the study, we discussed our experiences and views of training and recovery. We shared personal experience as coaches and athletes in endurance sport, professional experience of studying sport through the lens of expertise-based and self-regulatory frameworks, and professional beliefs that there are better and worse ways to engage in recovery. Our study included specific features to encourage athlete reflection such as the initial discussion of their past experiences with training and recovery, the activity journal, and the member reflection to begin INT2. After the study, we reflected on how the use of multiple interviews and the PI's knowledge of endurance sport helped build rapport with the athletes.

Results

In line with our two research questions, we organized the results in two sections to represent how the implementation of recovery was *athlete-led* and *environmentally integrated*. Each section is divided into main themes and subthemes. All participants have been assigned pseudonyms, and quotes have been lightly edited for grammar.

Recovery is Athlete-Led

The athletes described recovery as an athlete-led process because they felt *responsible* for its implementation and *accountable* for its outcomes. They described recovery as "95% my decision" (Sean) or "99% my responsibility" (Anna), largely because they actually experienced the stress that recovery must address. Zoe stated that, "no one [else] lives in your head and they can't tell you what you need for recovery. They can encourage you to have healthy recovery habits, but they can't, they don't know what you require." As Theo said, "[recovery] is your responsibility. [Others] can contribute to creating the proper atmosphere, but you're the one that has to do it." This uniquely first-hand, real-time experience of stress and recovery led the athletes to see themselves as the primary actor in shaping their recovery.

The athletes took responsibility for their recovery because they felt directly accountable to its outcomes. Eva explained, "it's very much my decision, how much I want to recover or not, and how well I'll feel next week if I do a good or bad job of that." The athletes held themselves accountable in the short-term because of what it meant to their long-term aspirations. James sometimes referred to recovery as something he "should" do; when the PI asked why, he said:

> [Take the] example of the World Championships where you just miss a medal by a little bit. And you think like, 'Fuck, was that in there somewhere? I should have done something better. I should have done something different. And I didn't.' So 'should' is like, holding myself accountable to a level that I can live with."

Four themes described the processes athletes used to self-regulate recovery: Knowing my body, Listening to my body, Respecting my body, and Learning my body. They are titled using the athletes' words; 'my body' represented their physical and mental self more generally.

Knowing My Body

This theme encompassed the importance of the athletes' refined self-knowledge for how their 'body' (i.e., self) interacted with situational characteristics, demands and contingencies in training and recovery. Anna said, "When I was younger, you were supposed to come prepared to each session, but I don't think I really *knew what my body needed* to be ready." 'Knowing' involved an athlete *knowing what to expect* from training and *knowing what to do* by implementing their knowledge as plans for recovery.

Knowing What to Expect. The athletes had specific ideas for how they expected to feel given the parameters and context of their training. Ryan explained how training usually involved,

> Some combination [of intervals] that I've done, you know, however many times over the last few years. So I just know what that feels like. And then I know, 'Oh, I'm in a big week [of training] and I'm already feeling tired, and I have *this* workout tomorrow, I know I'm gonna be really tired at the end of it'. Versus, 'This is a really easy week, I have a really easy intensity [workout], this is going to be like a walk in the park'.

In his response, Ryan describes how he expects to respond to specific training stimuli based on his knowledge of how he has previously responded, and his expectations may shift depending on the context of his training week, phase, or year. Theo explained how this type of knowledge comes from “just training for so long, you just kind of learn what works for you, how your body will react to different training loads, different training times, different types of training, so you know what you need at that moment [for recovery].”

The athletes also described a corresponding knowledge of what recovery they needed to match the expected effects of training. Elaborating on the quote above, Ryan explained that “[if] *this* intensity workout usually leaves me *this* tired, I need to make sure I’m *this* prepared.” Knowledge of the recovery they required was similarly framed by the training context. James described how, within a training week, “every day has its own importance … Thursday is the day that we do the least training, but it’s one of the most key days as far as setting [me] up for the Friday and Saturday [training sessions].” Similarly, Anna knew that recovery was the priority in her rest week; “if I need to do 0 hours [of training] to be ready, that’s probably not ideal, but it would be okay,” because it met that goal. The athletes drew confidence from the perceived strength of their knowledge and expectations of stress and recovery. Gabby said, “I know that if I fuel well, and I sleep well, and I don’t have injuries or whatever, … I know I can usually keep pushing [in training]. … As long as I go through the processes of recovery, I can keep going.”

Knowing What to Do. The athletes acted upon their self-knowledge by *planning* their recovery to address the anticipated importance and stress of upcoming training. Planning their recovery helped the athletes manage their time to avoid missing opportunities for recovery and to maximize the opportunities they had. Reflecting on her activity journal, Anna realized how much time she spent “organizing stuff, like getting my bag ready for training. …I did [these] little things to make it easier later when I knew I would be more tired.” Planning helped the athletes avoid feeling overwhelmed, stressed, or distracted from their recovery intentions. Sean felt that "by having [a plan for recovery] written out and blocked out [in a calendar], I'm more likely to stick to it as opposed to, like, getting distracted by other things." Olivia described how, "when I don't do that [planning] well, my week gets really hectic, and I don't get any [recovery] done."

The athletes planned around the structure of their training. They considered the timing of training sessions in the day and the week, and the relative importance or effort required at each, and then built structure into the rest of their day around those anchors. For instance, Ryan said:

> Say I have to be training at 8:30[a.m.], well then I need to be up by 7[a.m.]. And I want to get X number of hours of sleep, so I'm gonna be in bed by 10:30[p.m.] or 11[p.m.]. … When I get back [from morning workout], it's lunchtime and then I have a few hours before I have to go out and [train] again. Everything kind of fills in around the training.

Within their daily structure, the athletes identified *recovery opportunities*, or periods of time that could be leveraged for recovery. Opportunities included the buffer time spent at training sites before and after a training session, or designated time blocks with no demands like the post-lunch period many athletes used to nap. Paradoxically, planning for a recovery opportunity could mean removing structure within that opportunity. For example, several athletes identified a day of the week where they could sleep in (recovery opportunity). They would not set an alarm for that morning to give them the freedom to wake up when they wanted (removal of structure). As James said, "I get to sleep in if I want to sleep in. Usually I can't really [sleep in] [*laughing*] but at least it's not forced upon me." While structure may sound like rigidity, the athletes planned recovery opportunities to *promote* flexibility in how they were filled.

The athletes planned for multiple *recovery options* that could be employed within a recovery opportunity, depending on their needs. Talking about the aforementioned post-lunch opportunity, Anna described having multiple options available: "sometimes I read before my nap, sometimes I watch a show, …sometimes I can't nap and I just get up and do whatever. I know the few things that I could do, and just depending on the day, I kind of choose one." The athletes took steps to have the right recovery options available: they listed options for mental relaxation at the top of their agenda at the start of each week, booked massage appointments weeks in advance that could be used or cancelled as needed, and kept a selection of food on hand (e.g., at home, in their gym bag, in the car) to have options post-practice.

One important form of planning was building recovery routines, which involved a planned chain of sequential behaviours. For example, when Ryan considered an upcoming workout:

> I know I'm waking up at *this* time, I know I'm going to training. I know that when the training is over, I have my recovery drink literally right there. I can just grab it, drink it, and then I can finish the rest of my cooldown ski. … Then I know I'm going to go home, I'm going to have lunch and then … I'm probably going to have a nap. It's just like all these things I already know I'm going to do, before I'm even doing the training that day.

Ryan's routine promoted recovery through the benefits of the individual activities (e.g., cooldown ski) and the overall effect of reducing uncertainty. For Zoe, "a routine is how you ensure that you've checked all the boxes, that's part of the confidence piece. [Without routines], you're flying by the seat of your pants and it feels more haphazard." Routines took extra initial planning but eased the thinking required in the moment. The athletes emphasized how good their mind and body felt in the rhythm of a good routine. Ryan said, "I have a routine I've been doing for a long time. I know it's been working pretty well so I don't have to overthink or stress about it. It just is what it is. I just do what I do." In sum, athletes used their knowledge and expectations to plan structures, opportunities, and available options to meet situational recovery needs.

Listening to My Body

This theme encompassed self-monitoring and interpreting the body's response to recovery actions in various situations of training and recovery. Fiona described how "if you want to ride [cycle] on the upper limit, ride on the upper limit. If you're tired and you're stressed … ride at the low end of your [intensity] zone the next day. Just *listen to your body* and do what you need to do." Zoe felt that 'listening' was a necessary complement to 'knowing':

> you can make a plan, but you can't predict exactly what you're going to need. … I can't predict what the muscle tension will be like from having [cycled] a specific course. I can't predict like how emotionally challenging it was to learn a few new scary features on said course. You can't predict all those things until you're doing it.

'Listening' involved an athlete *becoming aware* of how they felt, and *interpreting* what those feelings meant for their recovery and training.

Becoming Aware of How I Feel. The athletes described being highly aware of how they felt physically, cognitively, and emotionally. For Olivia, "having that awareness of your feelings" and "being aware of what your body needs" were key characteristics separating her from non-athlete friends. Awareness could vary. Zoe said, "I have a pretty high degree of self-awareness, but I don't *always* have that self-awareness. Sometimes it's dormant or I'm too distracted and not living in my body, in the moment." The athletes expressed their self-awareness to varying degrees—some described each component of how they felt, others described an overall picture of how "good" they felt—yet all shared detailed understandings of their recovery state.

The athletes were split in how they described gaining awareness. Some used key events in the day to prompt introspection in a process of *checking in*. Anna explained, "A big way I judge [recovery] is how I feel in the morning when I wake up. If I'm super tired when the alarm goes off or feel like I don't wanna get out of bed, I take that as a sign." Athletes often checked in at wake-up, when they got home from a training session, or before an unstructured period (e.g., after lunch). Between check-ins, these athletes took a break from consciously exploring how they felt. Sean checked-in each morning ('Do I need to alter my recovery plans for today?') and at lunch ('Do I need a nap?'), but otherwise, "when I'm going about the rest of my day, until I get to that point again, I'm not thinking about [recovery]." Other athletes described gaining awareness as *background monitoring,* constantly running in the back of their minds until a meaningful or unexpected feeling grabbed their attention. This explanation reconciled how some athletes described thinking about recovery constantly and hardly at all. Theo said, "you could say always, or none of the time. … You're always considering the recovery aspect and being ready for the next [training session], but then you're not specifically thinking of like, recovering." Logan gained awareness via a process of bottom-up signalling more than top-down monitoring:

> I think I'm just generally tired, so that in and of itself triggers like, 'Oh, you need to recover'. … It's more like the stimulus, like my body's telling me, versus me focusing on it or worrying about it. …I guess what I'm saying is I don't consciously think of it all the time, but it's definitely on my mind [*pauses*], occasionally.

Interpreting How I Feel. The athletes interpreted the feelings they 'heard' (i.e., gained awareness of) by *assigning meaning* to those feelings. As part of checking in on herself each morning, Anna would judge, "[If] I feel really bad, maybe I need to do something to wake up, but if I feel fine, I can just sit in bed and read my book and I don't have to do anything extra." Specifically, she labelled her feelings as "bad" or "fine", meanings which implied certain consequent recovery actions. Athletes assigned meaning to their feelings in the context of their training. Olivia shared how feeling tired meant different things depending on her training goals:

> there's a time to be tired and there's a time not to be tired. Sometimes when you're training, the goal is to be tired. At the end of a volume block, I'm expecting to be tired, so I'm not just gonna cut my training, unless I'm [more] tired than I think I should be.

Considering the variability of these personal and contextual factors, recovery could not be subject to hard rules. Instead, it had to be continually re-assessed: "It's not like, 'If I feel a certain way, I do this'. It's kind of like, every day, feeling, touching, touching, feeling, [to see] how it goes each day" (Sean). Essentially, assigning meaning involved answering variants of, "'Am I just being lazy, or do I actually need a break?'" (Anna).

The athletes assigned meaning by *comparing* how they felt with how they expected to feel based on their self-knowledge and past experience. Ryan said:

> sometimes you expect the workout to go a certain way and maybe you feel even better than you thought you would, so you don't feel like you need to do as much recovery that day. … But then there's some days where it's like, 'I'm totally wiped'. Workout was good but I need to just go home and nap.

The comparisons could be specific to the situation, such as the feeling that "if I can't wake up at my alarm, then I know I'm probably not recovered" (Anna), or interpreted more generally, like how Logan described: "I have a gauge, and if that gets pretty low and I feel like crap, I think I'll put more emphasis into [recovery]." Based how their current feelings compared to their internal standards, the athletes assigned meaning to those feelings which created implications for action. Olivia summarized, "I look for a feeling which guides what I will do."

Most athletes relied primarily on their internal sensations, but two described checking in on and assigning personal meaning to information from objective monitoring devices. Quinn described using a Whoop band, which monitors heart and respiration rates, “as an experiment. Like, let’s do it and see what its sleep suggestions are, what its recovery scores are.” He found that, so far, “from a qualitative, subjective standpoint, I haven’t been able to equate the numbers to [my] sensations or to [my] performance on any given day.” On the other hand, Sean found that with his Oura ring, “even if I might feel good, if [the recovery score] plummets, I’ll listen to that a little bit more.” These two athletes used feedback from the devices as another source of information that they tried to reconcile with what they ‘heard’ from their body.

Respecting My Body

This theme described the athletes’ attempts to turn incoming recovery information (i.e., what they ‘knew’ and ‘heard’) into appropriate recovery action. Logan evoked this in two ways. First, he described *respecting what he ‘heard’* when he explained that recovery involves “giving your body the time, so not chasing a state, but just allowing your body to process what you’ve done. Like *respecting your body* in a way.” Second, he described the importance of *respecting what he ‘knew’* when discussing how, at times, “I’ve probably compared myself to what other people are doing [in training] and tried to mimic that. I think that’s where I’m *disrespecting* my capabilities …and then I’m [going to get] hurt and injured.” The athletes balanced their knowledge against their interpretations to alternately maintain or adjust their recovery plans.

Respecting What I ‘Know’. The athletes could respect their self-knowledge by following through on their situational recovery plans and intentions. They mainly talked about this theme in the context of situations where they ‘knew’ what they ‘should’ be doing for recovery, yet struggled to do so, or chose not to. Quinn said, “I’m theoretically dialed when it comes to nutrition, [but] I don't execute all the time. Especially when it comes to that third week of a [training] camp and I'm like, 'Wow, I'm thrashed [i.e., exhausted], I don't really care what I'm eating right now'." Fatigue could impair following through on recovery plans, as could disinterest or a lack of enjoyment. Gabby explained, "I wouldn't say that foam rolling and stretching is really exciting. I would rather do 1000 things than that. … it's definitely something I need to put in my schedule and kind of force myself to do." Sometimes, athletes chose to respect the quality of their plans and routines, even if their state of recovery differed from their expectations. For example, when Zoe struggled to fall asleep, she often chose to wake up at a regular time, because "the cost of shuffling or changing things is- [*pauses*] I'm already stressed about the lack of sleep and then I would be extra stressed about the change in the routine." Instead of making changes, "[her] strategy is to just adhere to the routine and trust that that will make me so tired that the next day I will be able to sleep and be back on track." Instead of adjusting to changing conditions, Zoe chose to trust her self-knowledge and the effectiveness of her routine.

Respecting What I 'Hear'. The athletes could respect the 'listening' process by adjusting planned recovery, training, or any non-sport plans to prioritize recovery based on their interpretations. For example, Quinn illustrated a rest day in his activity journal where he had planned to accomplish administrative tasks, but "kind of around lunch, I felt sick almost. Like you know that [feeling] when you get super, super tired?" Aware of his fatigue, he interpreted it meaningfully: "I was like, 'Okay, we're going to have to prioritize a nap here, we're going to have to make this happen'." He turned awareness and interpretation into action:

> I laid down [to nap] with the intention of, 'I need to make up for Saturday's [hard] ride'. … Then between like, 3:00[p.m.] and 4:30[p.m.], I have no recollection of what

> happened. I just woke up at 4:30[p.m.] and I was like, ‘Okay, that was sweet’. I felt instantly better.”

Quinn respected the sensations he felt by adjusting his plans to address them. The ability to respect and adjust depended on the athlete’s willingness to retain flexibility in their plans. Ryan felt that “if you get into [a certain recovery] habit and you can’t do it, that can almost like mess with you a little bit.” Instead, he emphasized flexibility: “If I just want to sit and do nothing, I’ll sit and do nothing. If I’m feeling totally fine and I don’t feel like I need to do anything [for recovery], then I won’t. I just take it as it comes.” Flexibility represented an openness to changing or abandoning one’s recovery plans, although some athletes found this challenging.

Despite their best efforts, the athletes acknowledged that their efforts of translating recovery knowledge and awareness into action would never be ‘perfect.’ Olivia was working on, “being able to let go if [planned recovery] doesn’t fit in. Like, if I don’t have time to do X-Y-Z, not being stressed about it, or if something happens and I have to go to bed at 11[p.m.], not being stressed that it wasn’t 10[p.m.].” Even if a recovery plan could be perfect, the athletes might fail to appropriately execute it or make the ‘theoretically correct’ adjustment. Ryan described, “it’s like a bit of give and take,” where if a nap needed to be skipped to go buy groceries, “it’s not the end of the world. Doesn’t have to be like 100% perfect, 100% of the time.” The athletes spoke with self-compassion for their recovery efforts and saw errors as part of the learning process.

Learning My Body

The athletes repeatedly engaged with elements of the first three themes (‘knowing’, ‘listening to’, and ‘respecting my body’), over and over in a *learning* process of consistent tinkering. Ryan said, “you just try it out. Like, ‘Oh, I took recovery drink after a workout and I felt better, so I’m gonna keep doing that’. …I might fine tune things a bit, but generally that’s how I get into the habit". Through self-experimentation, they developed an intimate understanding of the contingencies for how their knowledge, interpretations, actions and responses connected:

> It's been a lot of trial and error. ... I've learned how my body works a bit more personally, and then I'm able to focus on like, 'Oh, I know when *this* is tight, *this* goes *this* way and so I should probably focus on opening up my foot [by foam rolling], 'cause then I'm not gonna be compensating so much.'" (Logan)

The athletes continued to iterate this trial-and-error process over time, allowing their relationship with recovery to evolve in line with their recovery needs. Sean explained how, when he was younger, "I could get away with sleeping five hours [a night], eating whatever I wanted, [and] just power through it. Now [recovery] means a lot more, because I can't come back the next day and train like I used to." Along with age, the athletes had to adapt their recovery to their maturing training load. Olivia explained, "as you get older your training load gets bigger, so you can't afford to skimp on your recovery. … Because [my body]'s doing more, I have to be more diligent with my recovery [now]." Sean described his recovery evolving to prevent injury, whereas Zoe felt her recovery had to evolve with her training because "the closer you get to your potential, the more you have to focus on recovery." She elaborated, "When you're new and you have this massive amount to improve, doing anything will make you improve. But once you've been [training] for a decade, the same stuff is not going to yield an improvement."

The athletes felt their understanding of recovery matured in depth and complexity over time. Gabby reflected that when she was younger, "I just didn't really fully understand the whole [recovery] thing. I knew I had to sleep a lot, but [now] there's the whole thing about having a very steady sleeping schedule." Understanding also matured in breadth: "It's how many different things now make up what I think of as recovery. I used to think it was just change your shirt and you're good to go. Now, [there's] the nutrition and massage and mental training" (Anna). Understanding evolved through learning on large scales, from youth to adulthood, and on shorter ones. Zoe said, "I don't feel like I knew anything about recovery last year, and next year I'll probably think that I knew nothing about it this year." With greater understanding and maturity, came greater responsibility for recovery. Logan said, "in university, we would go from the workout and we would have massages and then ice baths and it was like our hands were held through recovery a bit. Now, it's solely on myself." The athletes did not divest themselves of others; rather they adopted a more athlete-driven perspective. James' National team was well-funded early in his career, so "we had so many people there, [saying], 'Make your next appointment!'. I probably relied on [others] more then, and now I probably rely on their knowledge to tell me what to do, but I rely on myself to do it."

With increasing self-responsibility, the athletes spoke of needing to develop their trust in recovery. This could be difficult, as trusting recovery ran counter to some of the skills that made them a good performer. Zoe said, "I'm someone who always feels like I'm not working hard enough, either physically or mentally, so it's very, very hard for me to let off the gas and just trust that recovery is the right move. …there's definitely just like a fixation on hard work [in endurance sport]." Gabby described, "it has a huge thing to do with performance, to be able to listen and trust yourself. Being able to tell your coach when you need to take a day or a week off, or when you can do more [training]." However, that trust had to be developed through practice, "if you never listen to your body for months, … how will you be able to trust yourself that you're ready? Because you've never listened to those signs, you don't know those signs."

Athlete-led Recovery is Integrated with Their Environment

The athletes' implementation of recovery was integrated with and influenced by various people and places in their environment. We interpreted more meaning in the forms of influence that the athletes attributed to their environment than exactly to whom or where the athletes attributed that influence. As such, we outline how the athlete's environment served to (1) supplement recovery, (2) facilitate recovery, or (3) provide for recovery.

Supplementing Athlete-led Recovery

The athletes described many people and places that shared, enhanced, or even somewhat performed the athletes' self-regulatory processes (i.e., 'knowing', 'listening to', 'respecting my body'). Many people (e.g., coaches, mental performance consultants) served as information sources on approaches to recovery, supplementing the athletes' own knowledge. James embraced the knowledge of these specialists, because "I have no education in being a coach, in nutrition, in physiotherapy, anything like that. So I just try to trust those people." Sean, however, often found these educational efforts overbearing: "Too much, there was too much information. And it wasn't exactly what I was looking for, it was what they thought they needed to tell me." Many athletes chose a more self-directed approach, either by researching recovery information themselves or by observing and interacting with their teammates. For Logan, "I would see my teammates after the run doing some stretches, doing some [foam] rolling, and I'd be like, 'Hmm, maybe there's something there, they were kicking my butt in the workout!". Athletes could draw on their team's 'culture' of recovery as a type of collective knowledge.

Other people supplemented the athletes' 'listening' processes by monitoring and interpreting the athletes' states of recovery/fatigue. The athletes interacted with various National team coaches or staff who took on this responsibility for monitoring and interpreting specific markers of their recovery. In some cases, the athletes were involved in interpreting this information, such as with a massage therapist who assessed their muscle tone and discussed potential causes. However, the athletes mostly had little involvement after this information was collected from them. They trusted, for instance, that the team physiologist who tracked their heart rate variability would interpret this information with a coach to improve their training. They also incorporated general impressions and interpretations of their mood or fatigue conveyed by those close to them (e.g., friends, teammates). Anna trusted her boyfriend's assessment of how tired she appeared: "He can tell how I'm doing. At breakfast, [he] sees I'm not in the mood to talk or whatever. Sometimes I need a bit of a nudge, and he's like, 'You should talk to [the coach]'." She could then go tell her coach, "I'm exhausted, like I woke up and I'm super tired. …What should I do?'," and then compare his interpretations with her own. Overall, the athletes trusted input from people who showed relevant professional and/or personal knowledge.

The athlete's environment supplemented their 'respecting' processes by prompting or motivating their engagement in recovery. Quinn rhetorically asked, "If all you see is other people [foam] rolling and stretching and napping, what are you gonna do?" James was teammates with World and Olympic champions, so while training was fun, he laughed, "we're pretty competitive with each other." As such, "[at] camp, if I see one of them doing stretching at night, and I'm working on stretching, it's way easier for me to do it. I already kind of know they're doing it, … but when you see it, it's different." Gabby was similarly motivated to recover to avoid getting dropped by her teammates next practice, yet was also motivated to recover *for* her teammates, because "we make each other stronger, and we definitely hold each other accountable for the things that we need to do."

The effectiveness of supplementing by others depended on their relationship with the athlete. For instance, coaches were uniquely positioned to help educate, monitor, and prompt the athletes' recovery. Zoe said, "[my coach] is in charge of planning [my training] and all of that, so he's the architect of my recovery and fitness," and she felt encouraged to provide feedback on her recovery to help shape her training. In contrast, Gabby described how a less supportive relationship with her previous coach had undermined her capability to self-regulate recovery:

> It took me a while to figure out those signs in my body that were like, telling me when to go, when to stop, and what to do. Because [the coach] was just like, 'The [training] plan is everything, you need to listen to that.' … I just thought I had to follow [coach's] plan. [Coach] was a National Team coach, [so] I was kind of scared that if I didn't listen to [coach] I wouldn't be raced and stuff. …With [that coach] my performance went downhill for sure, along with my confidence and my trust in my body.

While the athletes described different levels of involvement from others in guiding their training, no athlete mentioned positive outcomes for relinquishing control of guiding their recovery.

Facilitating Athlete-led Recovery

The athletes highlighted people and places with qualities that created conditions conducive to easier or better recovery. They enjoyed going to training camps in part because it removed some non-sport demands and freed up their time and energy for recovery. Anna explained, "I'm not cooking, not doing dishes. [At home], that probably takes like two hours out of my day, every day. So [at camp], I have more energy to do all of these meditations and extra mobility [recovery]." Partners or family at home could create a similar effect by taking on financial and logistical loads for non-sport tasks (e.g., cooking, cleaning), or by promoting an atmosphere that helped separate the athlete from their training world. The athletes generally valued being around people who "just understand" what is involved in recovery and training at an elite level. Logan, a marathoner, felt that "it would be so different if [my girlfriend] wasn't [also] a runner. Like it would be so tough to have a relationship, and for them to understand what I'm doing on a daily basis and understand like, the weight of it all." This understanding removed barriers of conflict and stress and helped the athletes get to their recovery more easily.

The stability of an athlete's environment could facilitate or impede their recovery. For Zoe, travel for training and competition meant, "I don't have a home base. I'm living in Airbnbs and moving around all the time, and that is not conducive to recovery. Having my own bed and knowing what to expect from my environment is really important for recovery." A stable environment removed the stress of navigating a new or unpredictable environment, which reduced unhelpful demands that distracted from recovery. Paradoxically, Zoe later said, "I get really fatigued by too much monotony, so that's when a change in environment is important," and she described how training in new locations in her off-season stimulated recovery. Logan similarly sought new environments for his recovery runs, "just taking a little bit more time out of my day and going to a softer or flatter surface that would help me detach mentally, [more] than just going and running near my house." Stable environments allowed athletes to more easily engage with their recovery routines yet could lead to monotony, while changing environments could create new affordances for recovery but also potentially disrupted regular routines.

Providing Athlete-led Recovery

The athletes often depended on their environments to provide recovery resources, like tools (e.g., self-massage guns) or services (e.g., massage therapy). Access to certain forms of recovery could be restricted by limited team funding, distance from specific facilities, bureaucratic sign-out systems, and issues with travel (e.g., language barriers, safety, hygiene customs, food availability). The athletes felt they had to take the initiative to seek the resources they needed. Some found their own massage therapists instead of waiting for team-affiliated ones, while Olivia advocated her needs to her coaches: “I can’t go and get the [compression pants]. But I can say, ‘Oh, I really like having the [compression pants]. Can we get them?’. I can’t physically sign them out, but I can remind [my coaches] to do it.” The athletes sometimes counted on their environment to be a source of enjoyment or relaxation, which they saw as providing mental recovery. For example, Eva valued time with her teammates because, “you might be exhausted, but sometimes to go to a restaurant and have a couple beers or whatever, it can make you feel so much better for the rest of the week.” For Fiona, being around family was mental recovery because they “provide that perspective that at the end of the day, you’re riding a bike. [Cycling] can be all consuming … [so] it provides balance.” In these cases, the athletes were clear that being in a specific environment supplied recovery, rather than the environment making the implementation of other recovery activities easier (facilitating) for them.

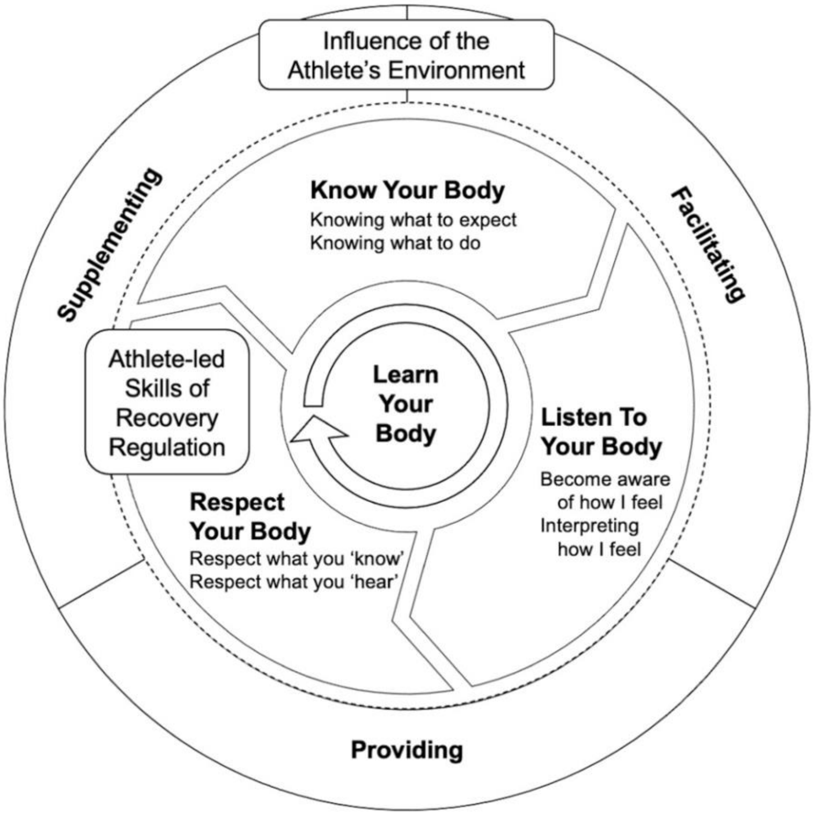
Discussion

We aimed to describe the process of implementing recovery from the perspective of elite endurance athletes. Recovery was primarily athlete-led, as the athletes played central roles in planning, decision-making, and acting on recovery. They located their recovery roles in relation to a supportive environment that supplemented, facilitated, and/or supplied recovery. More than a collection of modalities or strategies prescribed to athletes, our results present recovery as an athlete-centered decision-making process.

To help communicate our results, including how the dominant themes interact and relate to each other, we created a visual heuristic called the *Athlete Recovery Regulation Model* (ARRM; Figure 1). Our first three themes form an inner cycle of athlete-led processes (i.e., ‘Know’, ‘Listen To’, and ‘Respect Your Body’) that occur moment-to-moment. While inspired by Zimmerman’s (2000) SRL cycle, these themes do not represent discrete temporal phases (e.g., pre-, during, post-workout). Instead, they should be interpreted as interconnected processes that are blended within the periods between workouts to allow athletes to absorb the training of previous sessions and prepare for their next one (Wilson & Young, 2023). These processes draw on previous iterations of themselves (e.g., creating plans from previous experience) and feed forward into subsequent ones (e.g., adjusting future recovery plans based on current feelings). Thus, knowing, listening, and respecting interact with the fourth athlete-led process of ‘Learn Your Body’, which is placed in the middle because it is connected to the first three themes and represents how they span multiple inter-workout periods in recurring cycles of self-regulated recovery over weeks, months, or years. Balk and Englert (2020) similarly proposed that recovery self-regulation occurs in repeated cycles, and the ARRM expands this description to address how those cycles interact with learning or development over time.

In our model, the athlete-led processes are encircled by the ways in which they were integrated with the people and places in the athlete’s environment. The relationship between the athlete and environment is bi-directional; athletes relied on their environment, but they also sought information and regulatory support, located themselves in facilitating environments, and advocated for recovery resources. The self-regulatory strategy of seeking help in one’s surroundings is an underappreciated theoretical aspect of athletes’ SRL (Bain et al., 2023). Further, the notion that athlete-centered roles are nested within and reciprocally connected to their environment is characteristic of social-ecological models (e.g., Sallis et al., 2008).

Figure 1. *The Athlete Recovery Regulation Model*



Understanding the Processes of Recovery Regulation

Generally, the implementation of recovery was effectively informed by concepts from prior models of SRL and self-control. 'Knowing my body' involved the use of recovery-related self-knowledge to create recovery plans, which parallels forethought processes in Zimmerman's (2000) model of selecting a strategic approach to a task based on one's self-perceptions and self-motivational beliefs. Within 'listening to my body', athletes gained acute self-awareness of their feelings of recovery and fatigue by intermittently and intentionally checking in on themselves or consistently engaging in background self-monitoring. These strategies resemble learners' use of self-observation of task progress (Zimmerman, 2000) and Balk and Englert's (2020) account of self-monitoring to inform further self-control. 'Respecting my body' evokes aspects of self-control itself, as the athletes discussed respecting their recovery knowledge enough to enact unexciting or unappealing forms of recovery (e.g., stretching), and respecting what they ‘heard’ enough to let go of comfortable and predictable recovery plans or routines when confronted with new information. The models of both Zimmerman, and Balk and Englert, discuss the importance of self-control for adhering to performance of a (recovery) task, although our finding that athletes described using self-control to *change* recovery plans is novel.

Our findings emphasize certain nuances in the self-regulation of recovery that are not represented to the same degree in Zimmerman’s (2000) or Balk and Englert’s (2020) models. For instance, the athletes’ rooted their use of planning, self-monitoring, and interpreting in self-knowledge of their recovery needs and contingencies. Zimmerman’s cycle does not explicitly incorporate the learner’s knowledge, and thus this accent on self-knowledge has not been present in descriptions of athletes’ self-regulated behaviour in practice based on his model (e.g., Wilson et al., 2021). However, knowledge has been highlighted in other prominent social-cognitive theories of SRL in educational psychology. For example, Winne and Hadwin (1998) identify domain knowledge, task knowledge, and knowledge of learning strategies among the cognitive conditions (i.e., resources) that inform SRL.

Whereas Zimmerman’s (2000) SRL cycle has a distinct post-task self-reflection phase, our model has no explicitly comparable theme. Instead, two variations of reflection were woven into separate areas of our results. First, ‘listening to my body’ involved on-going reflection throughout each inter-workout period: Athletes interpreted feelings of stress and recovery by continually reflecting on their relative meaning in the context of current training goals and past efforts. Second, ‘learning my body’ implied periodic reflection on the relative effectiveness of one’s recovery actions and self-regulation (informing self-knowledge and future actions) as part of the “trial-and-error” process across multiple inter-workout periods. Thus, reflection was enacted *consistently* throughout the period between consecutive workouts, but also *expansively* across several inter-workout periods. This dynamic appears more complex than Zimmerman’s notion of self-reflection oriented towards a discrete learning task.

Our findings support Balk and Englert’s (2020) proposal that recovery self-regulation is a process of discrepancy reduction, while extending it with greater emphasis on personal agency. In line with their model, we found that athletes reacted to what they ‘heard’ and adjusted their recovery plans if their current state was discrepant from what they expected. However, recovery decisions were also informed by thoughts and feelings characterizing proactive self-regulation, as they created plans and contingencies for recovery based on nuanced expectations. Further, the athletes’ capability to self-regulate varied with personal and environmental factors. For example, the athlete who ‘lost’ her ability to listen to her body due to the autonomy-limiting style of her previous coach showed how the ability to draw on one’s self-knowledge, interpretations, or actions of recovery may vary with one’s trust in those processes. Trust implicated, among other characteristics, self-motivational beliefs (outcome expectancies, self-efficacy) that affected and were affected by one’s perceived recovery self-regulatory competencies. Our model asserts that recovery self-regulation is a complex and changing collection of cognitive and motivational processes that impact and respond to changes in the athlete’s self and their environments.

The ARRM contextualizes the athlete’s roles in relation to the people and places in their environment. These latter involved common forms of social support (Côté & Hay, 2002; MacLellan et al., 2018); specifically, emotional (e.g., conveying positive affect/caring), tangible (providing resources), informational (educating on recovery) and validation support (conveying understanding of what an athlete is going through). The athletes benefitted from social support but were not passive receptors; they engaged with their environments to stimulate and/or optimally integrate support. While their environments continued to supplement and facilitate recovery, the athletes described a general transition of self-regulatory responsibility as they gained competency, experience, and maturity. There were some exceptions due to the technical expertise or leadership styles/beliefs of others. For instance, team staff retained responsibility for monitoring certain recovery biomarkers, and certain coaches neglected to integrate athletes' feedback/autonomy or attempted to influence their recovery behaviours outside practice. Future work should explore the full ecological landscape of athlete recovery, including the role of coaches/staff in co-regulating athlete recovery and how it interacts with leadership styles.

Implications for Consulting and Research

Much research in elite sport is framed around developing the mental or physical skills underpinning sport performance. Recovery can be viewed in a similar light. The ARRM identifies several processes resembling key skills or competencies highlighted in models of mental performance in sport (e.g., Durand-Bush et al., 2023). For example, our athletes displayed *self-awareness* – the skill of understanding one's internal states through introspection – situationally, in relation to their momentary feelings of recovery and stress, and more generally, in relation to their recovery needs and contingencies. As part of learning, they discussed the need to develop trust in their recovery competencies, invoking elements of self-confidence, the skill of mobilizing beliefs that one has the internal resources or abilities to achieve a goal. Finally, they used interpersonal competencies (e.g., communication, relationship skills) to seek, integrate, and manage interactions with the environment. These parallels suggest that recovery regulation skills may be open to development through mental skills consultancy.

The domain of sport expertise examines the perceptual-cognitive skills that underpin reliably superior sport performance. These skills involve “the ability to identify and acquire environmental information for integration with existing knowledge such that appropriate responses can be selected and executed” (Mann et al., 2007, p. 457). While such research typically focuses on *visual* information processing (Mann et al., 2007), we invite readers to substitute kinaesthetic information for visual and consider our findings in similar terms. We found that elite athletes integrated domain-specific knowledge of their recovery needs and contingencies with information from internal sensory (e.g., feelings of fatigue/recovery) and environmental sources (e.g., time to the next workout). They interpreted that information to inform subsequent selection and execution of recovery responses. By this logic, effective recovery regulation can be understood in the classic paradigms of sport expertise (e.g., Starkes & Allard, 1993). For example, the self-knowledge and contingencies seen in ‘knowing my body’ compares to expert athletes’ superior use of sport-specific long-term memory representations, the selective attentional processes in ‘listening to my body’ compare with experts’ sport-specific discrimination of task-relevant stimuli, and the inherent recovery response selection/inhibition in ‘respecting my body’ parallels experts’ superior movement responses. We encourage future research to examine recovery-related skills for potential expertise-related differences to further an understanding of recovery as a product of skills that athletes can hone to maximize training.

Limitations and Conclusion

Our findings are contextualized by certain limitations. Participants were highly elite athletes of adult age, so their perspectives may differ from younger, less mature, and/or less skilled athletes. As endurance athletes, they may have different relationships with recovery than athletes in sports with different training and team dynamics. Further, their perspectives of their environment were likely influenced by the organizational structures (e.g., staff, facilities, funding) supporting high performance sport in Canada. Finally, our findings reflect discussions in constructed interview settings, while self-regulation is a situational, momentary process. Future research should consider how our findings apply *in situ* to the training and recovery process.

The ARRM locates athletes at the center of the recovery regulation process, integrated within supportive environments. Elite endurance athletes described optimizing their recovery across different contexts and perceptual, cognitive, and social dimensions using a set of self-regulatory processes developed over time. These regulatory efforts were reciprocally integrated with their environments. By describing recovery through the self-regulatory processes used to manage it, recovery can be understood as a series of skills that athletes can seek to own, develop, and master in pursuit of more effective and sustainable training and performance.

Data Availability Statement

The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research supporting data are not available.

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ARTICLE 3

How do Elite Endurance Athletes Self-Regulate Their Recovery Around Hard Training?

An Experience Sampling Study

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Cited in-dissertation as: Wilson et al. (*Article 3*) or Article 3.

Abstract

Effective training for high-performance sport requires recovery, yet little research has examined the psychology of how athletes shape their recovery between training sessions. Although qualitative research has described how elite endurance athletes implement recovery through self-regulatory processes, there is a need to explore how this evidence transfers to more ecologically valid contexts. This study employed experience sampling methods to describe how elite endurance athletes self-regulated their recovery around two important workouts, 2–3 days apart in their planned training. Twenty-two endurance athletes, (7 males, 15 females) training within able-bodied and parasport Canadian National cycling and triathlon teams reported on processes of recovery self-regulation and perceived recovery and stress states using their smartphone, up to eight times daily for five days. We described indices and patterns for how the athletes employed four recovery self-regulation processes (i.e., awareness, checking-in, interpreting, adjusting), as well as when in relation to their key workouts and recovery-stress states. The specific self-regulatory processes were strongly correlated but differed in frequency, intensity, consistency, and predictors of use, which suggests that the processes represent synergistic yet unique competencies. Greater use of recovery self-regulation processes was associated with states of higher perceived stress and, to a lesser extent, lower perceived recovery. Although the time remaining to a workout and elapsed after a workout were each associated with perceived stress and recovery states, time to/since a workout was not associated with any self-regulation process. Our findings indicate that elite athletes are highly engaged in dynamically self-regulating their recovery between important training sessions.

Keywords: self-regulated learning; performance; talent development; practice, expertise

How Do Elite Endurance Athletes Self-Regulate Their Recovery Around Hard Training? An Experience Sampling Study

Effective training for sport requires that athletes balance stress with recovery. Sufficient recovery compensates for stress and spurs further adaptation, while inadequate recovery allows stress to accumulate and increases the risk of outcomes like injury, illness, overtraining, or burnout (Kellmann, 2002; Kellmann et al., 2018). Athletes actively shape their recovery through the decisions and actions they take (or do not take) between hard training sessions (Balk & Englert, 2020; Kellmann, 2002). Research has examined the recovery outcomes of these decisions (Kölling et al., 2015) and the tools/modalities that are used in the process of acting on them (Venter & Grobbelaar, 2018). Recent work has proposed (Balk & Englert, 2020) or described via interviews what these decisions may involve (Wilson & Young, *in review*). However, no research has explored what the potential process of decision-making actually ‘looks like’ in the course of training. This study aimed to better understand the psychology underpinning high-performance athletes’ recovery between important training sessions.

Recovery Around Training

Recovery is the process of restoring performance capability between training sessions (Kellmann et al., 2018). It involves mechanisms, states, and activities across multiple dimensions (e.g., psychological, physiological, social) to compensate for stress accumulated from training and non-training sources (Kellmann, 2002). Stress is the product of the demands, or stressors, encountered by an individual and how they experience those demands (i.e., stress response). The relationship between stressor and response is mediated by the individual’s cognitive appraisal of the nature of the demands and their capacity to handle them (Lazarus, 1999). As such, stress involves complex interactions between non-conscious physical responses and, importantly, the individual's perception of stress responses. For example, a hard training session creates muscular fatigue that may result in further stress depending on how an athlete appraises/experiences the severity and their ability to manage it. Recovery must therefore be strategically implemented to address the cumulative effects of individual and contextual experiences of stress.

Stress and recovery are interrelated, but one is not defined by the absence of the other (Kenttä & Hassmén, 1998). According to the scissors model of the recovery-stress state (Kellmann, 2002), a state of high stress is manageable as long as it is matched with corresponding recovery, and remains within the athlete's stress capacity. An athlete under a high training load may alternately be over-stressed (i.e., beyond their capacity), underrecovered (i.e., inappropriate type or degree of recovery), or training productively (i.e., stress is matched with sufficient recovery). Research using measures grounded in Kellmann's (2002) model has found that similar dimensions of recovery and stress are moderately to strongly correlated, but not collinear (Kellmann & Kölling, 2019). Thus, an athlete's experience of recovery and stress should be assessed concurrently, but as separate constructs with multiple dimensions.

Research Perspectives on Recovery

Extensive research has examined recovery from training. For instance, many studies have monitored the impact of training loads and conditions on associated recovery states (e.g., Kölling et al., 2015). Another group of studies has examined the validity of various recovery modalities (e.g., cryotherapy; Dupuy et al., 2018) and how often athletes use them (e.g., Venter & Grobbelaar, 2018). These lines of research advance understandings of recovery, but are focused on the practitioner's perspective of what it involves: Designing training plans, monitoring recovery markers, and prescribing recovery modalities. An athlete-centered perspective would recognize that the effect of training loads on recovery outcomes, or the use and effectiveness of a modality, depend on how athletes think about, act on, and integrate recovery in their lives.

Considering that athletes influence and experience processes of recovery, it is surprising that their perspectives on the processes, experiences, and mechanics of enacting recovery have not been sufficiently factored in research, with some exceptions. Wilson and Young (2023) investigated what recovery meant for 13 elite endurance athletes, who had competed at multiple World Championships and/or Olympics. In two interviews contextualized by an intervening week of activity journaling, the athletes characterized recovery primarily according to the goals, demands, and priorities that it addressed. First, recovery helped them sustain and accumulate training long-term by accomplishing short-term goals of absorbing their previous training session and preparing for their next one. These short-term goals were framed around the 1–3 key workouts the athletes performed each week that were particularly challenging and beneficial for their improvement. Second, the athletes felt recovery involved getting a break from the specific demands they were feeling by engaging with another activity, identity, or setting they found meaningful. Third, they had to negotiate multiple recovery approaches, which sometimes were conflicting, to prioritize the perceived best approach for a particular context. The athletes described a broad range of approaches that could potentially fulfill recovery characteristics; these spanned multiple dimensions (e.g., physical, mental), levels of focus/investment, and personal variations. Importantly, the elite athletes attributed less importance to the specific modality or method they used. Instead, they emphasized the process of matching their approach to recovery at the right time, in the right context.

Other research similarly indicates that athletes actively select and implement their recovery between training sessions. For instance, athletes experience higher levels of emotional recovery at night when they match emotional stress with strategies that create more emotional detachment (i.e., switching off) from the day's training (Balk et al., 2017; Kenttä & Hassmén, 1998). Similarly, collegiate field hockey players have described actively creating mental rest by purposefully engaging with specific activities and environments (Eccles & Kazmier, 2019). For example, the players sought time with friends outside their team to create mental separation from constant thinking about their training and performance. The active role athletes play in shaping their recovery can be described as a process of self-regulation (Balk & Englert, 2020).

Self-regulation and Recovery

Self-regulation involves self-generated thoughts, feelings, and actions that are enacted and refined in pursuit of personal goals (Zimmerman, 2000). Specifically, "[self-regulation] entails not only behavioural skill in self-managing environmental contingencies, but also the knowledge and the sense of personal agency to enact this skill in relevant contexts" (Zimmerman, 2000, p.14). The use of self-regulation is thus dictated by characteristics of both the person and the situation, which can change across time and contexts (Winne, 1997).

Self-regulated learning (SRL) involves applying self-regulatory processes to enhance learning. Learners employ a combination of metacognitive competencies and motivational beliefs before, during, and after tasks in an ongoing cycle that is adapted to suit the current task and context (Zimmerman, 2000). In sport, an athlete may self-regulate learning during practice by planning an approach to a specific drill, monitoring their approach as they perform it, and reflecting afterward to inform how they approach the task in their next practice. Research has consistently found that higher-skilled athletes seek to tailor their training by making greater use of SRL processes (Young et al., 2023).

Wilson and Young (*in review*) explored how elite endurance athletes perceived the process of self-regulating their recovery in a series of interviews. Drawing on cyclical characteristics of SRL, they summarized their findings in an athlete recovery regulation model (ARRM), which contained four athlete-led processes of self-regulation expressed in the athletes' words: "knowing my body", "listening to my body", "respecting my body", and "learning my body". Of note, the athletes' use of "body" referred broadly to the self (e.g., physically, mentally, emotionally). "Knowing my body" involved personal knowledge of how they expected to respond to specific training and recovery stimuli, and how to implement that knowledge through recovery plans and routines. "Listening to my body" involved activating self-awareness of how tired or recovered they felt, either through background self-monitoring or intentionally checking in with their state, and then interpreting those feelings in relation to their expectations to inform subsequent actions. "Respecting my body" involved acting on those interpretations, either by "respecting what I know" and following through on plans/routines, or by "respecting what I hear" and flexibly adjusting plans to adapt to new information. Finally, "learning my body" encompassed how athletes engaged with the first three themes in repeated cycles of trial and error, which allowed them to grow and adapt their knowledge and regulatory skills over time.

Wilson and Young (*in review*) contended that these processes of recovery self-regulation represent a set of mental and perceptual-cognitive skills that athletes could own and develop to manage their recovery from moment to moment between key workouts. However, evidence for these processes came from conversations in interview settings divested from the training environment. Considering the dynamic and situational nature of self-regulation (Winne, 1997), which is reflected in the described skills of recovery regulation, we suggest that these processes should be explored in the ecological context of their use.

Experience Sampling Methods

Research on SRL in sport has been almost exclusively conducted using cross-sectional surveys or interviews (Young et al., 2023). While these methods have merits, they are limited by recall bias, neglect the influence of time, and lack ecological validity, thereby failing to capture self-regulation as a contextual process. In contrast, studies using experience sampling methodology (ESM) can provide a naturalistic assessment of a participant's current thoughts, feelings, and/or actions through repeated sampling (Larson & Csikszentmihalyi, 1983). With ESM, participants report on their current state multiple times per day across several days, for example, by completing very short surveys sent to their cellphone (Myin-Germeys & Kuppens, 2022). For instance, Nett et al. (2012) used ESM to describe how students self-regulated their learning throughout the 14 days preceding a math test. Within sport psychology research, ESM has been used to assess topics like pre-competitive emotions (Cerin et al., 2001), however, it has never been used to study self-regulation in sport or recovery from training.

Research Questions

In sum, elite athletes have described selecting and implementing recovery to meet the goals, demands, and priorities of their context using a set of skills comprising recovery-oriented self-regulatory processes. This evidence was derived from interview contexts and there is a need for further characterization of the self-regulation of recovery using methods that respect it as an ongoing process of moment-to-moment decision-making. In this study, we aimed to describe how elite endurance athletes self-regulate their recovery between key workouts in training. We chose to focus on the moment-to-moment aspects of recovery self-regulation represented by the two ARRM (Wilson & Young, *in review*) processes of "listening to my body" and "respecting my body". Three questions guided this exploratory investigation:

1. *Do they self-regulate recovery?* i.e., With what frequency and intensity do they report thinking or acting on their recovery throughout a day, and to what extent does this specifically involve processes of recovery self-regulation?
2. *What patterns describe how they self-regulate recovery?* i.e., How concurrently, how consistently, and when in relation to their key workouts do they use different processes of recovery self-regulation?
3. *How does their state of recovery relate to their self-regulation?* i.e., How do dimensions of their perceived recovery-stress state predict their use of self-regulatory processes?

Methods

This study used ESM to explore athletes' recovery self-regulation between important training sessions. All procedures were approved by the host university's Research Ethics Board (Appendix B).

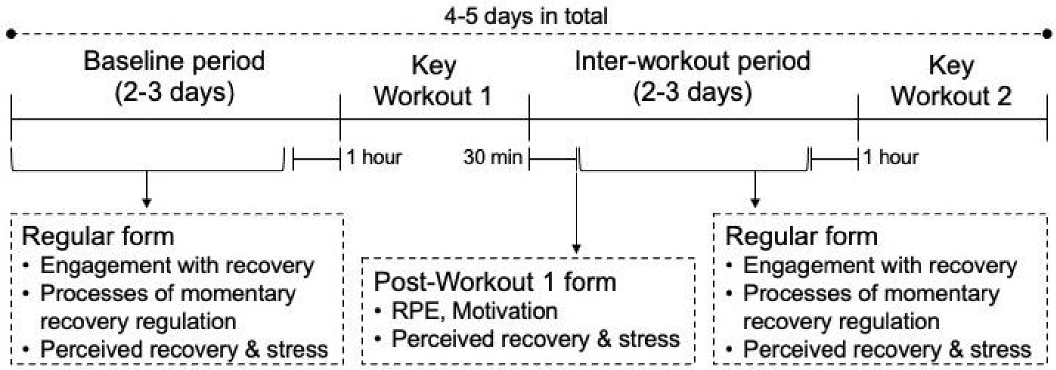
Participants

Our sample comprised athletes training with Canadian National Teams in cycling-based endurance sports. We aimed to recruit elite, endurance-sport athletes (a) because training loads are particularly high in endurance sports and for those competing at higher performance levels (van Erp et al., 2020), and (b) to match the population from which the recovery self-regulation skills had been identified (Wilson & Young, *in review*). In partnership with a Canadian Sport Institute, we identified the Olympic and/or Paralympic disciplines of road cycling, endurance track cycling, mountain biking, and triathlon as providing the largest possible pool of National team-affiliated endurance athletes from which to recruit. We met each team's coaches and sport science staff to discuss the aims and procedures, and to identify a suitable timeline. With coach approval, we met with each team to explain the study and provide a sign-up link. Sample size was determined by constraints on recruitment and the size of the population; we recruited as many participants as we could from the identified teams. Of approximately 60 athletes made available for contact, 27 completed the consent form and provided information to participate (Appendix J).

Design and Procedures

This study employed a within-person design to examine recovery regulation within an ecologically valid, ‘recovery-intensive scenario’, defined as the 2–3 days between consecutive key workouts in the athletes’ planned training. Key workouts are the weekly training sessions that are the most mentally and physically demanding and that are most impactful for improving performance (Wilson & Young, 2023); elite athletes generally have 1–3 of these workouts per week. After providing informed consent, the athletes identified, in consultation with their coaches, the dates/times of two upcoming key workouts separated by 2–3 days, along with their preferred waking hours (outside of which they would not be contacted during the study; default waking hours were 5 a.m. to 11 p.m.), and basic demographic information (Appendix K).

Figure 1. *Visual representation of the study design.*



Note. RPE = Rating of perceived exertion.

Figure 1 shows the timeline. The full study covered 5–6 days, including an *inter-workout period* representing the 2–3 days between key workouts 1 (W1) and 2 (W2), as well as a *baseline period*, representing the 2–3 days preceding W1. During the study, the athletes trained as usual: Key workouts were planned and implemented by their respective coaches, and between key workouts they continued with any other planned easier training sessions. We prioritized ecological validity, meaning that we did not intentionally influence the training or recovery processes, and instead worked to adapt our design to their constraints. As such, the exact length of baseline and inter-workout periods varied between athletes as the timing and content of their workouts were adjusted during the study as part of the normal training process.

During the inter-workout and baseline periods, each athlete received a text message to their smartphone once randomly within each two-hour block of their daily waking hours. Researchers sent the messages using an automated service (Klaviyo, 2023). No messages were scheduled to be sent within 45 minutes of another, and participants were instructed to complete each form within 30 minutes of receiving it. In the baseline period, athletes were scheduled to receive their first text message starting 48 hours before W1 and their final message one hour before W1. During the inter-workout period, they could receive messages starting 30 minutes after W1 up until one hour before W2 during the waking hours.

Each text message linked to an online form (hosted on SurveyMonkey). Every online form began with a preface reminding athletes that “what counts as recovery is up to you,” and that it generally “involves whatever helps you absorb the work from your previous workouts and prepares you for the work in your next workouts,” “can be mental, physical, or a mix of both,” and “can be more dialed-in and focused, or more dialed-out and relaxed” (based on descriptions from Wilson & Young, 2023). The repeating regular form contained measures for *engagement* *with recovery*, processes of *momentary recovery regulation,* and states of *perceived recovery and stress* (Appendix L). This regular form took a median of 88 sec to complete. The first form sent after W1 contained *manipulation checks* for effort and motivation and measures for *perceived recovery and stress* (Appendix M). After study completion, the athletes were sent individual reports of their recovery, stress, and recovery regulation, coaches and sport science staff were sent anonymized versions of these reports, and debrief sessions were held with each team and coaches separately.

Measures

Engagement with Recovery

We assumed that to engage specifically with self-regulatory processes, athletes would need to be engaged with recovery-related thoughts or actions *of any kind*. Thus, we created two items asking them to rate the extent to which their thoughts and actions (respectively) had been guided by recovery during the previous half-hour. They answered on a 5-point Likert scale, anchored from 0 (*Not at all*) to 4 (*Almost all the time*). These items were adapted from Nett et al. (2012) who used similar items to assess the extent to which students thought about an upcoming test, as a precursor to questions about specific SRL those thoughts involved.

Processes of Momentary Recovery Regulation

We created four items to assess aspects of two momentary recovery regulation process in the ARRM: “listening to my body” and “respecting my body” (Wilson & Young, *in review*).[1]

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[1] Of the four athlete-led skills of recovery self-regulation described by Wilson and Young (*in review*), we focused on the two skills that most involved *momentary* decision-making processes. We considered examining all four skills, but pilot work indicated the current design was more conducive to processes on these timelines compared to those involved in more dispositional (“Knowing my body”) or long-term (“Learning my body”) skills.

[1] For simplicity, in this manuscript we will refer to the respective SRSS items according to their scale and dimension in lieu of the original item titles (e.g., *Physical performance capability* became *Physical recovery*). The actual items (i.e., specific descriptive adjectives) remain unchanged.

Momentary processes are tied to the regulation of acute thoughts, feelings, or actions, as opposed to more dispositional or personality-related characteristics. All items were reviewed for their clarity and theoretical representativeness by two subject matter experts: a mental performance consultant and an academic expert in SRL research. Items were prefaced by, "During the past half-hour, …" and rated on a 5-point Likert scale anchored from 0 (Not at all) to 4 (Almost all the time). The first item, "…I was aware of how recovered I felt," represented the process of activating awareness of one's recovery-stress state. The second item, "…I checked in on how recovered I felt," represented intentionally checking-in on how one felt. The third, "…I compared how I felt with how I expected to feel," represented interpreting how one feels to guide subsequent actions for recovery. The fourth, "…I purposefully adjusted my current or planned recovery," represented flexibly adapting one's recovery based on those interpretations.

Perceived Recovery and Stress

The Short Recovery and Stress Scale (SRSS; Kellmann & Kölling, 2019) assessed the athletes' multidimensional recovery-stress state. It contains separate recovery and stress scales, which each contain four items assessing physical, mental, emotional, and overall dimensions.[2] For each item, respondents rate how they feel "right now" compared to their best/highest ever state on a 7-point scale, anchored at 0 (*Not at all*) and 6 (*Fully applies*). For example, mental recovery was assessed by the item, "Mentally, I feel... attentive, receptive, mentally alert, concentrated," whereas mental stress was assessed with "Mentally, I feel... unmotivated, sluggish, unenthusiastic, like I'm lacking energy." Higher scores are interpreted as experiencing a higher state of recovery or stress. The SRSS is a valid and reliable instrument in English-

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[2] For simplicity, in this manuscript we will refer to the respective SRSS items according to their scale and dimension in lieu of the original item titles (e.g., *Physical performance capability* became *Physical recovery*). The actual items (i.e., specific descriptive adjectives) remain unchanged.

speaking populations of athletes, and the eight items of the SRSS should be analyzed separately, without aggregation within scales or dimensions (see Kellmann & Kölling, 2019).

Manipulation Checks: RPE and Motivation

To assess whether W1 was demanding, 30 minutes after W1, the post-W1 form asked athletes to provide a rating of perceived exertion (RPE) using the 10-point modified RPE scale (Foster et al., 2001). Specifically, we asked them to provide a global rating for the difficulty of their entire W1 session. They also rated how motivated they were to perform well in W2, using a 5-point Likert scale, anchored from 0 (*Not at all motivated*) to 4 (*Very motivated*).

Analytic Approach

Analyses were conducted using R (R Core Team, 2023). Of the 27 participants, five completed < 15% of their forms and were excluded from analysis. The final sample of 22 included 15 females and seven males, with a mean age of 25.1 yrs (*SD* = 5.6), who were with National teams in able-boded (*n* = 14) and para divisions (*n* = 8) in cycling-related sports: Road cycling (*n* = 3), track cycling (endurance events only; *n* = 6), mountain bike (i.e., Olympic cross-country discipline; *n* = 7), and triathlon (*n* = 6).

Preliminary Analyses

The mean baseline period, representing the time from the first message received until the scheduled start of W1 was 36.55 hours (14.83–61.90; *SD* = 10.80). The mean inter-workout period, representing the time from the scheduled end of W1 to the scheduled start of W2 was 51.70 hours (41.00–77.50; *SD* = 12.10). Owing to the variability in the length of each period, we coded time during the inter-workout period two ways: the elapsed *time since key workout 1* (TSW1), which counts up from zero, and the remaining *time to key workout 2* (TTW2), which counts back from 0. For the baseline period, we similarly calculated the *time to key workout 1* (TTW1). There were no outliers (i.e., +/- 3.29 *SD*s) in the durations of TTW1, TTW2, or TSW1.

Regarding the manipulation checks, five athletes did not complete the post-W1 form and thus did not provide RPE and motivation values. The remaining 17 cyclists reported a mean RPE for W1 of 6.0 (3–9; *SD* = 1.9) which falls between the anchors of "Hard" and "Very Hard". They rated their motivation for W2 as "Motivated" or "Very Motivated" (*M* = 4.6, 4–5; *SD* = 0.5). These analyses indicated that the key workouts created a sufficient recovery-intensive scenario.

Main Analyses

The data reflected a two-level structure consisting of individual repeated points of assessment (*N* = 464 forms) within participants (*N* = 22). As such, all analyses were run with data nested by participant. For instance, descriptive statistics were first calculated for each individual and then averaged across the sample. We described the relationship between use of processes on the same form by calculating repeated measures correlations (rmcorr package; Bakdash & Marusich, 2017), which account for non-independence within participants by adjusting for inter-individual variability. Statistical significance was indicated where $p < .05$.

To describe whether athletes self-regulated their recovery in more consistent or intermittent patterns, we assessed the frequency and magnitude by which responses for a given process changed between any two consecutive forms by calculating difference score probabilities and root mean square difference (RMSD) values (Barchard, 2012). In a repeated measures design, difference score probabilities represent the probability that the 'score' (i.e., response level) for a variable will increase or decrease by a given amount from one time-point to the next. Difference score probabilities can be summarized using the RMSD, which represents the root mean square difference in a score from one time-point to the next.[3] We calculated difference score probabilities across the full sample, and calculated RMSD values by participant and then aggregated those across the sample.

We described the associations between processes of self-regulation, engagement with recovery, states of recovery and stress, and time, using three sets of multilevel models (MLMs) built with the lme4 package (Bates et al., 2015). Of note, following our exploratory aims, we specifically used MLMs to describe the relationship between variables as they occurred in this sample, not to build an externally predictive model generalizable across contexts. As a preliminary step, we calculated intraclass correlations (ICCs) for each variable. ICCs range from 0 to 1.0 and indicate the proportion of variance attributable to within-group factors; higher values indicate greater variability between participants than across participants (e.g., due to situational factors like time). Next, we built a first set of MLMs to describe when, in relation to their key workouts, athletes used processes of recovery self-regulation. Specifically, we built a separate model for each variable of engagement (two) and self-regulation (four) regressed onto each of the measures of time (TTW1, TTW2, TSW1); i.e., 18 separate models in total.

A second set of models regressed each of the eight variables of perceived recovery and stress onto the three timeline variables (i.e., 24 models in total). We centered variables of recovery and stress within participants so that 0 represented an athlete's average state during the study. Finally, we performed a third set of models wherein we regressed each of the four processes of self-regulation onto each of the eight variables of recovery and stress, separately for the baseline and inter-workout periods (i.e., 64 models in total).

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[3] We chose these calculations because they describe variability from moment to moment (form to form), as opposed to other statistics that describe variability across a full data set (e.g., coefficient of variation).

We built each MLM similarly, using maximum likelihood estimation. We added terms in steps and tested whether each step significantly improved the model using -2 log likelihood comparison ($p < .05$). The specific steps and terms used are detailed in the Results. Given the large number of MLMs, within each group of relevant effects we used the Benjamini-Hochberg (B-H) procedure to control for a false discovery rate of 10% (Benjamini & Hochberg, 1995). As such, we reported a fixed effect was statistically significant when its *p*-value was below the corresponding critical value.[4] All the MLMs are reported in the Supplementary Appendices (Appendices N–P). Considering the large numbers of models run, we interpreted these models with a focus on the aggregated direction and not on the *p*-value of any one test. Our intention was not to 'fish' for significance, but rather to build a fulsome picture of the data at hand.

Results

Overall, the athletes in our final sample received 717 text messages and responded on 459 forms (64.0%). They received 20–42 messages in total (*M* = 32.6, *SD* = 5.3) and completed 31.7%–92.9% of them (*M* = 65.3%, *SD* = 18.9%). During the baseline period, athletes received 338 messages and completed 232 forms (68.6%); each athlete received a mean of 15.4 messages and completed 12.0%–100% of them (*M* = 71.6%, *SD* = 21.4%), which represents 3–16 completed forms (*M* = 10.5, *SD* = 3.7). In the inter-workout period, athletes received 379 messages and completed 227 forms (59.9%); each athlete received a mean of 17.2 messages and completed 13.3%–92.3% of them (*M* = 61.7%, *SD* = 21.2%), which represents 2–17 completed

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[4] The Benjamini-Hochberg procedure functions as a less conservative approach to controlling for multiple comparisons than methods like the Bonferroni technique. Each p-value within a pool of tests is ranked in ascending order and compared against a critical value (i/m)Q, where i is the rank of the effect (i.e., 1, 2, …), m is the number of tests, and Q is the chosen false discovery rate (e.g., 10%). All p-values smaller than their corresponding critical value are significant. Thus, the indicated significance of an effect may not align with other indicators that readers are familiar with (e.g., confidence intervals).

forms ($M = 10.3$, $SD = 3.7$). Response rates decreased from the baseline to inter-workout period for 18 participants, while four responded more frequently between workouts.

Frequency and Intensity of Self-Regulation

Across the full study, athletes reported thinking about their recovery to some degree (i.e., level > 0) on 73.3% of all forms and reported having their actions guided by recovery (i.e., level > 0) on 74.0% of all forms, which indicates relatively high levels of engagement with recovery between workouts. They reported some level (> 0) of at least one momentary recovery regulation process on 78.5% of forms. They reported some level of *awareness* of how recovered they felt on 76.5% of forms, *checking-in* on their recovery on 72.4%, *interpreting* those feelings on 63.1%, and *adjusting* their recovery on 42.2% of forms. Table 1 shows descriptive statistics per participant across the study periods. Rates of recovery engagement and self-regulation were generally higher in the inter-workout period compared to baseline.

Table 1. *Percentage of athlete's responses > 0 for engagement in thinking/acting on recovery and use of processes of recovery regulation, aggregated across individuals.*

	Baseline			Inter-workout			Full study		
	n	*Mean % (SD)*	Range	*n*	*Mean % (SD)*	Range	*N*	*Mean % (SD)*	Range
Engagement									
Thoughts	232	72.1 (23.8)	25.0-100	210	80.4 (19.4)	35.3-100	442	75.7 (20.2)	30.3-100
Actions	232	71.6 (25.3)	6.2-100	210	81.1 (21.4)	23.5-100	442	76.5 (21.7)	15.2-100
Regulation									
Awareness	230	74.3 (22.9)	18.8-100	209	82.7 (20.0)	41.2-100	439	78.2 (19.8)	30.3-100
Checking-In	230	69.8 (27.4)	12.5-100	209	79.4 (21.9)	40.0-100	439	74.4 (22.8)	30.3-100
Interpreting	230	63.9 (31.6)	6.2-100	209	68.6 (31.3)	17.6-100	439	66.2 (29.9)	12.1-100
Adjusting	229	42.9 (28.5)	0.0-100	209	46.3 (35.0)	0.0-100	438	44.5 (28.8)	4.2-100

Note. n = count of individual responses.

Table 2 presents the mean levels of engagement in thinking/acting, momentary self-regulation processes, and perceptions of recovery and stress. Distributions for variables of engagement and self-regulation showed acceptable skewness (-0.08 – 1.24) and kurtosis (1.77 – 1.98), although *adjusting* was somewhat leptokurtotic (kurtosis: 3.49).

Table 2. *Levels of engagement in thinking/acting on recovery, use of processes of recovery regulation, and perceived stress and recovery states, aggregated across individuals.*

	Baseline				Inter-workout			
	n	*M (SD)*	Range	*ICC*	*n*	*M (SD)*	Range	*ICC*
Engagement								
Thoughts	232	1.51 (0.60)	.38-2.43	.163	210	1.71 (0.74)	.47-3.20	.259
Actions	232	1.68 (0.57)	.13-2.42	.076	210	1.97 (0.72)	.53-3.00	.195
Regulation								
Awareness	230	1.71 (0.69)	.31-2.78	.201	209	1.87 (0.66)	.60-3.20	.231
Checking-In	230	1.44 (0.71)	.25-2.67	.273	209	1.67 (0.81)	.40-3.50	.354
Interpreting	230	1.34 (0.75)	.13-2.75	.277	209	1.41 (0.85)	.30-3.20	.380
Adjusting	229	.83 (0.61)	.00-2.07	.210	209	.82 (0.74)	.00-2.50	.385
Recovery								
Physical	232	3.43 (1.02)	1.53-5.11	.637	227	3.62 (1.00)	1.80-5.60	.547
Mental	232	3.62 (1.05)	1.33-5.67	.557	227	3.88 (1.11)	1.70-6.00	.507
Emotional	232	4.16 (0.97)	1.33-5.89	.607	227	4.54 (1.00)	2.00-6.00	.516
Overall	232	3.40 (0.94)	1.20-5.38	.509	227	3.42 (0.91)	1.50-5.40	.428
Stress								
Physical	232	2.93 (0.79)	1.38-4.53	.351	227	3.01 (0.89)	.60-4.60	.372
Mental	232	2.17 (1.20)	.00-4.60	.537	227	2.01 (1.23)	.00-4.50	.545
Emotional	232	1.63 (1.10)	.00-4.07	.627	227	1.33 (1.24)	.00-4.50	.724
Overall	232	2.01 (1.11)	.11-4.60	.624	227	2.08 (1.37)	.00-5.00	.698

Note. n represents the count of individual responses; all other statistics represent aggregations of individual participant means. Engagement and regulation scores were each on a scale from 0–4; Recovery and stress scores were on a scale from 0–6. ICC = intraclass correlation.

Patterns of Self-Regulation

Relationships Between Concurrent Processes

Athletes' thoughts and actions on recovery on the same form were significantly correlated in the baseline and inter-workout periods (see Table 3). All four recovery self-regulation processes, from the same form, were similarly significantly positively correlated with each other, and with their thoughts and actions of recovery.

Table 3. *Repeated measures correlations between engagement with thoughts/actions on recovery and processes of recovery regulation.*

	Thoughts	Actions	Awareness	Checking-in	Interpreting	Adjusting
Thoughts	—	*** .566	*** .620	*** .640	*** .484	*** .414
Actions	*** .624	—	*** .488	*** .454	*** .294	*** .325
Awareness	*** .686	*** .610	—	*** .800	*** .636	*** .312
Checking-in	*** .730	*** .531	*** .817	—	*** .726	*** .264
Interpreting	*** .617	*** .442	*** .682	*** .807	—	** .208
Adjusting	*** .480	*** .506	*** .383	*** .395	*** .370	—

Note. Baseline period = bottom diagonal; inter-workout period = top diagonal.

*** p <.001, ** p<.01

Consistency of Recovery Self-Regulation

Table 4 shows difference score probabilities for each regulation process. Each value represents the proportion of responses that differed by a given amount from the response on the preceding form. In the inter-workout period, responses for *awareness* showed a change from the prior form (i.e., one or more levels of difference) in 52.1% of cases, while *checking-in* changed in 60.7% of cases, *interpreting* in 51.4%, and *adjusting* in 48.6%. Compared to a maximal RMSD value of 4.0 (i.e., changing from opposite poles of the scale), athletes recorded a mean

RMSD of 1.15–1.20 for all processes except *adjusting* (0.88). The range in values was double the mean, which suggests notable inter-individual variability for all processes.

Table 4. *Difference score statistics for each process of recovery self-regulation.*

	Difference score probabilities					RMSD	
	0	1 / -1	2 / -2	3 / -3	4 / -4	*M* (*SD*)	Range
Inter-workout							
Awareness	47.9	30.7	12.9	8.6	0.0	1.17 (0.70)	0.00 – 3.00
Checking-in	39.3	40.0	15.0	5.0	0.7	1.20 (0.65)	0.00 – 2.55
Interpreting	48.6	29.3	15.0	7.1	0.0	1.15 (0.57)	0.00 – 2.17
Adjusting	61.4	24.3	7.1	5.7	1.4	0.88 (0.67)	0.00 – 2.27
Baseline							
Awareness	36.9	33.3	17.9	10.1	1.8	1.42 (0.43)	0.71 – 2.14
Checking-in	36.9	39.9	17.3	4.8	1.2	1.23 (0.41)	0.00 – 1.91
Interpreting	47.0	29.2	15.5	6.5	1.8	1.35 (0.48)	0.41 – 2.19
Adjusting	50.0	25.9	12.7	10.8	0.6	1.30 (0.48)	0.00 – 2.42

Note. Columns for difference score probabilities are labelled by the magnitude of change in a score from the previous form, and values are reported as percentages; e.g., during the inter-workout period, 30.7% of awareness responses were 1 level higher or lower than the previous response (within the past six hours). RMSD = root mean square difference; the statistics presented are aggregated across individual participant means.

Timing of Self-Regulation in Relation to Key Workouts

ICCs are in Table 2. Values for thinking and acting on recovery (19.5–25.9%) and regulation (23.1–38.5%) indicated greater variability across participants (e.g., due to factors like time or one's recovery-stress state) than between participants during the inter-workout period.

When building the first set of MLMs, we followed four steps: (1) We fit a basic model with random intercepts for participants, (2) we added a linear slope for time, (3) we added a random term for time to allow slopes to vary between participants, and (4) we added a fixed, quadratic term for time. The inclusion of random slopes resulted in a singular model fit in nine of the 18 models, which meant some elements of the variance-covariance matrix were estimated as zero. We restored non-singularity by removing terms for random slopes and repeated the remaining steps (Matuschek et al., 2017). Of the 18 MLMs describing the linear effect of time regressed onto engagement in thinking/acting, and onto processes of recovery regulation, none of *p*-values for the 18 fixed effects of time were below their respective critical values, meaning that engagement with recovery and recovery self-regulation were not associated with time to, or time from, the two key workouts. The quadratic term for time did not significantly improve any model (see Appendix N for the full models).

Self-Regulation in Relation to Recovery and Stress

Experience of Recovery and Stress

Table 2 presents descriptive statistics for all dimensions of recovery and stress. All recovery and stress dimensions showed acceptable levels of skewness (-0.59 – 0.70), with slightly leptokurtic distributions (2.21 – 3.30) indicating a more even spread of responses across available options. The dimensions of perceived recovery and stress were generally significantly correlated in the expected directions, during both periods (Table 5): Correlations between dimensions *within* each of perceived recovery and perceived stress were generally positive, while correlations between dimensions of recovery and dimensions of stress were generally negative, with a few exceptions (e.g., some physical and emotional dimensions).

ICCs for variables of perceived recovery and stress during the inter-workout period ranged widely (see Table 2). While variance in emotional and overall stress was highly attributable to between-participant factors (69.8–72.4%), physical stress varied mostly according to situational factors (37.2%). The remaining variables of perceived recovery and stress varied according to a relatively even balance of between- and across-participant factors (42.8–54.7%).

Table 5. *Repeated measures correlations for perceived recovery and stress dimensions.*

	Recovery				Stress			
	Physical	Mental	Emotion	Overall	Physical	Mental	Emotion	Overall
Recovery								
Physical	—	*** .494	** .216	*** .543	*** -.470	*** -.361	* -.147	*** -.437
Mental	*** .520	—	* .157	*** .383	*** -.353	*** -.586	-.107	*** -.414
Emotion	.033	** .197	—	*** .364	-.114	*** -.313	*** -.366	** -.239
Overall	*** .409	*** .285	* .138	—	*** -.527	*** -.317	* -.157	*** -.455
Stress								
Physical	*** -.318	** -.223	-.002	*** -.301	—	*** .338	.049	*** .464
Mental	*** -.385	*** -.549	** -.222	*** -.304	*** .327	—	*** .332	*** .535
Emotion	-.047	** -.185	*** -.394	* -.169	** .184	*** .319	—	*** .347
Overall	*** -.367	*** -.467	* -.163	** -.277	*** .268	*** .519	*** .275	—

Note. Baseline period = bottom diagonal; inter-workout period = top diagonal.
*** p <.001, ** p <.01, *p < .05.

We built the second set of MLMs to predict perceived recovery and stress from time, using the same four steps as the first set of models. For perceived recovery, adding random slopes (step 3) resulted in singular fit for 10 of 12 models, so we removed that term and repeated the remaining steps. For perceived stress, the inclusion of random slopes significantly improved all 12 models, so the procedure remained as planned. Table 6 summarizes the fixed and random effects for these 24 models (see Appendix O for the full models). Models of perceived recovery indicated a fixed linear effect of time with random intercepts for participants, and a fixed quadratic effect of time only where the inclusion of that term significantly improved the model; models of perceived stress were the same with an additional random effect for the variation in linear slopes between participants.

Table 6. *Fixed effects for multilevel models predicting perceived recovery and stress from time in relation to the key workouts.*

		Time to workout 1		Time to workout 2		Time since workout 1	
Variable	Predictor	β	95% *C.I.*	β	95% *C.I.*	β	95% *C.I.*
Physical Recovery	Intercept	0.22	0.04 – 0.40	0.22	0.02 – 0.43	-0.19	-0.43 – 0.05
	Time	***-0.013**	**-0.020 – -0.007**	-0.005	-0.010 – 0.001	***0.027**	**0.008 – 0.046**
	Time^2					***-4.33e-4**	**-7.46e-4 – -1.19e-4**
Mental Recovery	Intercept	0.15	-0.09 – 0.39	0.20	-0.06 – 0.47	-0.02	-0.31 – 0.28
	Time	***-0.013**	**-0.021 – -0.005**	-0.002	-0.009 – 0.006	***0.022**	**0.000 – 0.044**
	Time^2					***-4.08e-4**	**-7.84e-4 – -3.19e-5**
Emotional Recovery	Intercept	-0.01	-0.19 – 0.17	0.28	-0.06 – 0.49	0.00	-0.25 – 0.26
	Time	***-0.008**	**-0.014 – -0.001**	-0.003	-0.009 – 0.003	***0.022**	**0.002 – 0.041**
	Time^2					***-3.78e-4**	**-7.07e-4 – -4.88e-5**
Overall Recovery	Intercept	0.35	0.15 – 0.56	0.17	-0.05 – 0.39	-0.41	-0.67 – -0.16
	Time	***-0.015**	**-0.023 – -0.008**	-0.005	-0.012 – 0.001	***0.040**	**0.019 – 0.060**
	Time^2					***-6.12e-4**	**-9.51e-4 – -2.73e-4**
Physical Stress	Intercept	-0.47	-0.72 – -0.23	-0.33	-0.69 – 0.03	0.49	0.14 – 0.83
	Time	***0.019**	**0.010 – 0.027**	***0.012**	**0.001 – 0.023**	***-0.033**	**-0.057 – -0.009**
	Time^2					***3.97e-4**	**-1.66e-5 – 8.11e-4**
Mental Stress	Intercept	-0.13	-0.39 – 0.13	-0.04	-0.43 – 0.35	-0.25	-0.50 – -0.01
	Time	***0.011**	**0.002 – 0.020**	-0.001	-0.011 – 0.009	0.006	-0.007 – 0.018
	Time^2						
Emotional Stress	Intercept	-0.07	-0.33 – 0.19	-0.14	-0.41 – 0.13	0.02	-0.24 – 0.28
	Time	0.009	-0.001 – 0.020	0.000	-0.006 – 0.007	***-0.020**	**-0.038 – -0.003**
	Time^2					***3.68e-4**	**8.11e-5 – 6.54e-4**
Overall Stress	Intercept	-0.24	-0.46 – -0.02	0.06	-0.29 – 0.40	0.10	-0.19 – 0.39
	Time	***0.010**	**0.002 – 0.017**	0.000	-0.009 – 0.008	***-0.022**	**-0.042 – -0.002**
	Time^2					***5.14e-4**	**1.63e-4 – 8.66e-4**

Note. Bolded terms represent significant effects. Parameters shown represent the model with random intercepts for participants and a fixed, linear slope for time, with an additional fixed, quadratic term for time if it significantly improved the model; models of perceived stress also include random linear slopes for time. Time is presented in hours; β weights represent the estimated change in the DV over one hour. * = p for time effect < B-H critical value (pool of 30 effects of time).

TSW1 was significantly associated with all dimensions of recovery and stress, except mental stress. As time progressed after W1, all four dimensions of recovery increased at a linear rate of one response level every 25.2–46.4 hours, and negative quadratic terms indicated a higher initial rate of increase following W1. Conversely, physical, emotional, and overall stress decreased at a linear rate of one level every 30.2–49.5 hours, and positive quadratic terms indicated a higher initial rate of decrease following W1. TTW2 was only significantly associated with physical stress; as time approached W2, feelings of physical stress decreased at a linear rate of one response level every 80.9 hours. TTW1 was significantly associated with linear terms for all dimensions except emotional stress. As time approached W1, the four measures of perceived recovery increased at a rate of one level every 65.6–77.6 hours, and physical, mental, and overall stress decreased at a rate of one level every 53.3–100.8 hours.

Predicting Self-Regulation from Recovery and Stress

We built the third set of MLMs to predict separate processes of momentary self-regulation from states of perceived recovery or stress. We did this in four planned steps: (1) We fit a basic model with random intercepts for participants, (2) added a linear term for perceived recovery or stress, (3) we allowed random slopes for recovery or stress, and (4) time variables that had significantly predicted a specific process would be added as a covariate for that process. The inclusion of random slopes only improved two of the 64 models, and no regulatory processes were significantly associated with time (as seen in Table 4), so we performed the progression without steps 3 and 4. Table 7 shows the fixed linear effects of stress or recovery on self-regulation for the 64 models (see Appendix P for full models).

In the inter-workout period, awareness, interpreting, and adjusting were each predicted by multiple dimensions of recovery or stress. *Awareness* was positively associated with physical, mental, and overall stress, and negatively associated with physical and mental recovery. *Interpreting* was positively associated with all four dimensions of stress, and negatively with mental recovery. *Adjusting* was positively associated with mental, emotional, and overall stress, and negatively with emotional recovery. Checking-in was not predicted by any dimensions of perceived recovery or stress. Overall, every estimate for the 16 tested associations between dimensions of perceived stress and self-regulation in this period was positive, and 10 were statistically significant. Conversely, every estimate for associations between perceived recovery and self-regulation was negative; four were statistically significant.

During baseline, there were fewer significant effects. *Adjusting* was predicted by physical, mental, and overall stress. *Interpreting* and *checking-in* were each predicted by physical stress, and *awareness* was predicted by physical stress and mental recovery.

Table 7. *Fixed effects of multilevel models predicting use of recovery self-regulation processes, from concurrent ratings of perceived recovery or stress.*

	Awareness		Checking-in		Interpreting		Adjusting	
Predictor	β	95% *C.I.*	β	95% *C.I.*	β	95% *C.I.*	B	95% *C.I.*
Inter-workout period								
Physical recovery	***-.25**	-.42 – -.08	-.09	-.26 – .07	-.08	-.24 – .08	-.13	-.28 – .02
Mental recovery	***-.20**	-.34 – -.06	-.12	-.26 – .01	***-.16**	-.30 – -.03	-.13	-.25 – -.00
Emotional recovery	-.06	-.22 – .10	-.06	-.21 – .09	-.01	-.16 – .14	***-.21**	-.35 – -.08
Overall recovery	-.12	-.27 – .04	-.06	-.20 – .09	-.10	-.25 – .05	-.06	-.20 – .07
Physical stress	***.34**	.20 – .48	.15	.01 – .29	***.19**	.05 – .33	.09	-.04 – .21
Mental stress	***.20**	.07 – .34	.13	.00 – .25	***.16**	.04 – .29	***.17**	.06 – .29
Emotional stress	.15	-.05 – .34	.14	-.04 – .32	***.28**	.10 – .46	***.26**	.10 – .43
Overall stress	***.29**	.13 – .46	.12	-.04 – .27	***.20**	.04 – .35	***.23**	.09 – .37
Baseline period								
Physical recovery	-.17	-.37 – .04	-.09	-.27 – .09	-.00	-.19 – .19	.00	-.18 – .18
Mental recovery	***-.22**	-.38 – -.06	-.08	-.23 – .07	-.05	-.21 – .10	-.05	-.20 – .10
Emotional recovery	-.10	-.30 – .10	-.04	-.22 – .14	.04	-.15 – .23	.15	-.03 – .33
Overall recovery	-.04	-.21 – .13	.03	-.13 – .19	.13	-.03 – .29	.01	-.14 – .17
Physical stress	***.24**	.09 – .39	***.20**	.07 – .33	***.23**	.10 – .37	***.21**	.05 – .36
Mental stress	.05	-.09 – .20	-.01	-.14 – .12	.05	-.08 – .19	***.15**	.03 – .28
Emotional stress	.14	-.05 – .33	.05	-.12 – .22	.10	-.07 – .27	.01	-.15 – .18
Overall stress	.16	-.02 – .33	.13	-.04 – .29	.18	.02 – .35	***.19**	.03 – .35

Note. Parameters shown represent fixed effects for a model with random intercepts for participants and a linear slope for perceived recovery or stress. *** = *p*-value < B-H critical value (pool of 64 effects).**

Discussion

This study explored how elite athletes self-regulate their recovery from moment to moment around two key workouts in their planned training. We used three questions to guide our description: (1) “Do these athletes self-regulate their recovery?”, (2) “in what patterns?”, and (3) “how in relation to their recovery-stress states?”. Our results determined that these athletes were indeed frequently engaged in thinking and acting on their recovery, and specifically through processes of recovery self-regulation. They employed the self-regulatory processes in patterns that indicated synergy between processes, as evidenced by mostly strong inter-correlations between the processes. ICCs for each process indicated their use was largely tied to situational factors, however, the time remaining to or elapsed from their key workouts did not significantly predict recovery self-regulation, meaning process use was not temporally related to the anticipation or response to key workouts themselves. In contrast, athletes generally engaged in momentary recovery self-regulation when experiencing states of higher perceived multidimensional stress and (to a lesser extent) lower perceived recovery. We interpret our findings—focusing on the inter-workout period—in relation to extant literature where applicable, though the novelty of exploring recovery in sport using ESM limited direct comparison.

What Did We Learn About the Use of Recovery Self-Regulation?

The elite athletes in this study were frequently engaged in thinking about, acting on, and self-regulating their recovery between workouts. They reported thinking or acting on their recovery to some degree over the past half-hour on over 80% of the forms they completed in the inter-workout period, at an average low-to-moderate intensity. For comparison, using a similar design in the academic realm, Nett et al. (2012) found that high school students indicated thinking about an upcoming math test to some degree on only 23% of ESM forms. Further, our athletes reported the four self-regulatory processes on an average of 46–82% of their completed forms in the inter-workout period, at an average low-to-moderate intensity. In comparison, Smith et al. (2022) found that high school and university students reported using various emotional regulation strategies on only 10.5–31.9% of ESM forms sampled across daily life. Our findings suggest that engaging with and managing recovery is a constant and important feature in the lives of these elite athletes. Frequently thinking and acting on recovery may indicate professionalism and investment in optimizing one's recovery, and frequent recovery self-regulation may indicate sensitive and (potentially) optimal adaptability to situational events (Wilson & Young, 2023). It is unclear whether this level of frequent engagement with recovery is always beneficial. For example, research has found that athletes need a mental break from thinking about their training, their sport, and sometimes from thinking altogether (Balk et al., 2017; Eccles & Kazmier, 2019; Wilson & Young, 2023). Future research should explore how athletes balance responsive self-regulation with periods of disengagement from their recovery.

Our findings suggest that athletes self-regulate their recovery largely in response to how they feel across several dimensions. This notion, epitomized by the skills of "listening to" and "respecting my body" in the in the ARRM (Wilson & Young, *in review*), was demonstrated by significant associations between perceived recovery and stress and use of most self-regulatory processes. Specifically, the athletes engaged in recovery self-regulation in response to poor recovery-stress states, as self-regulation was consistently associated with higher perceived stress and lower perceived recovery. Further, perceived stress was a more poignant (or more reliable) indicator of self-regulation than perceived recovery. One interpretation for this relative difference may be that a higher stress state is a signal for change, which prompts self-regulation, while higher feelings of recovery signal that one's goals are being met, which demands no further regulation. In an ESM study of emotional regulation by university and high school students, Smith et al. (2022) found that participants used maladaptive emotional regulation strategies more when reporting negative emotions, while positive emotions generally predicted the reported use of no emotional regulation strategy. Like Smith et al. (2022), we analyzed relationships between states and self-regulatory processes reported on the same form. Future work should consider whether the dynamics between self-regulation and recovery-stress states change within time-lagged analyses, and over longer training periods.

In contrast to comparable literature, the athletes in our study did not self-regulate their recovery directly according to the timeline of their key workouts. For example, Nett et al. (2012) found that students' use of self-regulated learning increased significantly over 14 days leading up to a math test. Compared to Nett et al.'s 14-day timeline, systematic variation in recovery self-regulation over time may have been limited or disguised by the relatively shorter 2–3-day inter-workout period in our design. In prior qualitative interviews on recovery, elite endurance athletes described structuring their training and recovery around a timeline related to the key workouts in their week (Wilson & Young, 2023, *in review*). Specifically, they engaged in recovery to "absorb" (i.e., adapt to) the stressors of their previous workouts, and to "prepare" their body and mind to engage in their next workout. Although athletes did not self-regulate their recovery on an identifiable timeline related to workouts in this study, it is unclear whether that means these timelines do not 'exist', or that they were simply hidden as the athletes transitioned from self-regulating to "absorb" to self-regulating to "prepare". That said, we generally found that perceived recovery increased, and perceived stress decreased, along predictable timelines. It is possible that any effect of time on recovery self-regulation may be mediated by the athletes' perceived recovery-stress state; that is, the timeline between workouts reliably predicts states of perceived stress and recovery, which in turn would predict use of recovery self-regulation.

What Did We Learn About the Specific Self-Regulatory Processes?

The four specific processes of recovery self-regulation were employed by the athletes in distinct but inter-connected patterns across this study. We observed strong correlations (i.e., r = .64–.80; Cohen, 1988) between awareness, checking-in, and interpreting reported on the same form. These close relationships reflect how these processes are tightly inter-connected in the ARRM (Wilson & Young, *in review*): background *awareness* and intentionally *checking-in* are two closely related strategies of “listening to my body” to gain information on one’s current recovery-stress state, which is then *interpreted* to inform subsequent action (i.e., “respecting my body”). The process of adjusting was an exception to this pattern; it displayed only small-to-moderate correlations (r = .21–.31) with the other processes. While awareness, checking-in, and interpreting are cognitive processes, adjusting reflects the step of turning cognition into appropriate action, and the lower strength of correlations may reflect several characteristics of that transition (Zimmerman, 2000). First, choosing *not* to adjust one’s recovery may have been the best situational interpretation if the athlete felt their current actions/plans were sufficient. Second, we only presented correlations between scores on the same form, whereas decisions to adjust may only come after one gains awareness of and interprets their recovery context (Wilson & Young, *in review*). Future work should consider the time-lagged associations between different self-regulatory processes to specifically examine whether adjusting may be more strongly correlated with the preceding use of the other processes.

We can characterize how each process was employed during the study, based on a relative comparison of the frequency, intensity, and consistency of use between processes in this study. For instance, awareness scores carried a moderate magnitude and frequency of change, and the highest mean intensity and frequency of use among processes, which we characterize as a pattern of “consistently moderate” use. Checking-in changed more often and by a larger magnitude than awareness, but with a slightly lower mean use, which could indicate a pattern of “high-frequency, intermittent” use. Interpreting changed as often and by the same magnitude as awareness, but with a lower mean intensity and frequency of use, which indicates a pattern of "low-level consistency". Adjusting changed the least often and by the smallest magnitude, with the lowest mean intensity and frequency of use, which may indicate a pattern of "low-frequency, intermittent use", likely tied to specific prompts/situations. While further study is needed to characterize these patterns, our findings suggest that athletes engage in various processes of recovery self-regulation using different patterns that beg individual consideration.

The distinct patterns characterizing each process may be related to the intentionality or effort each one demands. In Wilson and Young (*in review*), elite endurance athletes described awareness of their recovery-stress state as an automatic process running in the back of their minds, whereas taking the time to check in on one's state, to interpret its meaning, and then choose to act on those interpretations (i.e., adjusting) required additional cognitive investment. As processes become more demanding, athletes may choose to deploy them more selectively. Conversely, contextual characteristics may dictate how appropriate a specific process is: whereas awareness may be employed more generally, adjusting may have been used less frequently in this study because only certain situations call for a change in one's current actions or plans for recovery. All told, use of a process was likely determined by a combination of personal (e.g., effort) and contextual factors.

While processes of awareness, interpreting, and adjusting were each predicted by 4–5 dimensions of perceived recovery or stress, checking-in had no apparent relationships to the recovery-stress state. Qualitative evidence of recovery self-regulation offers some support that feelings of recovery/stress are not a strong input for checking-in (Wilson & Young, *in review*). Specifically, when the athletes described checking-in, it was often prompted by specific schedule or behavioural cues (e.g., waking up, finishing lunch routines), whereas awareness, interpreting and adjusting were prompted by athletes' perceptions of notable feelings or sensations. Future research could examine whether within-day timelines related to routines of recovery predict the use of any process of recovery self-regulation, but especially checking-in.

Limitations and Future Directions

Our research should be contextualized by certain limitations. First, we are open to the possibility that the ESM impacted how the athletes thought about and/or experienced recovery and stress. Prompting the athletes to report on recovery could have increased the frequency of recovery-related thoughts, or negatively impacted their recovery-stress state by impairing mental detachment from their sport (see Balk et al., 2017). That said, Cerin et al. (2001) found that ESM reduced cognitive intrusions and expectancy effects compared to fixed repeated measures or retrospective designs when studying sport emotions. Further, our baseline period provided familiarity with the regular forms, which, together with the minimal number of items, resulted in relatively short response times (< 90 sec). Considering the SRSS scores in our study were comparable with other studies of hard training (e.g., Kölling et al., 2015), we assume that any artificial influence of the ESM was minimal and offset greatly by the benefit of repeated, in-the-moment measurements. Second, we conducted many MLMs, which although keeping with our exploratory aims, opens the possibility of Type 1 errors. As such, we followed precedent from ESM studies of self-regulation (Smith et al., 2022) to control for the false discovery rate and to interpret trends in each set of analyses without focusing on any one *p*-value. Third, with our emphasis on ecological validity in an elite sample of Canadian cyclists, our findings are thus limited in terms of how directly they may be applied to other populations and contexts.

Future research should explore how the experience and regulation of recovery vary across high-performance sport contexts, including different sports (e.g., team sports, skill-focused sports) and phases of the yearly training cycle, such as comparing preparatory periods with a focus on high training loads and adaptation to competitive periods with a focus on lower training loads and performance. Further, Wilson and Young (*in review*) found that an athlete's social and physical environments influence how they implement recovery self-regulation. Future work should contextualize the athlete's use of recovery self-regulation with the constraints and affordances provided by the people and places in their daily training environment.

Conclusion

In relation to our three guiding questions, we found that elite endurance athletes were actively and dynamically engaged in self-regulating their recovery from moment to moment between key workouts. In general, the elite athletes self-regulated their recovery in response to perceptions of short-term stress as opposed to timelines around key workouts. However, while the processes we assessed were strongly correlated, they differed in frequency, intensity, consistency, and predictors of use, which suggests that recovery self-regulation involves synergistic, yet unique competencies employed in individual patterns. These findings support the instrumentality of the two more momentary processes of recovery self-regulation conceived in the ARRM ("listening to my body" and "respecting my body"; Wilson & Young, *in review*), evidenced in a quantitative *in situ* design in an ecologically valid training context. Recovery self-regulation should likely not be viewed as a single concept, but instead as an umbrella term for a set of skills that likely require specific and targeted development. Similarly, the individual athletes in this study showed variation throughout all measures and analyses, which favours an individualized approach to identifying personal approaches, preferential applications, and developmental activities for self-regulatory recovery skills.

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ARTICLE 4

Describing Recovery Self-Regulation Among Recreationally Competitive Cyclists Using Exploratory Sampling Methods

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Cited in-dissertation as: Wilson and Young (*Article 4*) or Article 4.

Abstract

Training for competitive sport involves accumulating stress that must be balanced with corresponding recovery. Elite endurance athletes play an active role in managing their recovery using skills of self-regulation, yet it is unclear whether, and if so to what effect, non-elite athletes engage in recovery self-regulation. The objectives of this study were to (a) describe the patterns of recovery self-regulation use by non-elite competitive endurance athletes, and (b) to determine the relationship between self-regulation and performance recovery, between two hard workouts. Sixteen recreationally competitive cyclists (11 male, 5 female) performed two prescribed workouts on the Zwift virtual platform, 48 hrs apart. Using an experience sampling method, they completed repeated forms via smartphone app, once randomly per two-hour period of waking hours. Each form contained self-report measures for processes of recovery self-regulation and perceived recovery and stress. Analyses described characteristics of the frequency, intensity, consistency, and associations between processes of self-regulation, and their relationships with time, and with recovery-stress states between workouts. We further analyzed whether the characteristics of self-regulation were related to the recovery of performance between workouts. The cyclists used self-regulatory processes frequently, in strongly correlated but distinct patterns. They made greater use of most self-regulatory processes when experiencing higher perceived physical stress, following the first workout, and use declined over time between the workouts. There was some benefit to more frequent use of self-awareness and interpreting processes, yet most characteristics of self-regulation use were not associated with performance recovery. We discuss how this non-elite sample self-regulated their recovery to a similar extent, yet in simpler and more reactive patterns, compared to extant descriptions of elite athletes.

Keywords: Performance; Training; Self-regulated learning; Talent development; Mental health

Describing Recovery Self-Regulation Among Recreationally Competitive Cyclists Using Experience Sampling Methods

Competitive cyclists often engage in large volumes of training, regardless of whether they are elite athletes striving for professional wins, or amateurs training for a local race (Priego Quesada et al., 2018). Demanding training requires corresponding recovery to sustain participation and improve performance (Kellmann et al., 2018). Adequate recovery can compensate for stress to spur adaptation and facilitate continued practice, while inadequate recovery allows stress to accumulate and may lead to negative outcomes such as overtraining, injuries, or burnout (Kellmann, 2002). Research has explored what recovery means to elite endurance athletes (Wilson & Young, 2023) and how they engage with it (Wilson et al., *Article 3*; Wilson & Young, *in review*), but there has been limited examination of how recovery is implemented by non-elite athletes. This study explored how recreationally competitive cyclists manage their recovery around training to restore performance between hard workouts.

Recovery between Training Sessions

We refer specifically to recovery between training sessions, as opposed to the processes of recovery within sessions (i.e., between intervals) or recovery from a traumatic event (e.g., injury; Bishop et al., 2008). Recovery involves mechanisms, states, and activities on multiple dimensions (e.g., psychological, physiological, social), employed to compensate for stress accumulated from training and non-training sources and to restore performance capability (Kellmann, 2002; Kellmann et al., 2018). Stress is the multi-dimensional product of the demands (stressors) encountered by an individual and their experience of those demands as a stress response (Lazarus, 1999). The relationship between stressor and response is mediated by various personal characteristics and processes, such as an individual’s physical fitness, or their cognitive appraisal of the nature of the demands and their capacity to cope with them. For example, a hard cycling workout will prompt a physiological response of muscular and mental fatigue, as well as additional cognitive and/or emotional stress depending on how an athlete appraises that fatigue. Thus, the experience of stress involves complex interactions between physical and mental processes, and recovery must address this broad and shifting range of experiences. According to Kellmann's (2002) scissors model of recovery-stress states, recovery and stress are interrelated processes; increases in stress must be matched with corresponding recovery. Further, recovery strategies are most effective when they match the type of demands experienced (e.g., strategies for physical recovery in response to physical stressors; Balk et al., 2017; Senttä & Hassmén, 1998). According to this model, an athlete's goal should not be to maximize their recovery state, but rather to implement recovery in a way that matches their current demands and context.

Athlete-Led Recovery

Research has examined the impact of recovery methods/modalities on physical, mental, and performance outcomes in training (Dupuy et al., 2018). For example, Wiewelhove et al. (2018) found that after a half-marathon, cold-water immersion and massage improved perceived stress and soreness but not performance markers for recreational runners. Various reviews have summarized this body of research to guide practitioners on how to prescribe evidence-based recovery methods (Dupuy et al., 2018; Haller et al., 2022). In many cases, however, athletes have limited access to practitioners: an amateur athlete may go weeks or months between interactions with a qualified practitioner. Decisions of why, when, and how to engage in recovery—which will influence the effectiveness of any recovery method, are left to the athlete.

A few studies have described the active role that athletes play in shaping their recovery. In interviews, Canadian Olympic and World Championship-caliber endurance athletes defined recovery as what matched their current training goals, demands, and priorities (Wilson & Young, 2023). They discussed a broad range of strategies or modalities they could use to fulfill those constraints, yet the utility of a specific approach was contingent on how well it fit their current context. They placed greater importance on the process of selecting the right approach to fit their perceived situation than on any one approach itself. Eccles and Kazmier (2019) described how collegiate field hockey players sought out experiences that provided mental rest—a form of recovery—by engaging with specific activities and environments. For example, players hung out with friends outside their team, away from the training grounds, to gain mental separation from thinking about their training and performance. In a daily diary study, Balk et al. (2017) found that athletes who addressed greater emotional demands from practice by engaging in activities that created more emotional detachment (i.e., by 'switching off' from training), experienced greater emotional recovery. While such evidence supports athletes' active roles in managing their recovery, limited work has described the psychological mechanics involved.

Emerging research portrays an athlete's role in implementing their recovery in terms of self-control (Balk & Englert, 2020), and more specifically in terms of self-regulated learning (SRL) processes (Wilson & Young, *in review*). SRL involves self-generated thoughts, feelings, and actions enacted and refined in pursuit of learning goals; it describes how learners engage with learning tasks (Zimmerman, 2000). In sport, higher-skilled athletes make greater use of specific SRL processes to enhance their engagement in training, such as by self-monitoring practice task performance or reflecting on practice actions to improve subsequent training (Young et al., 2023). Similar processes are involved in how athletes implement and manage their approaches to recovery (Wilson & Young, *in review*).

A recent study (Wilson & Young, *in review*) described an athlete recovery regulation model (ARRM), which portrayed the self-regulated processes used in learning and managing training-related recovery by endurance athletes. Based on multiple interviews with elite athletes, it specified four self-regulatory skills, expressed in the athletes' words: 'knowing my body', 'listening to my body', 'respecting my body', and 'learning my body'. The athletes used 'body' to refer broadly to the self, physically, mentally, and emotionally. 'Knowing my body' involved self-knowledge for how they expected to respond to certain stimuli around training and recovery, and using that self-knowledge to build recovery plans and routines. 'Listening to my body' involved paying attention to their state of recovery (or fatigue), either by self-monitoring with a background level of awareness or by intentionally checking-in on their state, and then interpreting those feelings compared to how they expected to feel. 'Respecting my body' involved engaging with those interpretations, either by following through on plans/routines ('respecting what I know') or by flexibly adjusting plans in response to new information ('respecting what I hear'). Finally, 'learning my body' described how they engaged with the first three processes in repeated cycles of trial and error to develop their regulatory knowledge and skills over time. The authors advanced these facets of recovery self-regulation as a set of mental and perceptual-cognitive skills that athletes could develop to manage their recovery.

Self-Regulation and Recovery from Moment to Moment

While informed by dispositional properties (e.g., accumulated knowledge), learners enact SRL moment-to-moment according to characteristics of their context (Winne, 1997). As such, there is a need for methods that afford a real-time, naturalistic account of a learners' self-regulated traces (Zimmerman, 2008), instead of retrospective methods that have dominated sport research (Young et al., 2023). Experience sampling methods (ESM) provide a natural account of participants' current thoughts, feelings, and/or reported behaviours (Larson & Csikszentmihalyi, 1983). ESM provides real-time assessment of experiences in the natural context of their occurrence by asking participants to complete measures on a personal device, like a smartphone, multiple times per day across several days (Myin-Germeys & Kuppens, 2022). For example, Nett et al. (2012) asked students to report on how often and to what extent they employed SRL processes over 14 days preceding an important math test. Although ESM has been used to assess topics in sport psychology like pre-competitive emotions (Cerin et al., 2001) and post-concussion symptoms (Sufrinko et al., 2019), it has not been used to study self-regulation in sport or recovery from training, with one exception.

Wilson et al. (*Article 3*) used ESM to explore how national team cyclists and triathletes self-regulated recovery in an ecologically valid context. The athletes completed up to eight repeated forms per day around two key workouts in their planned training to describe how they used two momentary self-regulation skills from the ARRM: 'listening' and 'respecting' one's body (Wilson & Young, *in review*). Specifically, each form assessed use of four self-regulatory processes derived from those skills: gaining *awareness* of one's recovery state, *checking-in* on one's recovery, *interpreting* the resultant information, and *adjusting* recovery plans as needed. Athletes reported thinking/acting on recovery on over 80% of experience sampling forms and engaged in processes of recovery self-regulation on an average of 46 to 82% of forms (depending on the process). The self-regulatory processes were implemented in synergistic but unique patterns, with varying frequencies, intensities, and consistencies of use. The enactment of recovery self-regulation was not associated with the time remaining to, or elapsed from, a key workout. The athletes engaged in greater recovery self-regulation when they experienced states of higher perceived stress and lower perceived recovery. Overall, the findings described how elite athletes actively and dynamically self-regulate their recovery between key workouts.

This line of research presents an intriguing understanding of recovery self-regulation, yet the findings must be weighed by the limits of their scope. Most prominently, the ARRM and its constituent SRL skills were identified (Wilson & Young, *in review*) and examined *in situ* (Wilson et al., *Article 3*) in elite samples, who negotiate different demands under different circumstances compared to non-elite competitive athletes. For instance, professional or national team athletes are paid to some extent to train, whereas amateur athletes often fit training around jobs or other priorities (Makepeace et al., 2021), which might not afford them the time to self-regulate or even think about their recovery. Conversely, dedicated practitioners and facilities support elite athletes in regulating their recovery (Wilson & Young, *in review*), whereas amateur athletes receive much less support and may have to take on relatively more regulatory responsibility for themselves. It is therefore unclear whether non-elite competitive athletes identify with the skills and processes outlined in the ARRM, and, if so, how they enact them during recovery.

Wilson et al. (*Article 3*) further chose to prioritize ecological validity at the expense of some experimental control in their ESM study design. For instance, the study was designed to fit around existing workouts in the athletes' already-planned training, to allow a more naturalistic description of elite training. However, this design meant that the timeline between key workouts varied from 2–3 days, and the content of those workouts was not set by investigators. Moreover, they only assessed subjective perceptions of the recovery-stress state, and not objective measures of the recovery of performance between workouts. Thus, while Wilson et al. showed *in situ* that elite athletes engaged in recovery self-regulation, it was unclear whether and how those processes impacted actual performance outcomes in a subsequent hard workout.

It remains unclear how recovery self-regulation skills are employed in non-elite populations. Further, no research to date has examined how these skills relate to the recovery of performance from one workout to the next. The purpose of this study was to describe recovery self-regulation in a non-elite population of competitive endurance athletes. Specifically, our objectives were (a) to describe the patterns of frequency, intensity, consistency, and timing of recovery self-regulation, associations between the self-regulatory processes, and their relation to recovery-stress states; and (b) to assess these characteristics of recovery self-regulation skill use in relation to the recovery of performance between training sessions.

Methods

We used ESM (Larson & Csikszentmihalyi, 1983; Myin-Germeys & Kuppens, 2022) to assess the naturalistic self-regulation of recovery moment-to-moment between two challenging workouts performed remotely on the Zwift (2023) virtual cycling platform. Other than the key workouts, athletes were encouraged to continue participating in regular activities (e.g., easy training, recreation). The workouts were separated by 48 hrs; in the 48 hrs before each workout, athletes answered repeated experience sampling forms using an app downloaded to their smartphones. Procedures were approved by the Research Ethics Board at the host university (Appendix C).

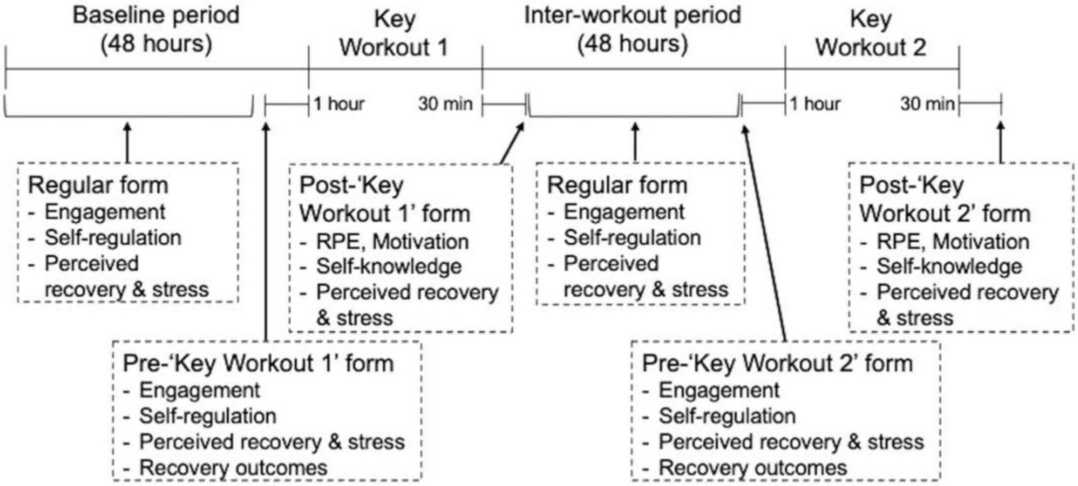
Participants

We recruited competitive, non-elite cyclists with experience training and competing on Zwift (2023). Zwift is an online cycling platform where users train in a selection of virtual worlds using a stationary cycling trainer. The Zwift platform controls the rolling resistance of a user's cycling trainer to mimic the changes in gradient along a virtual course, and uses the real-time data of the power produced by the cyclist to dictate their speed on that course, after adjusting for various "in-world" environmental factors. In addition to self-led "free rides", users may participate in a common library of structured workouts and regularly scheduled races against other users. We thus assessed Zwift users with Zwift racing experience to be a population of actively training, competitively-minded athletes with remote access to standardized workouts.

We recruited athletes via social media posts and emails to cycling clubs in Canada, USA, Australia, and New Zealand. At the start of the online sign-up form, participants had to indicate that they (a) were 17 years of age or older, (b) were engaging in regular endurance training three or more times per week, (c) owned a smartphone (to download the experience sampling app), (d) were able to train on Zwift, (e) had previous experience completing a Zwift cycling race (to indicate competitiveness), (f) had previous experience completing a Zwift fitness test workout (to show familiarity with the study workouts), and (g) consented to sharing their workout data during the study with researchers (Appendix Q). Athletes then completed questions about demographics, experience on Zwift, training history, and body weight (Appendix R). Of 35 who completed the consent form, 20 engaged in the experience sampling forms. Of those 20, three did not engage in the required workouts and one withdrew for personal reasons.

The final sample had 16 cyclists (11 males, five females) with a mean age of 48.2 yrs (*SD* = 13.3). They had 15.2 yrs (*SD* = 14.1) of training experience, including 4.4 yrs (*SD* = 2.2) since they began training on Zwift and 3.3 yrs (*SD* = 1.9) since they first raced on Zwift. They reported a mean of 7.38 hrs (*SD* = 5.05) of weekly endurance training over the prior four weeks.

Figure 1. *Visual representation of the study design.*



Note. RPE = Rating of perceived exertion.

Procedures

Figure 1 shows a schematic representation of the timeline and measures for this study.

Workout Procedures

The design centered around a "recovery-intensive scenario" represented by the 48 hrs between two key workouts (Wilson et al., *Article 3*). Endurance athletes often structure their training week around 1-3 key workouts that are particularly mentally and physically demanding and impactful for improving performance (Wilson & Young, 2023). This study focused on two of such workouts by situating two of Zwift's stock performance tests (available to all users) at set points in time. These tests are used in Zwift to estimate a user's functional threshold power (FTP), defined as the highest power output a cyclist can maintain in a quasi-steady state for approximately one hour (Karsten et al., 2021). FTP estimates generated from these tests act as the central performance measure in Zwift and are used to categorize users into performance levels for racing. *Key Workout 1* (KW1) was the "Zwift FTP Test (shorter version)", which involves a 20 min self-paced time trial, preceded by a 20 min warm-up of easy riding broken up by accelerations of 1 min and 5 min respectively, and followed by a 5 min cooldown. *Key Workout 2* (KW2) was the “Zwift Ramp Test”, which involves a 5 min warm-up, followed by a series of 1 min intervals with sequentially higher resistance where the goal is to reach the highest level possible. For most users, the ramp intervals begin at 100W and increase by 20W each minute; for participants who indicate a weight below 60kg or a previous FTP below 2.0 W/kg, the test starts at 50W and increases by 10W each minute. The ramp test ends when the user stops pedaling, and automatically transitions to a 10 min cooldown. During these protocols, Zwift provides users with on-screen instructions for each step and real-time feedback in terms of their current power output, pace, and the time remaining in the test. These protocols are typical of FTP and ramp tests (e.g., Karsten et al., 2021) and we chose to follow the Zwift-specific protocols for their standardization, ecological validity, and familiarity to Zwift users.

During the sign-up process, athletes indicated their preferred date and time for KW1 with the knowledge that KW2 would be scheduled for 48 hrs later. Instructions for the workouts were available on a study website at all times, and were emailed to participants 12 hrs before their scheduled workout times. Participants performed both workouts on their own indoor bike trainer. They were instructed to prepare their trainer and environment before beginning the workout, including calibrating their trainer according to the manufacturer’s specifications and ensuring they had a fan, water bottle, and any preferred entertainment (e.g., music) available. They were instructed to perform both workouts on the “Tempus Fugit” course in Zwift, which contains minimal elevation change. We asked the cyclists to share the .FIT files for their workout data by syncing their Zwift account with the online training log platform TrainingPeaks (2023).

Survey and Experience Sampling Procedures

The study was divided into a baseline (i.e., the 48 hrs preceding KW1) and an inter-workout period (i.e., the 48 hrs between KW1 and KW2; Figure 1). During these periods, once randomly within each two-hour block of the waking day (7 a.m. to 11 p.m.), each athlete received a smartphone notification prompting them to complete a short form hosted on a dedicated smartphone app[1]. They could receive up to eight notifications per day, which were spaced at minimum by 45 mins. They got a reminder notification if a form remained incomplete after 15 mins; each form closed to responses after 30 mins. During baseline, athletes received their first notification no more than 48 hrs before KW1 and their final one 60 mins before KW1. During the inter-workout period, they received their first message 30 mins after KW1 and their final one 60 mins before KW2. They also received a final notification 30 mins after KW2.

Every form had a preface reminding athletes that "what counts as recovery is up to you," and that it (a) "involves whatever helps you absorb the work from your previous workouts and prepares you for the work in your next workouts," (b) "can be mental, physical, or a mix of both," and (c) "can be more dialed-in and focused, or more dialed-out and relaxed" (based on description from Wilson & Young, 2023). The regularly repeating form had measures for *engagement with recovery*, processes of *momentary recovery self-regulation,* and states of *perceived recovery and stress*; it took a median of 60 secs to complete (Appendix S). The post-workout form (sent 30 mins after KW1 and KW2) contained *manipulation checks* and measures of *perceived recovery and stress,* and measures of dispositional characteristics not assessed in

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[1] To accommodate technicalities in scheduling across different time zones, we used different smartphone apps depending on the participant's location. North American participants used the SEMA3 app (Koval et al., 2019); participants in Oceania used the m-Path app (Mestdagh et al., 2022). Both apps were designed for ESM studies and contain similar interfaces that allowed identical question formats.

this study; it took a median 2 mins to complete (Appendix T). The post-KW2 form marked the end of the study.

Measures

Momentary Recovery Self-Regulation

We measured four processes of momentary recovery self-regulation using items from Wilson et al. (*Article 3*), which were created to represent key aspects of the skills for "listening to my body" and "respecting my body" described by Wilson and Young (under review). Participants answered all items on a 5-point Likert scale anchored at each point from 0 (Not at all) to 4 (Almost all the time). Each item followed the preface "During the past half-hour, …", and stated: (1) "…I was aware of how recovered I felt," which represented the process of gaining *awareness* of one's recovery state; (2) "…I checked in on how recovered I felt," which represented intentionally *checking-in* on how one felt; (3) "…I compared how I felt with how I expected to feel," which represented the process of *interpreting* how one feels to guide subsequent actions for recovery; and (4) "…I purposefully *adjusted* my current or planned recovery," which represented adapting one's recovery based on those interpretations. All items were reviewed for their clarity and theoretical representativeness by two subject matter experts.

Engagement With Recovery

Following the precedent of Wilson et al. (*Article 3*), as a precursor to assessing specific self-regulatory strategies, we checked whether participants were engaged in thinking about or acting on recovery. Engaging in self-regulatory thoughts or actions assumes that a learner is engaged in thinking or acting on a goal at all (Nett et al., 2012). We employed two items that asked athletes to report the extent to which their thoughts or actions (respectively) had been guided by their recovery during the previous half-hour. Responses were on a 5-point Likert scale anchored at each point from 0 (Not at all) to 4 (Almost all the time).

Perceived Recovery and Stress

The Short Recovery and Stress Scale (SRSS; Kellmann & Kölling, 2019) contains two scales that assess the respondent's current state of recovery and stress, respectively, compared to their best/highest ever state. Each scale contains four items that represent respective physical, mental, emotional, and overall dimensions. Cyclists answered the items on a 7-point scale anchored at 0 (Not at all) and 6 (Fully applies), where higher scores represent a state of higher recovery or stress on that dimension. For example, mental recovery is represented by the item, "Mentally, I feel... attentive, receptive, mentally alert, concentrated," while mental stress is represented by "Mentally, I feel... unmotivated, sluggish, unenthusiastic, like I'm lacking energy." The SRSS is a valid and reliable instrument in English-speaking competitive athletes, and its eight items should be analyzed separately, without aggregation within scales/dimensions (Kellmann & Kölling, 2019). For simplicity, we refer to the SRSS items according to their scale and dimension: physical recovery, mental recovery, emotional recovery, overall recovery, physical stress, mental stress, emotional stress, and overall stress.

Recovery of Performance

We defined the participants' capability to recover their workout performance by the extent to which they restored performance on KW2 relative to KW1. Performance was defined by a cyclist's estimated relative FTP for that workout (expressed in W/kg), calculated using Zwift's native protocols. For the 20-min time trial test (i.e., KW1), Zwift estimates a user's relative FTP as 95% of their average 20-min power output, divided by their weight. For the ramp test (i.e., KW2), relative FTP is estimated as 75% of their highest 1-min average power output, divided by their weight (Schlange, 2022). Recovery of performance was defined by the residual variance in performance on KW2 after removing variance predicted by performance in KW1 (i.e., residuals for KW2 performance after regressing it on KW1 performance). Two cyclists, who completed the key workouts as prescribed, provided workout data that were unusable due to equipment malfunctions; thus, 14 cyclists were included in recovery of performance analyses.

Manipulation Checks

We checked that the key workouts were demanding using the 10-point modified rating of perceived exertion scale (RPE; Foster et al., 2001). Thirty mins after KW1 and KW2, cyclists provided a global rating of the difficulty of the full session. After KW1, we checked that they were invested in recovering by asking them to rate how motivated they were to perform well in KW2 on a 5-point Likert scale, anchored from 0 (Not at all motivated) to 4 (Very motivated).

Analyses and Results

For the sake of clarity, we have organized our analyses and results according to the study objective they address. We conducted all analyses using R (R Core Team, 2023).

Objective 1: Describing Patterns of Recovery Self-Regulation by Non-Elite Athletes

Analyses

As per Wilson et al. (*Article 3*), we analyzed six characteristics for recovery self-regulation use: Frequency, intensity, consistency, and timing of self-regulation processes, relationships between the processes, and relationships with dimensions of perceived recovery and stress. All analyses were nested by participant to match the two-level structure of our data, which comprised repeated responses (*N* = 385 forms) within participants (*N* = 16). *Intensity* was represented by the response level (e.g., 0–4), while *frequency* was a binary variable of no use (i.e., response of 0 [*Not at all*]) versus any use (i.e., response of 1–4). In line with the nested data structure, descriptive statistics for frequency and intensity were calculated within individuals and then aggregated across the sample. We described the *relationships between processes* using repeated measures correlations between scores on the same form (rmcorr package; Bakdash & Marusich, 2017), which account for non-independence within participants by adjusting for inter-individual variability. Statistical significance was indicated at $p < .05$.

We assessed *consistency* through the frequency and magnitude by which responses for a recovery self-regulation process changed between consecutive forms. The frequencies of change were calculated by difference score probabilities, which represent the probability that a 'score' (i.e., response level) will increase/decrease by a given amount between time-points (Barchard, 2012). To assess the magnitude of changes, we summarized difference score probabilities by calculating the root mean square difference (RMSD) in scores between consecutive time-points (Barchard, 2012). In contrast to statistics that describe variability across a full data set, these statistics describe variability from moment to moment (i.e., form to form). We calculated difference score probabilities across all responses, while RMSD values were calculated for each self-regulatory process by cyclist and then aggregated across the sample.

We described the *timing* of recovery self-regulatory processes and their relationships with participants' recovery-stress states using separate sets of multilevel models (MLMs), built using the lme4 package (Bates et al., 2015). As a preliminary step, we calculated intraclass correlations (ICCs) between each self-regulatory process and recovery/stress dimension by fitting a null model with a constant predictor and random intercepts for participants. ICCs range from 0 to 1.0, where higher values indicate greater variability between participants and across observations (e.g., more trait-like variables), while lower values indicate greater variability between observations and across participants (e.g., more state-like variables).

We conducted three sets of MLMs as part of the descriptive analyses. We used these MLMs to *describe* the relationships between variables in this sample, and not to be externally predictive or generalizable. As such, we employed an exploratory model-building approach within each set of variables (Field et al., 2012). Using maximum likelihood estimation, we added terms to each model in steps and tested whether each step significantly improved the model using -2 log-likelihood comparison ($p < .05$). Specific steps are detailed in the Results. Given the large number of MLMs, we used the Benjamini-Hochberg (B-H) procedure to control for a false discovery rate of 10% within each group of relevant effects (Benjamini & Hochberg, 1995). As such, we reported statistical significance of a fixed effect when the *p*-value of that effect was below its corresponding critical value.[2] We report all MLMs in the Supplementary Appendices (Appendices T–V).

The first two sets of MLMs predicted self-regulatory process use and levels of perceived recovery and stress, respectively, in relation to time. We coded the time of completion for each form in relation to KW1, such that positive values indicated the time (in hrs) elapsed since the start of KW1, and negative values indicated the time remaining until KW1 (i.e., -12.5 = 12 hrs and 30 mins before the start of KW1). In the first set, we built separate models to represent the relationship between each variable of engagement (two) and self-regulation (four) regressed on time, for each of the baseline and inter-workout periods (i.e., 12 models in total). We repeated this process for the second set, building separate MLMs for each variable of perceived recovery

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[2] The Benjamini-Hochberg procedure controls for the false discovery rate, which functions as a less conservative approach to controlling for multiple comparisons compared to techniques using family-wise error rates (e.g., Bonferroni; Thissen et al., 2002). Each p-value within a pool of tests is ranked in ascending order and compared against a critical value (i/m)Q, where i is the rank of the effect (i.e., 1, 2, …), m is the number of tests, and Q is the chosen false discovery rate (e.g., 10%). All p-values smaller than their corresponding critical value are significant. Thus, the indicated significance of an effect may not align with other indicators that readers are familiar with (e.g., confidence intervals).

and stress (eight) regressed on time for each period (i.e., 16 models in total). Variables of perceived recovery and stress were centered within participants so that 0 represented a cyclist's average state during the study. The third set of MLMs predicted self-regulatory process use from levels of perceived recovery/stress on the same form. Specifically, we regressed each of the eight variables of perceived recovery/stress on each of the four processes of self-regulation, separately for the baseline and inter-workout periods (i.e., 64 models in total).

Results

Preliminary. All 16 cyclists reported an RPE for KW1 at a mean level of 8.1 (*SD* = 2.0; 5–10), which falls between "Very Hard" and "Maximal". They were highly motivated to perform in KW2, reporting a mean score of 4.2 out of five (*SD* = 0.5; 3–5). Eleven cyclists reported their RPE after KW2 at a mean level of 7.6 (*SD* = 1.9; 4–10), which corresponds to "Very Hard". These results indicate that the key workouts created a sufficiently recovery-intensive scenario.

Overall, participants received 529 notifications and answered on 385 forms (72.8%). During the baseline period, each participant received 10 to 23 messages (*M* = 15.6, *SD* = 3.3) and completed five to 17 of them (*M* = 10.9, *SD* = 3.6), which corresponds to a mean rate of 69.5% (*SD* = 18.2%; 35.7–94.4%). During the inter-workout period, each participant received 11 to 17 messages (*M* = 16.4, *SD* = 1.5) and completed seven to 16 of them (*M* = 12.4, *SD* = 2.5), which corresponds to a mean rate of 75.0% (*SD* = 12.4%; 52.9–94.1%).

Describing the Frequency and Intensity of Self-Regulation. Across both periods, cyclists reported that recovery guided their thoughts to some degree (i.e., response > 0) on 61.8% of forms, and guided their actions to some degree on 61.0%. They reported using at least one recovery self-regulation process to some degree on 85.1% of forms. Specifically, they reported some level of *awareness* of their state of recovery on 81.9% of forms, intentionally *checking-in* on that state on 74.4% of forms, *interpreting* that state on 74.5%, and *adjusting* their recovery on 42.4% of forms. Table 1 shows the frequency of some level of self-regulation, and the mean intensity of responses, aggregated across cyclists.

Table 1. *Engagement in thinking/acting on recovery and use of recovery self-regulation processes, aggregated across participants in baseline and inter-workout periods.*

	Baseline period				Inter-workout period			
	n	*Intensity* *M (SD)*	*Frequency* *M* % (*SD*)	ICC	*n*	*Intensity* *M (SD)*	*Frequency* *M* % (*SD*)	ICC
Engagement								
Thoughts	169	1.06 (0.62)	58.6 (26.6)	.191	179	1.27 (0.81)	64.3 (28.5)	.309
Actions	169	1.11 (0.67)	55.3 (27.9)	.183	180	1.37 (0.82)	64.0 (26.2)	.277
Regulation								
Awareness	166	1.58 (0.93)	78.5 (29.6)	.534	177	1.81 (0.72)	87.5 (15.5)	.283
Checking-In	167	1.24 (0.89)	64.1 (37.5)	.487	177	1.53 (0.64)	81.5 (15.1)	.194
Interpreting	165	1.34 (0.91)	65.9 (34.8)	.477	176	1.53 (0.69)	79.4 (22.1)	.277
Adjusting	165	0.60 (0.50)	37.2 (30.5)	.165	177	0.67 (0.55)	41.8 (31.3)	.208
Recovery								
Physical	164	3.99 (0.99)	——	.493	192	3.85 (0.97)	——	.546
Mental	164	4.15 (0.98)	——	.529	192	4.13 (0.95)	——	.525
Emotional	163	4.31 (0.99)	——	.717	192	4.27 (1.01)	——	.638
Overall	162	3.90 (1.06)	——	.547	192	3.71 (0.82)	——	.328
Stress			——				——	
Physical	162	1.78 (1.04)	——	.011	192	1.99 (0.99)	——	.392
Mental	162	1.60 (0.91)	——	.388	191	1.51 (0.94)	——	.486
Emotional	162	1.31 (0.85)	——	.613	191	1.34 (0.97)	——	.544
Overall	162	1.44 (0.81)	——	.441	191	1.63 (0.92)	——	.496

Note. N = count of individual responses; all other statistics represent aggregations of individual participant means. Engagement and regulation scores were each on a scale from 0–4; Recovery and stress scores were on a scale from 0–6. *Intensity* = item score; *Frequency* = proportion of items scores above 0. ICC = intraclass correlation.

Describing the Relationships Between Concurrent Processes. Use of the four recovery self-regulation processes, as well as engagement in thinking and acting on recovery, were all significantly correlated with the other processes on the same form, in both the baseline and inter-workout periods (all *p*s < .001; See Table 2).

Table 2. *Repeated measures correlations between engagement with thoughts/actions on recovery and momentary processes of recovery self-regulation.*

	Thoughts	Actions	Awareness	Checking-in	Interpreting	Adjusting
Thoughts	——	.877	.546	.643	.622	.493
Actions	.858	——	.566	.660	.604	.488
Awareness	.378	.375	——	.727	.721	.402
Checking-in	.565	.552	.716	——	.770	.460
Interpreting	.452	.403	.599	.685	——	.496
Adjusting	.473	.389	.299	.407	.467	——

Note. Baseline period = bottom diagonal; inter-workout period = top diagonal; all *p*s < .001.

Describing the Consistency of Self-Regulation. Difference score probabilities between consecutive forms are shown in Table 3. In the inter-workout period, *awareness* levels changed from the previous form (i.e., one or more levels higher/lower than the prior response for that cyclist) in 57.6% of cases, in 61.1% of cases for *checking-in*, 59.7% of cases for *interpreting*, and 46.4% for *adjusting*. Checking-in was the least stable process, showing no change on 38.9% of successive forms, changes of an absolute value of 2 on 15.1% of forms, and changes of an absolute value of 3 or more on 5.6 % of forms. In terms of RMSD scores, on average, participants changed awareness and interpreting scores between forms by just over one level (up or down). In contrast, the mean change in checking-in was approximately 15% larger, and mean change in *adjusting* was approximately 30% smaller.

Table 3. *Difference score statistics for each process of recovery self-regulation.*

	Difference score probabilities					RMSD	
	0	1 / -1	2 / -2	3 / -3	4 / -4	*M* (*SD*)	Range
Inter-workout							
Awareness	42.4	39.2	14.4	3.2	0.8	1.05 (0.46)	0.50 – 2.12
Checking-in	38.9	40.5	15.1	3.2	2.4	1.22 (0.56)	0.65 – 2.81
Interpreting	40.3	43.5	13.7	2.4	0.0	1.06 (0.43)	0.50 – 2.00
Adjusting	53.6	31.2	12.0	3.2	0.0	0.81 (0.55)	0.00 – 1.87
Baseline							
Awareness	49.6	35.0	13.7	1.7	0.0	0.99 (0.53)	0.00 – 2.19
Checking-in	58.0	27.7	10.9	3.4	0.0	0.84 (0.57)	0.00 – 1.67
Interpreting	50.9	36.2	10.3	1.7	0.9	0.97 (0.57)	0.00 – 2.28
Adjusting	67.2	19.0	6.0	6.0	1.7	0.88 (0.72)	0.00 – 2.61

Note. Columns for difference score probabilities are labelled by the magnitude of change in a score from the previous form, and values are reported as percentages; e.g., during the inter-workout period, 39.2% of responses for awareness were 1 level higher or lower than the previous response (within the past six hours). RMSD = root mean square difference; the statistics presented are aggregated across individual participant means.

Describing the Timing of Self-Regulation in Relation to Key Workouts. ICCs for variables of engagement and self-regulation during the inter-workout period (see Table 1) indicated that 19.4 to 30.9% of variance in these processes was attributable to between participant factors, leaving the majority of variance attributable to situational factors across participants, such as the timing of use or one's recovery-stress state.

The first set of MLMs predicted separate states of perceived recovery or stress from time, either approaching (baseline) and following (inter-workout period) KW1. We built each model in four steps, (1) fitting a basic model with random intercepts for participants, (2) adding a linear effect for time, (3) adding a random effect for time, and (4) adding a fixed, quadratic effect for time. Table 4 summarizes the fixed and random effects for these 12 models, with quadratic effects shown only where they significantly improved the model (See Appendix U for the full models). During the inter-workout period, time significantly predicted engagement in thoughts and actions on recovery, as well as processes of *awareness*, *checking-in*, and *interpreting*, but not the use of adjusting. The slope estimate indicated that cyclists' use of the three significant processes decreased at a linear rate of one level every 50.4–65.7 hrs following KW1. During baseline, time was significantly positively associated with *checking-in* and *interpreting*. Linear estimates indicated these processes increased at respective linear rates of one level every 20.2 and 22.7 hrs leading into KW1, and positive quadratic estimates indicated higher initial rates of increase for checking-in and interpreting that slowed with proximity to KW1.

Table 4. *Fixed effects for multilevel models of engagement in thinking/acting on recovery, and use of momentary recovery self-regulation processes, predicted by time in relation to key workout 1.*

		Baseline period		Inter-workout period	
Variable	Predictor	β (95% *C.I.*)	*SDpart.*	β (95% *C.I.*)	*SDpart.*
Thoughts	Intercept	1.29 (0.89 – 1.69)	0.60	1.66 (1.16 – 2.15)	0.79
	Time	0.011 (-0.001 – 0.022)	0.003	* -0.015 (-0.027 – -0.004)	0.008
Actions	Intercept	1.38 (0.93 – 1.83)	0.69	1.86 (1.39 – 2.33)	0.70
	Time	0.012 (-0.003 – 0.027)	0.015	* -0.019 (-0.030 – -0.008)	0.000
Awareness	Intercept	1.74 (1.25 – 2.23)	0.90	2.20 (1.78 – 2.62)	0.63
	Time	0.007 (-0.006 – 0.021)	0.019	* -0.015 (-0.025 – -0.005)	0.000
Checking-in	Intercept	1.82 (1.25 – 2.39)	1.04	2.05 (1.61 – 2.48)	0.65
	Time	* 0.049 (0.018 – 0.081)	0.032	* -0.012 (-0.030 – -0.009)	0.006
	Time^2	* 7.25e-4 (9.20e-4 – 1.36e-3)			
Interpreting	Intercept	1.79 (1.20 – 2.38)	1.06	2 (1.62 – 2.38)	0.54
	Time	* 0.044 (0.011 – 0.077)	0.028	* -0.018 (-0.028 – -0.009)	0.003
	Time^2	* 8.07e-4 (1.22e-4 – 1.49e-3)			
Adjusting	Intercept	0.71 (0.42 – 1.00)	0.35	0.91 (0.41 – 1.41)	0.90
	Time	0.005 (-0.005 – 0.015)	0.002	-0.009 (-0.023 – 0.005)	0.022

Note. Parameters shown represent the model with random intercepts and slopes, by participant, for the linear effect of time. *β* weights represent the estimated change in the DV over one hour. SD_{part} = Standard deviation of the estimate between participants. * = *p* for time effect < B-H critical value (pool of 14 effects).

Describing Self-Regulation in Relation to Recovery and Stress. Table 1 presents descriptive statistics for the eight dimensions of recovery or stress. Dimensions of perceived recovery and stress were generally correlated as expected (see Table 5). Dimensions of recovery were positively correlated with each other, as were dimensions of stress, while dimensions of recovery were negatively correlated with dimensions of stress. There were two exceptions: During the baseline period, emotional recovery and emotional stress were only significantly correlated with each other, and during the inter-workout period, emotional recovery and physical stress were not significantly correlated.

Table 5. *Repeated measures correlations for dimensions of perceived recovery and stress.*

	Perceived recovery				Perceived stress			
	Physical	Mental	Emotional	Overall	Physical	Mental	Emotional	Overall
Recovery								
Physical	——	*** .721	*** .326	*** .437	*** -.421	*** -.451	*** -.247	*** -.413
Mental	*** .566	——	*** .428	*** .413	*** -.325	*** -.412	* -.187	*** -.370
Emotional	* .181	*** .322	——	*** .375	-.099	*** -.385	*** -.510	*** -.404
Overall	*** .568	*** .667	*** .327	——	*** -.455	*** -.343	*** -.270	*** -.440
Stress								
Physical	*** -.413	** -.263	.047	*** -.453	——	*** .375	** .249	*** .282
Mental	*** -.352	*** -.444	-.128	*** -.450	*** .295	——	*** .531	*** .342
Emotional	-.038	-.011	** -.254	-.103	.096	*** .342	——	*** .397
Overall	** -.267	** -.236	-.129	*** -.405	*** .340	*** .472	*** .506	——

Note. Baseline period = bottom diagonal; inter-workout period = top diagonal.
*** p <.001, ** p <.01, *p < .05

ICCs differed between the states of perceived recovery and stress during the inter-workout period (see Table 1). Variance in most variables was attributable relatively evenly to both between- and across-participant factors (48.6–54.6%). Emotional recovery varied mostly between participants (63.8%), whereas variance in each of overall recovery and physical stress (32.8–39.2%) was more attributable to factors across participants.

The second set of MLMs predicted separate states of perceived recovery or stress from time in relation to KW1. We built these models using the same steps as in the first set of models. Table 6 summarizes the fixed and random effects for these 16 models, with quadratic effects presented only where they significantly improved the model (See Appendix V for the full models). In the inter-workout period, only physical stress was significantly predicted by time following KW1; it decreased at a linear rate of one level every 36.9 hrs. During baseline, physical recovery was significantly predicted by time; it increased at a linear rate of one level every 26.8 hrs leading into KW1, and the positive quadratic term indicated a higher initial rate of increase in physical recovery that slowed as KW1 approached.

The third set of MLMs predicted each recovery self-regulation process from separate states of perceived recovery or stress. We built these models by, (1) fitting a basic model with random intercepts for participants, (2) adding a fixed effect for the dimension of perceived recovery/stress, and (3) adding a random effect for that dimension. Including random slopes improved only seven of 64 total models. Thus, Table 7 shows the fixed effects of models with random intercepts and fixed slopes, except where random slopes are indicated (See Appendix W for the full models). During the inter-workout period, greater use of processes of *awareness, checking-in*, and *interpreting* was significantly predicted by higher levels of physical stress reported on the same form. During baseline, *awareness* was significantly predicted by lower physical recovery, *checking-in* was predicted by higher physical stress, and *interpreting* was predicted by higher overall stress. Adjusting was not significantly predicted by any dimension of the athletes' recovery-stress states in either the inter-workout or baseline periods.

Table 6. *Fixed effects for multilevel models predicting perceived recovery and stress from time in relation to key workout 1.*

		Baseline period		Inter-workout period	
Variable	Predictor	β (95% *C.I.*)	*SDpart.*	β (95% *C.I.*)	*SDpart.*
Physical Recovery	Intercept	0.31 (-0.21 – 0.83)	0.91	-0.25 (-0.61 – 0.11)	0.63
	Time	* 0.037 (0.004 – 0.071)	0.037	0.007 (-0.006 – 0.021)	0.024
	Time^2	* 8.42e-4 (2.20e-4 – 1.46e-3)			
Mental Recovery	Intercept	0.06 (-0.23 – 0.34)	0.35	-0.16 (-0.50 – 0.17)	0.55
	Time	0.002 (-0.010 – 0.014)	0.015	0.006 (-0.007 – 0.019)	0.022
Emotional Recovery	Intercept	0.02 (-0.13 – 0.18)	0.03	-0.01 (-0.31 – 0.29)	0.49
	Time	-0.001 (-0.011 – 0.008)	0.012	-0.001 (-0.012 – 0.010)	0.019
Overall Recovery	Intercept	0.14 (-0.11 – 0.40)	0.20	-0.55 (-1.02 – -0.09)	0.83
	Time	0.002 (-0.008 – 0.012)	0.002	0.020 (0.003 – 0.038)	0.032
Physical Stress	Intercept	-0.32 (-0.65 – 0.02)	0.44	0.73 (0.37 – 1.10)	0.53
	Time	-0.016 (-0.037 – 0.005)	0.034	* -0.027 (-0.041 – -0.013)	0.022
Mental Stress	Intercept	-0.18 (-0.48 – 0.12)	0.30	-0.02 (-0.34 – 0.31)	0.49
	Time	-0.011 (-0.026 – 0.004)	0.018	0.000 (-0.013 – 0.013)	0.021
Emotional Stress	Intercept	-0.09 (-0.28 – 0.09)	0.16	0.05 (-0.21 – 0.31)	0.33
	Time	-0.003 (-0.010 – 0.004)	0.001	0.000 (-0.011 – 0.010)	0.015
Overall Stress	Intercept	-0.07 (-0.29 – 0.15)	0.01	0.30 (-0.04 – 0.64)	0.57
	Time	0.002 (-0.007 – 0.012)	0.000	-0.008 (-0.022 – 0.006)	0.024

Note. Parameters shown represent the model with random intercepts and slopes, by participant, for the linear effect of time. β weights represent the estimated change in the DV over one hour. SD_{part} = Standard deviation of the estimate between participants. * = p for time effect < B-H critical value (pool of 17 effects of time).

Table 7. *Fixed effects of multilevel models predicting use of momentary recovery self-regulation processes, from concurrent ratings of perceived recovery or stress.*

	Awareness	Checking-in	Interpreting	Adjusting
Predictor	β (95% C.I.)	β (95% C.I.)	β (95% C.I.)	β (95% C.I.)
Inter-workout period				
Physical recovery	-.08 (-.29 – .14)	-.10 (-.32 – .12)	-.06 (-.26 – .15)	-.09[a] (-.37 – .18)
Mental recovery	-.11 (-.31 – .10)	-.13 (-.35 – .08)	-.10 (-.30 – .11)	.08[a] (-.20 – .30)
Emotional recovery	-.06 (-.29 – .17)	.12 (-.12 – .35)	.08 (-.14 – .30)	-.05 (-.25 – .15)
Overall recovery	-.18 (-.35 – .00)	-.15 (-.32 – .03)	-.15 (-.31 – .02)	-.13[a] (-.32 – .11)
Physical stress	* .25 (.10 – .39)	* .26 (.12 – .41)	* .19 (.05 – .33)	.13 (.00 – .26)
Mental stress	.06 (-.11 – .23)	.08 (-.10 – .25)	.00 (-.16 – .17)	-.01 (-.16 – .14)
Emotional stress	-.02 (-.20 – .17)	-.12 (-.31 – .07)	-.10 (-.27 – .08)	-.04 (-.20 – .12)
Overall stress	.12 (-.07 – .29)	.05 (-.13 – .24)	.02 (-.16 – .19)	.11[a] (-.12 – .33)
Baseline period				
Physical recovery	* -.21 (-.35 – -.07)	-.04[a] (-.25 – .17)	-.15[a] (-.38 – .08)	.11 (-.05 – .26)
Mental recovery	-.14 (-.29 – .02)	-.04 (-.20 – .12)	-.13 (-.30 – .03)	.13 (-.03 – .29)
Emotional recovery	.11 (-.11 – .33)	.00 (-.23 – .22)	.09 (-.14 – .33)	.13 (-.10 – .35)
Overall recovery	-.13 (-.28 – .01)	-.08 (-.23 – .08)	-.17 (-.32 – -.01)	.10 (-.06 – .25)
Physical stress	.15 (.02 – .29)	* .18 (.05 – .32)	.14[a] (-.06 – .35)	.06 (-.07 – .20)
Mental stress	.06 (-.07 – .19)	.04 (-.10 – .17)	.13 (.00 – .27)	-.01 (-.15 – .13)
Emotional stress	.09 (-.12 – .30)	.18 (-.04 – .39)	.15 (-.07 – .37)	.10 (-.11 – .32)
Overall stress	.12 (-.03 – .28)	.10 (-.06 – .26)	* .24 (.07 – .40)	-.03 (-.19 – .14)

Note. In general, the parameters shown represent fixed effects for a model with random intercepts for participants and a linear slope for perceived recovery or stress; [a] indicates that slopes were allowed to vary in that model. * = *p*-value < B-H critical value (pool of 64 effects for perceived recovery or stress).

Objective 2: Self-Regulation and Recovery of Performance

Analyses

We used separate regression models to assess the relationship between characteristics of the use of each process of momentary recovery self-regulation and the recovery of performance. These analyses were performed only for the inter-workout period. Specifically, we examined whether residuals for KW2 performance after controlling for KW1 performance (i.e., performance residuals) predicted the characteristics presented in the results for objective 1:

Frequency, intensity, consistency, timing, and relationships with the recovery-stress state within each process. Although it may seem counter-intuitive to use performance outcomes to *statistically* predict preceding patterns of self-regulation, the order of variables in regression analyses does not imply theoretical causality; it determines only how the statistical relationship should be interpreted (Field et al., 2012). Following the example of Nett et al. (2012), we used the participant-level variable of performance residuals (i.e., Level 2 variable) to statistically predict observation-level self-regulatory variables (i.e., Level 1 variables; collected on each form) to reduce residual error and therefore improve the explanatory power of our analyses.

The type of analytic model depended on the nature of the characteristic examined. For *frequency*, we used multilevel logistic models to assess whether participant-level performance residuals predicted observation-level use of each recovery self-regulation process. Performance residuals were entered as fixed and random terms, and process ‘use’ was coded binarily (0 = no use; 1 = use at any level). For *intensity*, we used multilevel linear regression models to assess whether performance residuals (entered as participant-level fixed and random terms) predicted observational-level intensity of each self-regulation process (i.e., response level from 0–4). For *consistency*, we linearly regressed participant-level RMSD values for each self-regulation process on the performance residuals. To assess whether the *timing of self-regulation* varied between participants who performed better or worse than expected on KW2, we entered performance residuals as a moderator in the respective linear multilevel models presented in Table 5. Specifically, we regressed each process of self-regulation on the fixed interaction term between time and performance residuals, with random slopes for time. To assess whether the relationships between *self-regulation and perceived states of recovery/stress* varied in line with performance recovery, we entered performance residuals as a moderator in the respective linear multilevel models presented in Table 8. Specifically, we regressed each self-regulation process on the fixed interaction term between performance residuals and each recovery/stress dimension. Statistical significance was reported if the *p*-value of an effect was below its corresponding Benjamini-Hochberg critical value within that group of relevant effects.

Results

The cyclists recorded a mean relative FTP of 3.26 W/kg (*SD* = 0.64; 1.99–4.19) in KW1 and 3.33 W/kg (*SD* = 0.64; 2.34–4.19) in KW2. Performance marks in KW1 and KW2 were correlated ($r = .842$, $p < .001$); performance improved for seven participants and decreased for seven. Residual variances for KW2 performance were normally distributed ($W = 0.93$, $p = .270$) around a mean of 0 (*SD* = 0.30; -0.67 – 0.68).

Table 8 presents a summary of the fixed main or interaction effects for performance residuals on the self-regulatory characteristic in question. Performance residuals were significantly associated with the binary use of *awareness* and *interpreting*, such that cyclists who performed better than expected in KW2 (i.e., higher performance residual) were more likely to have used these processes during the inter-workout period. Neither the intensity with which any self-regulation process was used, nor the magnitude of form-to-form change in any self-regulation process was associated with performance recovery on KW2. There were no interaction effects on performance recovery; not for the respective relationships between each recovery self-regulation variable and time, nor by dimension of perceived recovery/stress.

Table 8. *Estimates of associations between residuals in performance for key work out 2 and key characteristics of the use of processes of recovery self-regulation in the inter-workout period.*

	Awareness	Checking-in	Interpreting	Adjusting
	β (95% C.I.)	β (95% C.I.)	β (95% C.I.)	β (95% C.I.)
Frequency (>0 vs. 0)	* 2.75 (0.84 – 4.66)	1.30 (-0.34 – 2.94)	* 2.68 (0.45 – 4.90)	1.04 (-1.20 – 3.29)
Intensity (0–4)	1.24 (-0.63 – 3.12)	0.24 (-1.52 – 1.99)	1.18 (0.00 – 2.35)	-0.25 (-1.72 – 1.21)
Consistency (RMSD)	-0.17 (-1.06 – 0.72)	0.01 (-1.02 – 1.04)	-0.05 (-0.75 – 0.65)	0.16 (-0.83 – 1.14)
Interaction Effect with Time	0.01 (-0.03 – 0.04)	0.01 (-0.03 – 0.05)	0.01 (-0.02 – 0.05)	-0.04 (-0.09 – 0.01)
Interaction Effect with Recovery-Stress State				
Physical recovery	0.85 (0.03 – 1.68)	0.81 (-0.05 – 1.67)	0.64 (-0.16 – 1.43)	0.63 (-0.39 – 1.65)
Mental recovery	0.42 (-0.26 – 1.09)	0.50 (-0.20 – 1.20)	0.34 (-0.31 – 0.99)	0.42 (-0.42 – 1.26)
Emotional recovery	0.35 (-0.45 – 1.15)	0.21 (-0.62 – 1.03)	0.04 (-0.73 – 0.80)	0.32 (-0.39 – 1.03)
Overall recovery	0.41 (-0.22 – 1.03)	0.51 (-0.14 – 1.16)	0.19 (-0.41 – 0.79)	0.47 (-0.26 – 1.21)
Physical stress	-0.13 (-0.69 – 0.43)	-0.15 (-0.73 – 0.43)	0.10 (-0.45 – 0.64)	-0.06 (-0.57 – 0.46)
Mental stress	-0.24 (-0.73 – 0.24)	-0.08 (-0.59 – 0.43)	-0.06 (-0.52 – 0.41)	-0.33 (-0.77 – 0.10)
Emotional stress	-0.10 (-0.54 – 0.34)	-0.19 (-0.65 – 0.26)	-0.04 (-0.46 – 0.37)	-0.03 (-0.42 – 0.37)
Overall stress	-0.14 (-0.69 – 0.41)	-0.31 (-0.88 – 0.27)	-0.20 (-0.72 – 0.33)	-0.33 (-1.08 – 0.42)

Note. Values represent unstandardized estimates for each characteristic of self-regulation use. Frequency estimate represents log-odds of score above 0 versus score of 0; all other estimates represent linear change in variable given 1-unit increase in performance residual. RMSD = Root mean square difference. *p-value < B-H critical value (within effects for that characteristic).

Discussion

The first objective of this study was to describe patterns for how non-elite competitive cyclists used processes of recovery self-regulation between two highly challenging workouts. They reported frequently engaging in self-regulating their recovery, at low to moderate mean levels. Processes of awareness, checking-in, and interpreting were strongly positively correlated with each other, and moderately correlated with the process of adjusting. These processes changed with moderate frequency in low magnitudes of change, and variation was largely explained by within-person (i.e., situational) as opposed to between-person factors. Higher levels of awareness, checking-in, and interpreting coincided with higher perceived stress, and decreased over time during the inter-workout period. Below, we interpret these findings, with a focus on the inter-workout period, first as a description of recovery self-regulation in non-elite athletes, then in relation to patterns seen in elite athletes.

The recreationally competitive athletes frequently engaged in recovery self-regulation in our recovery-intensive scenario. In the inter-workout period, recovery guided their thoughts and actions on over 64% of forms, and they engaged in recovery self-regulation processes on an average of 42-87% of forms, generally at a low or low-to-moderate intensity. These rates are much higher than similar ESM studies of academic contexts. Nett et al. (2012) found that students thought about an upcoming math test on 23% of forms and engaged in self-regulation on 9-17% of forms, while Smith et al. (2022) found that students reported emotional regulation strategies on 10-32% of forms (although not in relation to a goal event). Compared to non-sport domains, our findings suggest that recovery self-regulation is a relatively pervasive phenomenon in the lives of non-elite endurance athletes.

The results characterizing the consistency of self-regulatory process use indicate that our non-elite athletes *actively* engaged in self-regulating recovery. Scores for each process changed between 46-61% of forms (depending on the process), at an average magnitude of 0.8 –1.2 levels each time. Instead of static levels of processes, the athletes were frequently shifting and adapting their use of recovery self-regulation. Awareness and interpreting showed similar patterns of frequent shifts (~58-60% of forms) of approximately one level each time, which may indicate a consistently adaptive implementation pattern. Checking-in changed at a similar frequency to awareness and interpreting, yet by a higher mean magnitude, which may indicate a consistent baseline punctuated with more intense periods. In contrast, adjusting was characterized by the lowest frequency and magnitude of use, suggesting a lower overall level of use and a more intermittent, “when needed” type of implementation. These differing patterns suggest that each process may be implemented under differing reasons or conditions.

Our findings support the inter-connected nature of recovery self-regulation described in the ARRM (Wilson & Young, *in review*). In that model, awareness and checking-in represent processes of the athlete-led skill of ‘listening to my body’. Adjusting is a process related to the skill of ‘respecting my body’ where athlete decide either to alter or maintain their recovery plans and routines. Interpreting represents how ‘listening to my body’ informs the actions of ‘respecting’. In our study, levels of awareness, checking-in, and interpreting reported on the same form were strongly correlated with each other (r = .72–.77; Cohen, 1988), which supports their conceptual proximity as ‘listening’-related processes in the ARRM. Adjusting was moderately correlated with concurrent reports of the other three processes (r = .40–.50; Cohen, 1988), which locates it as relatively more conceptually distant from the ‘listening’-related processes. Considering the ARRM was developed from qualitative analyses of conversations with elite endurance athletes, our findings allow the inference that the ARRM may be useful for understanding recovery self-regulation in non-elite populations as well.

The cyclists in this study appeared to employ processes of recovery self-regulation to manage the physical effects of KW1, as evidenced by three related findings. First, processes of self-regulation (except for adjusting) were highest immediately following KW1 and decreased with time over the inter-workout period. While checking-in and interpreting increased over the baseline period leading to KW1, no self-regulatory processes increased leading into KW2. These findings contrast with evidence from a school-based achievement context, where Nett et al. (2012) found that students’ SRL increased over the 14 days approaching an important math test. Instead, our cyclists appeared to employ processes of recovery self-regulation predominantly in response to participation in KW1, as opposed to anticipation of KW2. Second, the cyclists reported greater use of recovery self-regulation when experiencing greater physical stress during the inter-workout period. Specifically, awareness, checking-in, and interpreting (but not adjusting) were associated with higher ratings on the item, “Physically, my muscles feel exhausted, fatigued, sore, stiff.”. These findings indicate that athletes may employ processes of recovery self-regulation as a ‘problem-solving’ mechanism when faced with higher physical stress. Third, physical stress decreased with time during the inter-workout period. On its own, this finding describes the expected trajectory of the participants’ physical state following KW1, considering they rated their exertion in KW1 as “Very hard” to “Maximal”. Taken together, this evidence indicate that the non-elite cyclists enacted processes of recovery self-regulation in response to the physical (muscular) fatigue resulting from KW1, which was highest immediately following the workout and decreased over time. Despite being “motivated” or “very motivated” to perform in KW2, their recovery self-regulation still appeared anchored to the effects of KW1. This is different than elite endurance athletes, who used recovery between key workouts to “absorb” the effects of the last session *and* to “prepare” for their next important training session (Wilson & Young, 2023). The patterns of recovery self-regulation in this sample supported the goal of “absorbing” the work of KW1, with little indication of “preparing” for KW2.

Comparing Elite and Non-Elite Competitive Athletes

Our findings may be readily compared with Wilson et al.’s (*Article 3*) description of recovery self-regulation among elite endurance athletes. Wilson et al. used a similar ESM design and identical measures to describe how 22 Canadian National Team cyclists and triathletes self-regulated their recovery, also between two key workouts. Wilson et al. chose to prioritize ecological validity: the athletes identified key workouts in their already-planned training, which were separated by 2–3 days depending on their training, and executed the workouts in their natural training environments (i.e., not on Zwift). Although the current design was more controlled, comparing the findings from our sample with Wilson et al.'s may be helpful to infer which patterns of self-regulation vary between different skill levels, and which patterns hold.

There were subtle differences, but mostly similarities around engagement in recovery and processes self-regulation of recovery across our non-elite sample and the elite one of Wilson et al. (*Article 3*). Of note, the non-elite cyclists reported thinking and acting on their recovery less often (64% of forms in this study vs. 80-81% of forms among elite athletes) and with a lower mean intensity (Non-elite: 1.3-1.4; Elite: 1.7-2.0). Yet, the non-elite athletes engaged in recovery self-regulation between key workouts to a similar extent as the elite athletes. For example, the frequency of any level of self-regulatory process use was within 4 percentage points between studies for awareness (Non-elite in our study: 87%; Elite: 83%), checking-in (Non-elite: 81%; Elite: 79%) and adjusting (Non-elite: 42%; Elite: 46%), with a wider gap for interpreting (Non-elite: 79%; Elite: 69%). Similarly, the mean intensities of each process across studies were all within 0.15 levels of each other on the same scale. The discrepancy between studies may indicate that these non-elite athletes interpreted ways of self-regulating recovery without acknowledging having their thoughts/actions guided by recovery. This discrepancy may also relate to design differences. Wilson et al. (in prep; see also Nett et al., 2012) presented the self-regulatory process items once the participants had already indicated thinking/acting on recovery, whereas participants in this study always answered self-regulatory items regardless of their level of thinking/acting (due to technical limitations of our apps). The main takeaway is that although the skill levels thought/acted on recovery differently, they were very similar in how highly engaged they were with processes of recovery self-regulation.

Patterns of consistency of recovery self-regulation provide further evidence that competitively-minded athletes similarly engage in processes of recovery self-regulation, regardless of their skill level. In both our study and that of Wilson et al. (*Article 3*), checking-in changed between 61% of consecutive forms by a mean magnitude of 1.2 levels. Awareness and interpreting showed more consistent patterns of implementation than checking-in in both studies (i.e., lower magnitude and frequency of change), although our non-elite sample reported slightly more frequent changes than the elite sample. Adjusting changed the least often and by the lowest magnitude in both studies, although, again, the non-elites changed slightly more often than in the study of elite athletes, both skill levels reported similar pattern of associations between processes on the same form. In both studies, awareness, checking-in, and interpreting were strongly correlated with each other, and less strongly (although still significantly) with adjusting. Still, the overall similarities between skill levels—using the same measures taken from independent samples—indicate that the concept and experience of recovery self-regulation is relatively consistent between non-elite and elite athletes.

We found more notable differences in how our non-elite sample chose to employ processes of recovery self-regulation, compared to the elite athletes (Wilson et al., *Article 3*). Although both samples engaged in greater self-regulation when experiencing states of perceived stress, only physical stress predicted self-regulation in our non-elite sample. The elite sample in Wilson et al. (*Article 3*) employed self-regulatory processes in association with multiple, different dimensions of perceived stress and recovery. Further, Wilson et al. found that elite athletes reported changes in seven of eight dimensions of perceived recovery and stress following a key workout, whereas our non-elite athletes only identified a change over time in the most poignant signal of physical stress. It may be that elite athletes experience a more sensitive and complex perception of their recovery-stress state, based on a more sophisticated self-knowledge of what those sensations mean for their recovery/training (Wilson & Young, *in review*). Conversely, non-elite athletes appeared more narrowly focused on physical sensations.

Finally, our non-elite sample chose to employ processes of recovery self-regulation with notably different timing than the elite sample (Wilson et al., *Article 3*). The use of multiple self-regulatory processes declined over time following KW1 for the non-elite cyclists, yet no comparable time-related associations were found among the elite athletes (Wilson et al., *Article 3*). While the non-elite athletes appeared to enact self-regulation largely in response to KW1 and its resultant physical stress, it is unclear why these patterns differ from elite athletes. explanation for this discrepancy remains unclear. The most likely explanation is that elite athletes engage in self-regulation more regularly in response to interoceptive signals throughout the inter-workout period, thereby nullifying a specific time-based trajectory, although this specific comparison should be addressed in future research.

Self-Regulation and Recovery of Performance Between Workouts

The second objective of this study was to take the novel step of comparing non-elite competitive cyclists' use of processes of recovery self-regulation with their capability to restore performance from one hard workout to the next. Athletes who demonstrated better performance recovery, by performing better than expected in KW2, had more frequent use of any level of awareness and interpreting. Thus, athletes who "listen to their body" more frequently may be better equipped to restore their performance between key workouts. However, recovery of performance was not associated with the intensity or consistency of self-regulation. Additionally, the relationships of recovery self-regulation with time or the recovery-stress state did not vary predictably between cyclists who performed better or worse than expected in KW2. Thus, while recovery self-regulation was generally higher with greater perceived stress and decreased with time following KW1, those relationships did not vary between athletes performed better or worse than expected in KW2. While our descriptive findings (objective 1) illustrate distinct patterns in how the cyclists employed recovery self-regulation, these characteristics did not generally influence workout performance in KW2 in this study (objective 2).

Our results present differing implications for the influence of recovery self-regulation on training performance, especially if we consider direct versus indirect measures of performance. On one hand, we found few indications that characteristics of recovery self-regulation were associated directly with the short-term recovery of performance (i.e., between two workouts). On the other hand, we found multiple indications that non-elite athletes may self-regulate recovery differently than previously described for elite athletes (Wilson et al., *Article 3*), and differences between non-elite and elite samples are commonly interpreted as an indirect correlate of long-term performance improvement (Baker et al., 2020). It is not uncommon for correlates of expertise to have a delayed effect on performance outcomes (Baker & Young, 2021). However, we cannot reconcile these opposing perspectives given the existing evidence, and so we recommend that future research examine the use of recovery skills across multiple performance levels, in association with recovery outcomes, and along different time frames.

Limitations

We advance that this study provides a proof of concept that recovery may be studied as a skill within a quasi-experimental recovery-intensive scenario. With some refinements, and particularly considerations for how to address limitations in the assessment performance recovery, this design might be instrumental in future research on recovery. Specifically, variance in the cyclists' physiological profiles may have masked variance in the recovery of performance attributable to recovery self-regulation. Zwift estimates a user's FTP using both its native 20 min time trial test, used in this study for KW1, and its native maximal incremental ramp test, used for KW2 (Schlange, 2022). While both tests can produce valid estimates of FTP, their differing protocols favour slightly different physical capabilities. As such, the shorter duration of the ramp test means it may overestimate FTP for more powerful cyclists (Karsten et al., 2021), which may have unintentionally confounded the relationship between performance in KW1 and KW2. We used a ramp test for KW2 because pilot testing indicated that two 20 min time trials, 48 hrs apart, may be challenging for recruitment and introduce learning effects in within-test pacing.

We used a remote research design, where athletes performed workouts on their own bike trainers, at home, using the Zwift platform. This design allowed us to naturalistically assess self-regulation and recovery in the athlete's chosen context, as opposed to requiring them to come to a lab setting for testing. As a requisite trade-off, field-based testing introduces a greater potential for error in procedures/measurement, although research evidences the validity and reliability of a 20 min time trial performed on Zwift using a participant's own equipment (Matta et al., 2022. Relatedly, the workouts we used are labelled as "tests" on Zwift, so cyclists may have viewed their participation as more performance-oriented (versus training-oriented), although it is unknown whether this may have affected recovery self-regulation.

Conclusion

Using a unique remote-research ESM design, the findings demonstrated that recreationally competitive non-elite athletes were highly engaged in processes of recovery self-regulation, in patterns that align with descriptions from the ARRM (Wilson & Young, *in review*). Our study suggests that the ARRM, and recovery self-regulation more broadly, is an important and active process for non-elite competitive athletes as well as elite athletes. Our results showed that non-elite athletes engaged in recovery self-regulation in very similar patterns to elite athletes, although how they responded to recovery-states was simpler (mainly focused on physical stress) and more reactive (mainly focused on absorbing stressors in the immediate time after a key workout). Although there was some indication that greater recovery of performance over 48 hrs between hard workouts was associated with strategies of frequent, low-intensity awareness and interpretation of one’s recovery-stress state, overall, diverse characteristics of the implementation of recovery self-regulation were not associated with greater performance recovery. From a methodological stance, our study provided a proof of concept that recovery can be examined through a set of skills that athletes can own and hone to shape their recovery, and potentially their training and performance.

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GENERAL DISCUSSION

The overall purpose of this dissertation was to explore and describe the psychology of recovery in relation to sport expertise, framed by the overall question, “What might it mean for an endurance athlete to be *skilled* at recovery?”. I examined this overall purpose in three parts, guided by respective questions and objectives:

1) “What does *recovery* mean to elite endurance athletes?”, which involved describing the meanings, experiences, and processes of recovery from the perspective of elite endurance athletes.
2) “What athlete-led skills are involved in the process of implementing recovery?”, which involved identifying potential skills of recovery that could be validly examined as a characteristic of athlete expertise.
3) “How are these skills implemented to effectuate expert recovery?”, which involved:
    a) Examining the skills of expert recovery in their natural environment.
    b) Developing a representative task to assess whether these skills are reproduced and reliably executed under more controlled conditions.

I addressed these objectives in the four articles of this dissertation, which were organized in a sequential exploratory mixed methods design and framed in a philosophy of critical realism. In this general discussion, I will summarize, integrate, and interpret the findings of the four articles in relation to the overall purpose of this dissertation, and outline their theoretical, methodological, and practical contributions to the understanding of recovery and sport expertise.

Integration and Interpretation of Findings

The findings of each article may be interpreted in relation to each objective, as well as the overall question, “What might it mean for an endurance athlete to be skilled at recovery?”.

Objective 1 – What does recovery mean to elite endurance athletes?

Objective 1 was addressed most directly by Article 1, which aimed to describe what recovery means to a sample of 13 elite endurance-sport athletes. Specifically, I characterized the purposes, experiences, and processes of recovery expressed by the athletes during two semi-structured interviews, enhanced by an intervening week of activity journaling. Recovery helped the athletes accomplish long-term goals of sustaining and accumulating quality training, by helping them to achieve short-term goals of 'absorbing' the effects of their previous training sessions and 'preparing' for the effort of their next session. Recovery involved getting a break from the demands of their training and sport by engaging in other activities, identities, or contexts they found meaningful. Finally, what constituted recovery in any moment was guided by an athlete's situational priorities. The athletes fulfilled these conditions (i.e., purposes, experiences, priorities) by drawing on a wide range of potential recovery approaches that spanned multiple sensory dimensions,[1] levels of focus (i.e., dialed in to dialed out), and personal variations. These findings suggest that an athlete who is skilled in recovery can readily draw on a variety of recovery options to meet the goals, conditions, and priorities of their recovery context.

The findings of Article 1 provide an athlete-centered perspective that characterizes recovery according to the athletes' understanding of what is meaningful—i.e., their goals, experiences, and priorities. From this perspective, meaningful recovery is defined according to the extent that recovery *methods* match the *athlete*, which means that a recovery method is 'good' or 'useful' (or whether it constitutes recovery at all) only if it fulfills the athletes'

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[1] Within the findings of Article 1, the multiple sensory dimensions of recovery are referred to as "feelings" to reflect the words of the participating athletes, and included physical, mental, and holistic feelings. In these cases, the term "feelings" may not align with common operational definitions (e.g., feeling states). For instance, the label "mental feelings" was used to reflect the athletes' descriptions of any self-perceptions (feelings) made cognate (mental).

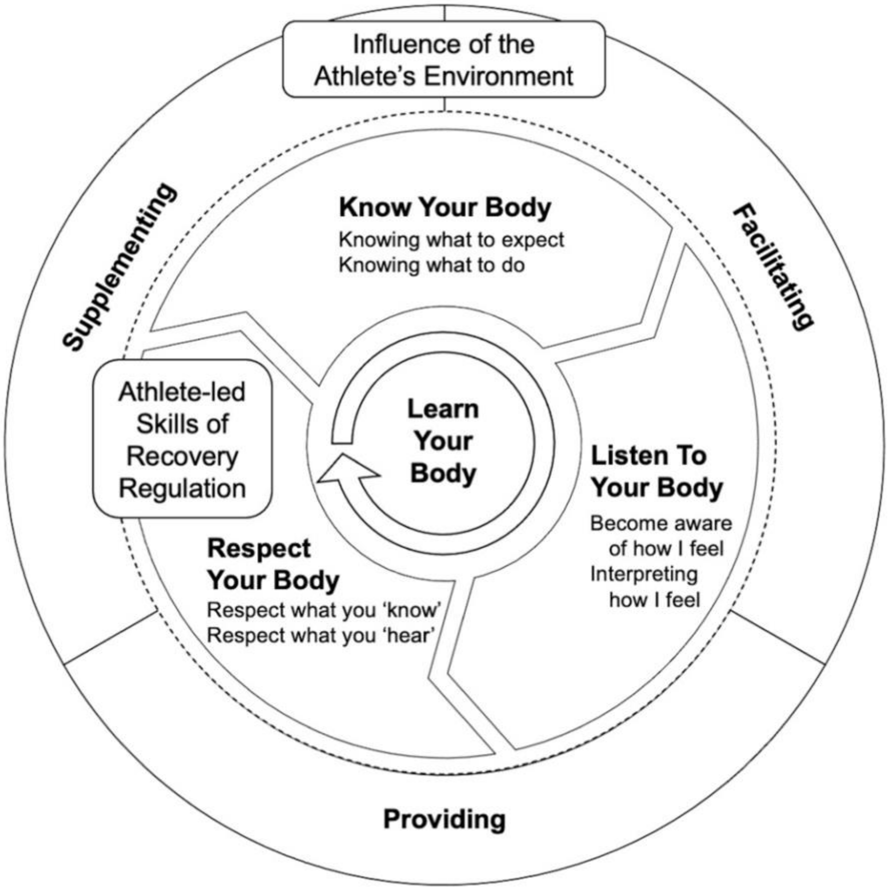
contextual conditions. This perspective implies that athletes should be encouraged to explore and define recovery according to the conditions of their personal context, not what is readily measured or easily prescribed.

An athlete-centered perspective contrasts with the method-centered perspective often adopted in recovery research, which assesses the extent that *athletes* match the *methods*. For instance, many investigations begin with a list of types or characteristics of particular recovery methods—such as an inventory of evidence-based modalities like cold water immersion, foam rolling, and compression garments—and assess whether athletes use them in line with physiological guidelines (Braun-Trocchio et al., 2022; Crowther et al., 2017; Leabeater et al., 2022; Tavares et al., 2017; Venter et al., 2010). A method-centered approach may be effective for evaluating the validity or effectiveness of resource allocation (e.g., Dupuy et al., 2018), but it largely ignores the understandings of recovery held by the human who engages in it.

Objective 2 – What athlete-led skills are involved in the process of shaping recovery?

Objective 2 was most directly addressed in Article 2, which aimed to describe the process of implementing recovery from the perspective of elite endurance-sport athletes. Based on data from the same interviews used for Article 1, the analyses portrayed four themes that described the athletes' roles in implementing recovery. 'Knowing my body' involved self-knowledge of how the athletes expected to respond to specific training and recovery stimuli, and using that self-knowledge to build recovery plans and routines. 'Listening to my body' involved paying attention to one's state of recovery (or fatigue), and then interpreting those feelings compared to how one expected to feel. 'Respecting my body' involved engaging with those interpretations by 'respecting what I know' and following through on plans/routines, or by 'respecting what I hear' and flexibly adjusting plans with new information. Finally, 'learning my body' involved engaging with the aforementioned three themes in repeated cycles of trial and error to develop regulatory knowledge and skills over time. In these findings, the athletes' recovery responsibilities were integrated with and influenced by various people and places in their environment. People and places could supplement, facilitate, and provide for elite athletes' recovery efforts. To illustrate the interactions between the athlete-led and environmental themes, I developed a descriptive Athlete Recovery Regulation Model (ARRM; Figure 1).

Figure 1. *The Athlete Recovery Regulation Model*



Note. Reproduced from Wilson and Young (*in review*)—i.e., Article 2.

Regarding the purpose of this dissertation, the findings of Article 2 suggest that being skilled at recovery means engaging with the skills and component processes of the ARRM to fulfill the conditions of meaningful recovery described in Article 1. Together, Articles 1 and 2, accomplish the preliminary step of characterizing expert recovery and the skills it may involve, which allows further investigation using the original expertise approach (OEA; Ericsson & Smith, 1991). Much like a competitive swimmer pursues their outcome goals of finishing a race in a particular time using multiple skills (e.g., perception of effort, stroke technique) with multiple components (e.g., technical competencies for the beginning, middle, and end of a stroke), being skilled at recovery involves using multiple skills comprised of multiple processes to address the conditions of meaningful recovery. In Articles 3 and 4, I chose to focus on a subset of the various conditions, skills, and processes outlined in Articles 1 and 2. Specifically, I examined certain momentary processes that represented aspects of the skills 'Listening to my body' and 'Respecting my body', within a recovery scenario informed by the short-term goals of 'absorbing' and 'preparing' between workouts. That said, all the conditions, skills, and processes outlined in Articles 1 and 2 are important features of athlete-centered recovery deserving of future, dedicated investigation.

Objective 3 – How are recovery skills implemented to effectuate expert recovery?

Articles 3 and 4 drew on the OEA (Ericsson & Smith, 1991) to address Objective 3. Step 1 of the OEA involved (i) examining expert performance and its composite skills in their natural environment, to (ii) subsequently inform the design of a representative task that reproduces these skills under controlled conditions (Ericsson & Smith, 1991). The results of Article 1 indicated that an important aspect of expert performance in recovery involved the restoration of performance over the recovery-intensive scenario between two consecutive key workouts—i.e., absorbing one key workout and preparing for the next. The results of Article 2 indicated that while certain recovery skills involved more dispositional processes (e.g., self-knowledge involved in 'knowing my body'), the majority were employed moment-to-moment to address the athletes' current context. Informed by these findings, I employed experience sampling methods (Larson & Csikszentmihalyi, 1983) in Articles 3 and 4 to describe the momentary use of certain recovery skills during the recovery-intensive scenario between two key workouts.

Article 3 addressed the first half of Step 1 of the OEA by describing how 22 national team cyclists and triathletes employed select recovery skills from moment to moment between two key workouts in their planned training. Article 4 addressed the second half of Step 1 of the OEA by standardizing certain conditions of the recovery-intensive scenario observed in Article 3 to create a representative task of inter-workout recovery. Specifically, I used a remote research design so that all participants completed the same two key workouts, separated by the same 48-hr inter-workout period. While representative tasks in the original expertise approach are often lab-based (Ericsson & Smith, 1991), Articles 1 and 2 indicated that expert performance in recovery involved negotiating contextual elements of 'real life' that would only be present in the participants' natural training/home environments. In Article 4, I leveraged this representative task to describe the patterns of momentary recovery self-regulation employed by 16 non-elite competitive cyclists, and to examine how those patterns related to the recovery of performance between workouts.

Together, the findings of Articles 3 and 4 suggest that athletes who are skilled at recovery listen to their bodies frequently and respond to states of higher perceived stress and lower perceived recovery in regulating their recovery. Both elite cyclists/triathletes (Article 3) and non-elite cyclists (Article 4) engaged frequently and dynamically in a subset of synergistic yet unique processes from the skills of ‘Listening’ and ‘Respecting’ in the ARRM (Article 2). The similarity of these findings between samples indicates the relevance of these self-regulatory processes of recovery to endurance athletes competing at multiple performance levels. The elite sample (Article 3) engaged in greater recovery self-regulation when experiencing states of higher multidimensional stress and (to a lesser extent) lower perceived recovery, and not in predictable timelines around their key workout. In contrast, the non-elite sample (Article 4) reported simpler and more reactive self-regulatory patterns that were focused on responding to states of *physical* stress on a timeline following Key Workout 1. The OEA suggests that performance characteristics demonstrated by domain experts that differ from non-experts may be inferred as partially responsible for the experts’ superior performance capabilities (Ericsson & Smith, 1991). Therefore, the elite athletes’ patterns of multi-dimensional and persistent recovery self-regulation, which differed from the non-elite athletes’ simpler and reactive patterns, may be preliminarily interpreted as a characteristic of long-term expertise development, subject to further investigation. Most importantly, this work provides proof of concept of a method to examine recovery as a skill in line with traditional paradigms of expertise research. Finally, Article 4 provided some indication that greater recovery between hard workouts was associated with more frequent awareness and interpretation of one’s recovery-stress state, although the majority of characteristics of the implementation of recovery self-regulation were not associated with greater performance recovery over the 48-hr timeframe.

Contributions of the Dissertation

The collective findings of this dissertation advance the understanding of athlete-centered recovery from training. These theoretical, methodological, and practical contributions are presented below.

Conceptual and Theoretical Contributions

The overarching conceptual contribution of this dissertation has been to specifically examine the psychology of recovery from training and, therefore, the experience or integration of various established psychological processes in the context of recovery. Below, I focus on two specific conceptual/theoretical areas advanced by examination through the lens of recovery.

'Skillful' Recovery and the ARRM. This dissertation takes the novel step of describing recovery in terms of athlete-led skills, as presented in the ARRM. I submit that preliminary support for the construct validity of these skills is provided by the qualitative findings of Article 2 and key similarities with established mental and perceptual-cognitive skills of sport performance. For instance, the self-knowledge and planning involved in the skill of 'knowing my body' parallel consistent findings that expert athletes hold a more extensive knowledge base of sport-specific information than novices (Moran, 2004), which they use to develop more complex and specific plans for action (Cleary & Zimmerman, 2001; McPherson, 2000). The ARRM skill of 'listening to my body' involved processes of attentional control of one's recovery-stress state, and perceiving/interpreting relevant patterns or cues within that information. Similarly, expert athletes demonstrate more efficient and effective patterns of selective attention (e.g., quiet eye; Wilson et al., 2015), as well as greater anticipatory skill driven by faster and more accurate visual perception of sport-specific patterns (Farrow & Abernethy, 2015). Within the skill of 'respecting my body', the process of 'respecting what I know' described the self-control required for an athlete to follow through on recovery plans. Similarly, Tedesqui and Young (2017) found that greater self-control was associated with greater engagement in voluntary practice among athletes in a multisport sample. Conversely, the process of 'respecting what I hear' described adapting to incoming feedback, which resembles expert athletes' use of reflection to cyclically adapt and refine practice-related learning processes (Jonker et al., 2012; Toering et al., 2009). ‘Learning my body’ incorporated characteristics of how self-regulated learning contributes to long-term skill development, including specifically how elite athletes employ metacognitive processes to continually learn from individual practice experiences (Jonker et al., 2012; Young et al., 2023). Just as a coach can supplement an athlete’s self-regulated learning and spur skill development during practice (Bain et al., 2023), these athlete-led recovery skills may be enhanced (or constrained) by the influence of people and places in the athletes’ environment.

Alongside their similarities, the athlete-led recovery skills of the ARRM carry certain distinctions from predominant perceptual-cognitive skills in sport. Most notably, the ARRM recovery skills generally involve self-paced interoception, the processing of internal visceral or emotional sensations (Craig, 2003). For instance, the ARRM skill of ‘listening to my body’ directly describes gaining information through interoceptive awareness of one’s recovery state, while the skills of ‘knowing’, ‘respecting’, and ‘learning’ respectively involve comparing, acting on, and reflecting on that information. In contrast, sport expertise research has typically focused on exteroceptive processing of cues in one’s environment that are often time-dependent (i.e., speeded) and visual in nature (Mann et al., 2007), such as the skills a batter uses to make contact with an incoming pitch.

A growing collection of studies suggests that athletes may gain an expert advantage in interoceptive processing. For example, Chinese national team athletes in sport shooting and archery demonstrated greater interoceptive accuracy and sensitivity in a breath detection task compared to their provincial team counterparts (Li et al., 2021). Further, the national team athletes improved interoceptive accuracy/sensitivity after 5-8 weeks of mindfulness training. In endurance sports, conflicting evidence suggests that attending to internal bodily sensations may alternately aid or impair performance based on the specific context and cues attended to (Brick et al., 2019). Brick et al. (2015) reconciled these positions by suggesting, based on participant interviews, that elite endurance runners periodically attend to certain internal sensory information by adopting a situationally appropriate focus of attention. This description of context-specific interoception resembles how elite athletes employ recovery self-regulation according to the conditions of their context and state (Article 1; Article 3). Therefore, I submit that sport expertise may be characterized by a wider variety of skills guided by a broader range of sensory information that may be currently represented in research. Specifically, I submit that greater investigation of recovery self-regulation skills would contribute to understanding the development of sport expertise.

Implications for Models of Self-Regulated Learning in Sport. Frameworks of social-cognitive self-regulated learning could be effectively used to describe recovery self-regulation skills. As described in Article 2, the athlete-led skills of the ARRM paralleled several processes in Zimmerman's (2000) cyclical model of self-regulated learning. For instance, 'knowing my body' involved aspects of strategic planning from the pre-task 'forethought' phase of Zimmerman's model, 'listening to my body' involved elements of self-observation from the 'performance' phase, and 'respecting my body' evoked aspects of self-control as it was also described in the 'performance' phase. Further, the skills of the ARRM built on and fed into each other in an iterative cycle, as described by athletes in Article 2 and evidenced in Articles 3 and 4 by stronger correlations between conceptually-proximal self-regulated recovery processes (e.g., between awareness and checking-in) and moderate correlations between slightly more distal processes (e.g., awareness and adjusting). The results of this dissertation demonstrate that

Zimmerman's model of self-regulated learning is applicable to a further learning domain of recovery around training in sport.

While effective, Zimmerman's (2000) conceptualization of self-regulated learning was insufficient to explain all the recovery self-regulation skills in the ARRM. For instance, an athlete's self-knowledge was directly described in 'knowing my body' and implicated as a resource for expectations in the other three athlete-led recovery skills. However, Zimmerman's model does not explicitly locate a learner's accumulated declarative (or procedural) knowledge. In contrast, Winne and Hadwin (1998) identify domain knowledge, task knowledge, and knowledge of learning strategies among the cognitive resources that inform the use of self-regulated learning. Winne and Hadwin's accent on knowledge better reflects the description of recovery self-regulation in Article 2, which involved athletes continuously drawing on knowledge of their domain (sport), task (training session), and strategies of training/recovery.

Further, Article 2 presented evidence that recovery self-regulation was integrated with the people and places in the athletes' environment, which was not explicitly addressed in Zimmerman's (2000) model of self-regulated learning. Concerning environmental influences, Zimmerman (2000) implicates observing and adjusting environmental conditions or outcomes (i.e., environmental self-regulation) as one of the triadic processes of self-regulation (alongside personal and behavioural self-regulation). Further, he identifies observation and emulation of a model's self-regulation as early steps in the development of self-regulatory competency (Zimmerman, 2000). However, his self-regulated learning model does not explain the reciprocal roles and influences involved in the regulatory relationships between a learner and their environment. In contrast, Hadwin et al. (2017) explicitly locate the development of self-regulated learning processes in the context of the learner's past experiences and, notably, within their current social/physical environment. They detail specific roles, relationships, and responsibilities for ‘others’ in the development and performance of a learner’s self-regulation. For instance, shared regulation refers to collective metacognitive control of a task by a group, while co-regulation describes how shared regulation (often between a learner and teacher/coach) is transitioned to self-regulation (Hadwin et al., 2017). Among the types of environmental influences on an athlete’s recovery, the ‘supplementing’ roles of coaches or support staff in an athlete’s recovery self-regulation could be explored as a co-regulatory relationship, while certain ‘facilitating’ roles resemble characteristics of shared regulation. While the investigation of ‘others’ in the development and execution of self-regulation is relatively new to sport research (c.f., Bain et al., 2023), the findings of this dissertation suggest these relationships in the broader ecology of recovery deserve future research. For instance, the reflexive inclusion of environmental characteristics in the analysis meant that the findings of Article 2 largely presented positive characteristics of their influence on recovery regulation. Future research should explicitly consider how athlete recovery self-regulation is influenced by their perceptions of barriers, perceived behavioural control, and constraints in their environment.

Research on self-regulated learning and sport expertise has been predominantly guided by Zimmerman’s description of self-regulated learning (McCardle et al., 2019), despite compatible social-cognitive alternatives (Hadwin et al., 2017; Winne & Hadwin, 1998). This foreclosure around Zimmerman’s model spans separate research groups from Canada (Young et al., 2023), Europe (Reverberi et al., 2021; Toering et al., 2012), and Asia (Ikudome et al., 2017; Pitkethly & Lau, 2016). These investigations have specifically focused on self-regulated learning in sport practice, and convergence on one theoretical perspective may indicate its ultimate utility for that context. However, this dissertation contributes evidence that athletes engage in processes of self-regulated learning beyond what has been represented in extant literature, which suggests that the broader understanding of self-regulated learning in sport could benefit from the consideration of multiple theoretical perspectives.

Methodological Contributions

The major methodological contribution of this dissertation has been to demonstrate proof of concept that recovery can be examined in traditional paradigms of expertise, which addresses a longstanding gap in sport expertise research (Baker & Young, 2014). Specifically, I followed the guidelines of the OEA to develop a context (i.e., representative task) and method to examine the psychological mechanisms of expertise in recovery.

Context of Examination. The context of examination was the representative task of recovery between two key workouts. I identified this task based on athletes' descriptions of the goals that give meaning to their recovery; specifically, the dual priorities of 'absorbing' stressors following a hard workout and 'preparing' to engage in the next workout (Article 1). In Articles 3 and 4, I found evidence that athletes meaningfully engaged with their recovery in this context, as evidenced by their reported frequent and dynamic use of the self-regulatory skill. Further, juxtaposing the findings of these Articles indicated that the elite athletes engaged differently than the non-elite cyclists, which may indicate evidence of an expert advantage. As such, the collective evidence indicates that this representative task may be effectively used to study expertise in recovery. In Article 4, The collective evidence indicates that this representative task may be effectively used to study expertise in recovery. Still, Article 4 indicated only slight evidence that superior representative task performance (i.e., greater than expected recovery from workout 1 to workout 2) was associated with recovery skill use within a sample. The interdisciplinary nature of training and recovery means that further use and development of this representative task will benefit from consultation with experts in physiology on the validity of the workout contents and length of the inter-workout period. Such consultation may facilitate the observation of more direct evidence of performance recovery from one hard workout to the next. Further, recovery between two workouts likely represents but one aspect of recovery expertise. The varied meanings and timelines of recovery described in Article 1 indicate that future research should explore recovery expertise in additional contexts, such as across longer or more time-delayed timelines.

Method of Examination. I identified experience sampling methods as an appropriate method to examine recovery expertise in a controlled task because they allow momentary and naturalistic description of a phenomenon (Myin-Germeys & Kuppens, 2022). Article 1 indicated that athletes attributed meaning to recovery based on shifting contextual conditions. Article 2 detailed the skills and processes they used to negotiate those shifting conditions, which involved integrating knowledge of dispositional attributes (‘knowing my body’, ‘learning my body’) with momentary characteristics appraised in their current situation (‘listening to my body’, ‘respecting my body’). In Articles 3 and 4, I demonstrated how experience sampling methods can be used to describe perceived experiences and processes of recovery close to real-time (< 30 min delay). Experience sampling methods have been used to examine pre-competitive emotions and track post-concussive symptoms in sport research (Cerin & Barnett, 2011; Sufrinko et al., 2019), and to examine self-regulated learning in non-sport domains (e.g., Nett et al., 2012), but never to examine self-regulated learning or recovery in sport. A further merit of my method of examination related to the granularity of my sampling. Whereas time-course analyses of experience sampling data typically average values within a day to examine between-day trends (e.g., Nett et al., 2012), I leveraged the data afforded by frequent sampling to analyze patterns within and across several days (Articles 3, 4).

The use of experience sampling methods in Articles 3 and 4 provides an exciting platform on which further sport research may be developed. While it would require larger sample sizes, within-day analyses of sampling data could be integrated with continuously recorded data from wearable devices for a multi-dimensional perspective of recovery. Specifically, measures of recovery skills could be compared with physiological measures of one's recovery-stress state (e.g., heart rate variability; Vacher et al., 2023) to provide a more in-depth understanding of their bi-directional relationship. To support this expansion, future research should examine the scope, variety, and psychometric validity of the items used to assess recovery skills.

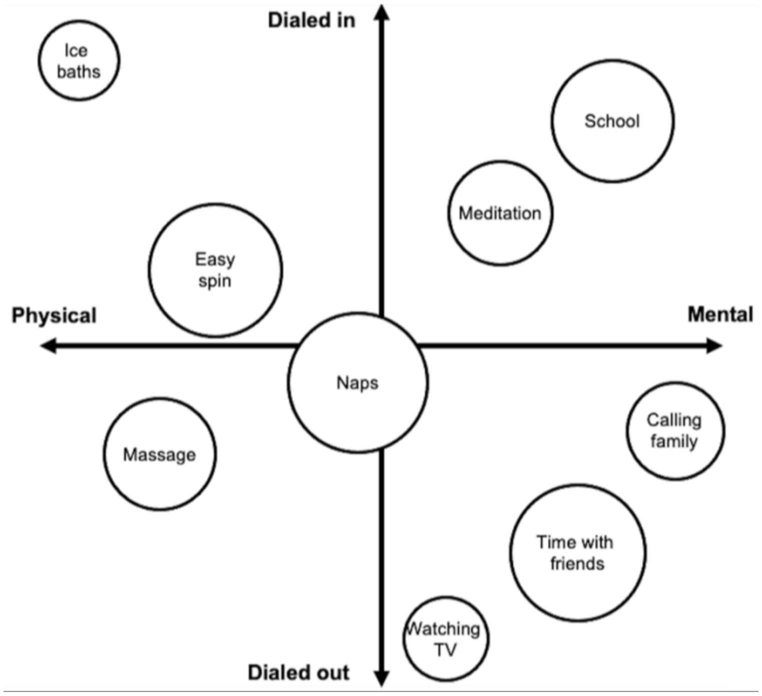
In addition to the suggested directions of development for the task and method of analysis, future studies of recovery expertise must consider the final facet of the OEA). Step 3 of the OEA, which was not directly addressed herein, involves examining the experiences and activities associated with the development over time of the psychological mechanisms underpinning expert performance (Ericsson & Smith, 1991). For example, Ericsson et al. (1993) found that differences in accumulated deliberate practice statistically predicted pianists' performance on representative tasks of piano-playing skill. While associations between skilled performance and the types of practice or learning activities that develop it may seem relatively evident, recent reviews indicate that this final step of the OEA is often neglected due to the difficulty in identifying and measuring appropriate activities specific to the development of certain skills (Baker et al., 2020; Young et al., 2021). In Article 2, elite endurance athletes described developing recovery competencies over their careers through a process of "trial and error", represented in the ARRM by the athlete-led skill of 'learning my body'. These accounts suggest that athletes may develop their recovery skills by engaging in some equivalent form of 'practice' or experimentation and refinement. Although it may be similarly (if not more) difficult to identify how athletes 'practice' recovery skills, future research should examine the activities that athletes use to develop recovery them.

Contributions to Applied Practice

This dissertation contributes an athlete-centered and skills-based understanding of recovery, which provides an alternative avenue for applied practitioners and sport organizations to address recovery with endurance athletes. Below, I describe three examples of how this understanding may influence efforts to support athletes.

In contrast to a modality-centered approach to recovery, an athlete-centered approach encourages athletes to discuss the experiences or outcomes they seek, and then find appropriate strategies to match. Practitioners can support this process by empowering athletes to develop a *personalized* inventory of strategies that they can readily draw on when needed. As an example, during debriefs after Phase 2 of data collection, I led athletes through an activity called "Cover the Map" where we used the three characteristics describing the breadth of recovery (Article 1) to create a 'map' of recovery options (Figure 2). I asked athletes to draw a large cross and label the opposite ends of the horizontal line as 'physical' and 'mental' dimensions, and the ends of the vertical line as 'dialed-out' and 'dialed-in' levels of focus. I then asked them to start placing their favourite recovery strategies in the appropriate quadrant of the 'map' (e.g., ice baths in the physical and dialed-in corner, hanging out with friends in the dialed-out and mental corner) and to draw a circle around each strategy according to its personal importance. Finally, I asked the athletes to reflect on their map: "How covered is your map?"; "Are you stronger in some areas than others?"; and "How easily accessible are each of these options to you?". This activity could be used at different periods of the year and for different contexts (e.g., home, training camp) to help athletes profile their relative strengths or areas in need of environmental support (see environmental influences in Article 2).

Figure 2. *A Sample Recovery Map*



This dissertation describes a skills-based understanding of recovery by detailing the processes athletes can use to actively shape and improve their recovery. Recovery is often discussed in medical and physiological texts in terms of its absence or inadequacy, and resulting negative consequences; for example, recovery monitoring is presented as an exercise in risk mitigation (Kellmann, 2010), recovery states are predictors of overtraining or burnout (Hooper et al., 1995), and recovery methods are tools of injury prevention (Brink & Lemmink, 2018). These perspectives are valid and useful, but they frame recovery primarily as an exercise in avoidance and overcoming deficits. A skills-based understanding frames recovery as an approach-oriented process of improving personal assets, similar to how other skills of training and competition might be viewed and discussed. Practitioners might therefore draw on strategies/tools they use to help athletes develop those other skills when addressing recovery with athletes. I do not mean to claim that ‘approach’ is always better than ‘avoidance’, but rather that equipping athletes and practitioners with the narrative flexibility to address recovery as a skill to be improved should help them adapt to a greater range of consulting contexts.

Together, athlete-centered and skills-based perspectives empower the athlete to own their recovery. In Article 1, athletes discussed how certain coaches use recovery as an avenue to exert control (malicious or not) outside of practice by prescribing activities and expectations that athletes ‘must’ follow. This narrative frames athletes as machines without agency, evaluated on their compliance (Denison et al., 2017). By framing recovery as a series of athlete-led skills, the results of this dissertation flip the narrative on recovery by re-distributing power to the athletes. The ARRM centers recovery on the learning and skills of the athlete, and surrounds and supports their efforts with the people and places in their environment. This descriptive model provides an initial framework that could be useful in terms of further organizational exploration. For example, instead of a national sport organization asking, “How well are athletes following our recovery guidance?”, they can ask, “How are we supporting or impeding the expressed recovery needs of our athletes?”.

Limitations and Future Directions

The findings of this dissertation are necessarily balanced by their limitations. Below I present limitations for the dissertation as a whole, alongside corresponding future directions.

Samples

Three of the four articles in this dissertation focused on endurance athletes competing at an elite level, which leaves unexplored the understanding of recovery and the skills it involves for other populations. Articles 1 and 2 were qualitative descriptions of the meanings and processes of recovery relevant to elite endurance athletes from nine, racing-based sports, thus it is unclear how athletes in other types of sports would identify with these descriptions. For example, experiences of recovery may differ for more skill-focused sports (e.g., archery) with less physical exertion, more interactive team sports (e.g., basketball) with different social dynamics, or even for other events within individual sports that involve different types of training (e.g., sprinting vs. endurance running).

The findings of Article 4 suggest that the athlete-led recovery skills of the ARRM may be generalized to non-elite competitive adult cyclists, all aged 25 and older. It is unclear how the ARRM and its constituent skills would manifest in younger athletes who may still be developing self-regulatory capacities more generally (McClelland et al., 2015). As such, future research should explore the meanings, processes, and skills of recovery in a wider variety of sports, skill levels, ages, and stages of development.

Articles 3 and 4 had respective sample sizes of 22 and 16 athletes, which were sufficient for the descriptive purposes of these studies but lacked the statistical power to make more specific predictions about certain relationships. The understanding of recovery self-regulation will benefit from larger, better-powered investigations.

Design

In this dissertation, I made preliminary inferences about the characteristics of recovery expertise based on comparisons between elite (Article 3) and non-elite (Article 4) samples. These inferences are common practice as part of Step 2 of the OEA (e.g., Ericsson et al., 1993), although they typically take place between groups within the same study. In this case, I compared findings between two separate studies, which featured slightly different designs. Specifically, in Article 3 the elite athletes engaged in two key workouts from their already-planned training that took place 48-72 hrs apart, whereas the key workouts in Article 4 were prescribed to the non-elite athletes and all took place 48 hrs apart. While these differences should not meaningfully alter the findings of this dissertation, future research should consider comparing recovery self-regulation skills between skill-level groups within the same study.

Measures

This dissertation focused on subjective measures for perceived recovery-stress states and the use of recovery self-regulation. While a critical realist perspective acknowledges that individuals experience and make sense of phenomena on an empirical level, it also encourages examination of the *actual* behaviours (e.g., observation of recovery-related actions) and *real* biological processes (e.g., biomarkers of recovery) underlying those perceptions. As such, future research on recovery skills should seek multi-disciplinary perspectives to incorporate the biological and physical processes in physiological recovery. The ARRM outlines four athlete-led skills of recovery self-regulation, each with further component processes, which are integrated with multiple environmental influences. In the interest of feasible research, Articles 3 and 4 only examined certain processes (i.e., awareness, checking-in, interpreting, adjusting) derived from two ARRM skills (‘listening to my body’ and ‘respecting my body’). Future research should examine the processes involved in ‘knowing my body’, in ‘learning my body’ over time, and those that connect the athlete-led processes with the influences of their environment.

Conclusion

Endurance athletes take part in large volumes of high-quality training, which requires corresponding recovery. Despite its importance, recovery has not been examined for characteristics of expert performance—i.e., skills of recovery that athletes could systematically leverage for a consistent expert performance advantage. One reason for this gap may be that recovery is often framed in terms of monitoring processes or modalities used by practitioners, not as a property of the athlete. The purpose of this dissertation was to answer, "What might it mean for an endurance athlete to be *skilled* at recovery?", by describing the psychology of recovery in relation to sport expertise.

In Article 1, I described how elite endurance athletes drew from a wide variety of potential approaches to define recovery in a given time and context according to the goals, experiences, and priorities it addressed. In Article 2, I described how these athletes implemented recovery to fulfill those meanings using four skills of recovery self-regulation, which were influenced and supported by the people and places in their environment, as described in the Athlete Recovery Regulation Model. Together, these two Articles outline an athlete-centered and skills-based understanding of recovery that may provide a foundation for future research grounded in the perspectives of the athletes who engage in it.

In Articles 3 and 4, I found that elite and non-elite endurance athletes engaged frequently and dynamically in synergistic yet unique processes representing components of the ARRM skills of 'listening' and 'respecting'. The elite athletes (Article 3) engaged in greater recovery self-regulation when experiencing states of higher states of multidimensional stress and (to a lesser extent) lower perceived recovery, as opposed to timelines around the key workouts. In contrast, the non-elite sample (Article 4) reported self-regulatory patterns that appeared simpler and more reactive to workout 1. Together, these Articles suggest that elite and non-elite endurance athletes alike identify and engage with the examined ARRM processes, although in differing patterns that may be characteristic of an expert recovery advantage. Moreover, Article 4 provides a proof of concept that recovery can be examined as a skill in a traditional expertise paradigm.

Overall, athletes locate themselves at the center of recovery, with the agency and responsibility to engage in recovery processes that deliver the recovery outcomes they seek. The results of this dissertation present recovery as a set of athlete-led skills that athletes can own and hone to improve their recovery, and, hopefully, by extension their long-term training and performance outcomes. As opposed to directly enhancing expert performance in competition, this work represents an initial step in describing recovery as a set of skills that may potentially enhance the *development* of expertise in sport. Further research is required to expand and assess the conceptual understanding of recovery skills, and to evaluate how best to translate this information to athletes.

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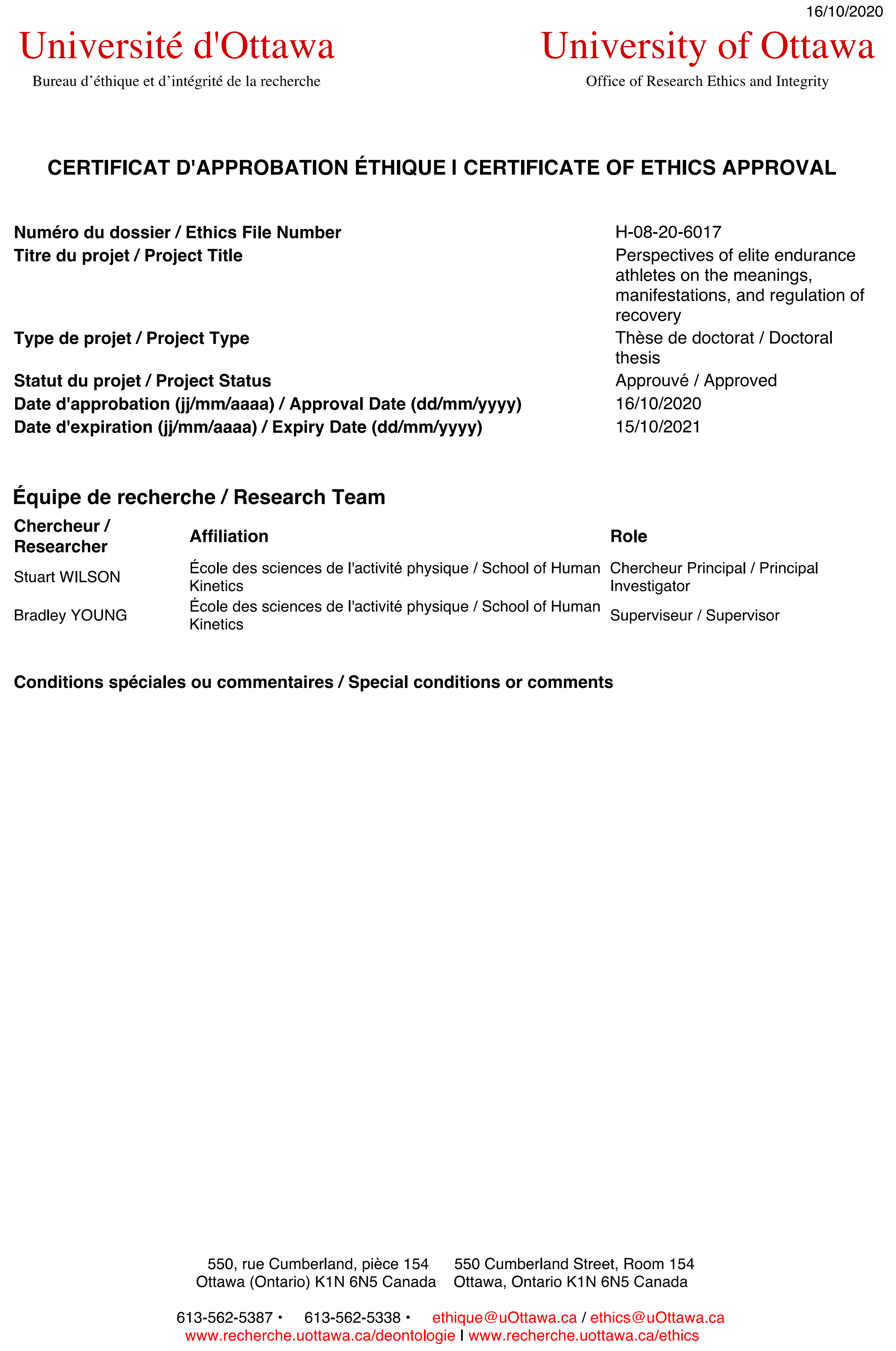
Appendix A: Articles 1 & 2 – Ethics Approval



16/10/2020

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CERTIFICAT D'APPROBATION ÉTHIQUE I CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number	H-08-20-6017
Titre du projet / Project Title	Perspectives of elite endurance athletes on the meanings, manifestations, and regulation of recovery
Type de projet / Project Type	Thèse de doctorat / Doctoral thesis
Statut du projet / Project Status	Approuvé / Approved
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	16/10/2020
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	15/10/2021

Équipe de recherche / Research Team

Chercheur / Researcher	Affiliation	Role
Stuart WILSON	École des sciences de l'activité physique / School of Human Kinetics	Chercheur Principal / Principal Investigator
Bradley YOUNG	École des sciences de l'activité physique / School of Human Kinetics	Superviseur / Supervisor

Conditions spéciales ou commentaires / Special conditions or comments

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www.recherche.uottawa.ca/deontologie I www.recherche.uottawa.ca/ethics

16/10/2020

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Le Comité d'éthique de la recherche (CÉR) de l'Université d'Ottawa, opérant conformément à l'*Énoncé de politique des Trois conseils* (2014) et toutes autres lois et tous règlements applicables, a examiné et approuvé la demande d'éthique du projet de recherche ci-nommé.

L'approbation est valide pour la durée indiquée plus haut et est sujette aux conditions énumérées dans la section intitulée “Conditions Spéciales ou Commentaires”. Le formulaire « Renouvellement ou Fermeture de Projet » doit être complété quatre semaines avant la date d'échéance indiquée ci-haut afin de demander un renouvellement de cette approbation éthique ou afin de fermer le dossier.

Toutes modifications apportées au projet doivent être approuvées par le CÉR avant leur mise en place, sauf si le participant doit être retiré en raison d'un danger immédiat ou s'il s'agit d'un changement ayant trait à des éléments administratifs ou logistiques du projet. Les chercheurs doivent aviser le CÉR dans les plus brefs délais de tout changement pouvant augmenter le niveau de risque aux participants ou pouvant affecter considérablement le déroulement du projet, rapporter tout évènement imprévu ou indésirable et soumettre toute nouvelle information pouvant nuire à la conduite du projet ou à la sécurité des participants.

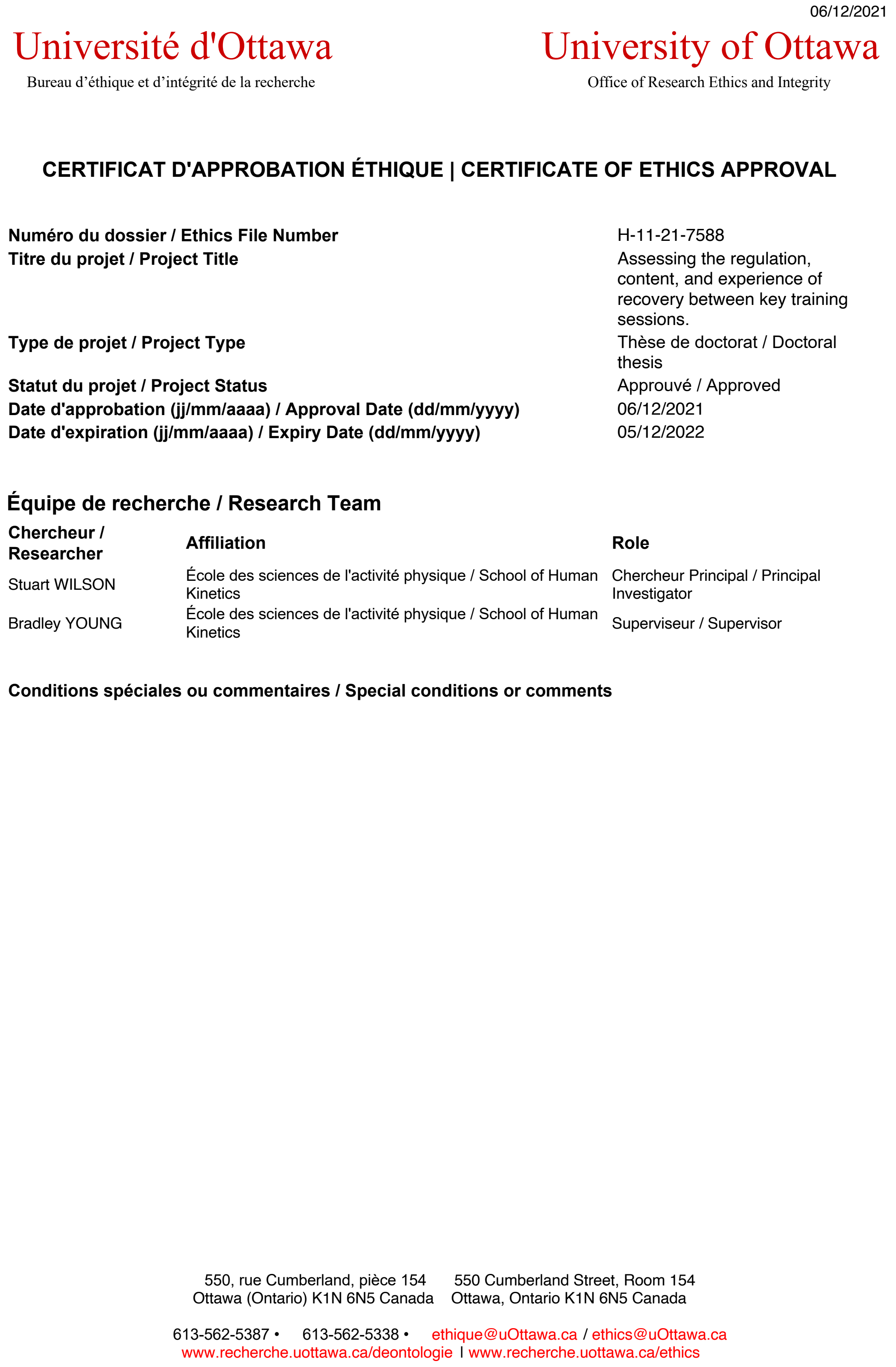
The University of Ottawa Research Ethics Board, which operates in accordance with the *Tri-Council Policy Statement* (2014) and other applicable laws and regulations, has examined and approved the ethics application for the above-named research project.

Ethics approval is valid for the period indicated above and is subject to the conditions listed in the section entitled “Special Conditions or Comments”. The “Renewal/Project Closure” form must be completedfour weeks before the above-referenced expiry date to request a renewal of this ethics approval or closure of the file.

Any changes made to the project must be approved by the REB before being implemented, except when necessary to remove participants from immediate endangerment or when the modification(s) only pertain to administrative or logistical components of the project. Investigators must also promptly alert the REB of any changes that increase the risk to participant(s), any changes that considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project or the safety of the participant(s).

Germain ZONGO
Responsable d'éthique en recherche / Protocol Officer
Pour/For **Daniel LAGAREC** Président(e) du/ Chair of the **Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board**

Appendix B: Article 3 – Ethics Approval



06/12/2021

Université d'Ottawa
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University of Ottawa
Office of Research Ethics and Integrity

CERTIFICAT D'APPROBATION ÉTHIQUE | CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number	H-11-21-7588
Titre du projet / Project Title	Assessing the regulation, content, and experience of recovery between key training sessions.
Type de projet / Project Type	Thèse de doctorat / Doctoral thesis
Statut du projet / Project Status	Approuvé / Approved
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	06/12/2021
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	05/12/2022

Équipe de recherche / Research Team

Chercheur / Researcher	**Affiliation**	**Role**
Stuart WILSON	École des sciences de l'activité physique / School of Human Kinetics	Chercheur Principal / Principal Investigator
Bradley YOUNG	École des sciences de l'activité physique / School of Human Kinetics	Superviseur / Supervisor

Conditions spéciales ou commentaires / Special conditions or comments

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06/12/2021

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University of Ottawa
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Le Comité d'éthique de la recherche (CÉR) de l'Université d'Ottawa, opérant conformément à l'*Énoncé de politique des Trois conseils* (2014) et toutes autres lois et tous règlements applicables, a examiné et approuvé la demande d'éthique du projet de recherche ci-nommé.

L'approbation est valide pour la durée indiquée plus haut et est sujette aux conditions énumérées dans la section intitulée "Conditions Spéciales ou Commentaires". Le formulaire « Renouvellement ou Fermeture de Projet » doit être complété quatre semaines avant la date d'échéance indiquée ci-haut afin de demander un renouvellement de cette approbation éthique ou afin de fermer le dossier.

Toutes modifications apportées au projet doivent être approuvées par le CÉR avant leur mise en place, sauf si le participant doit être retiré en raison d'un danger immédiat ou s'il s'agit d'un changement ayant trait à des éléments administratifs ou logistiques du projet. Les chercheurs doivent aviser le CÉR dans les plus brefs délais de tout changement pouvant augmenter le niveau de risque aux participants ou pouvant affecter considérablement le déroulement du projet, rapporter tout évènement imprévu ou indésirable et soumettre toute nouvelle information pouvant nuire à la conduite du projet ou à la sécurité des participants.

The University of Ottawa Research Ethics Board, which operates in accordance with the *Tri-Council Policy Statement* (2014) and other applicable laws and regulations, has examined and approved the ethics application for the above-named research project.

Ethics approval is valid for the period indicated above and is subject to the conditions listed in the section entitled "Special Conditions or Comments". The "Renewal/Project Closure" form must be completedfour weeks before the above-referenced expiry date to request a renewal of this ethics approval or closure of the file.

Any changes made to the project must be approved by the REB before being implemented, except when necessary to remove participants from immediate endangerment or when the modification(s) only pertain to administrative or logistical components of the project. Investigators must also promptly alert the REB of any changes that increase the risk to participant(s), any changes that considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project or the safety of the participant(s).

Riana MARCOTTE
Responsable d'éthique en recherche / Protocol Officer
Pour/For **Daniel LAGAREC** Président(e) du/ Chair of the **Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board**

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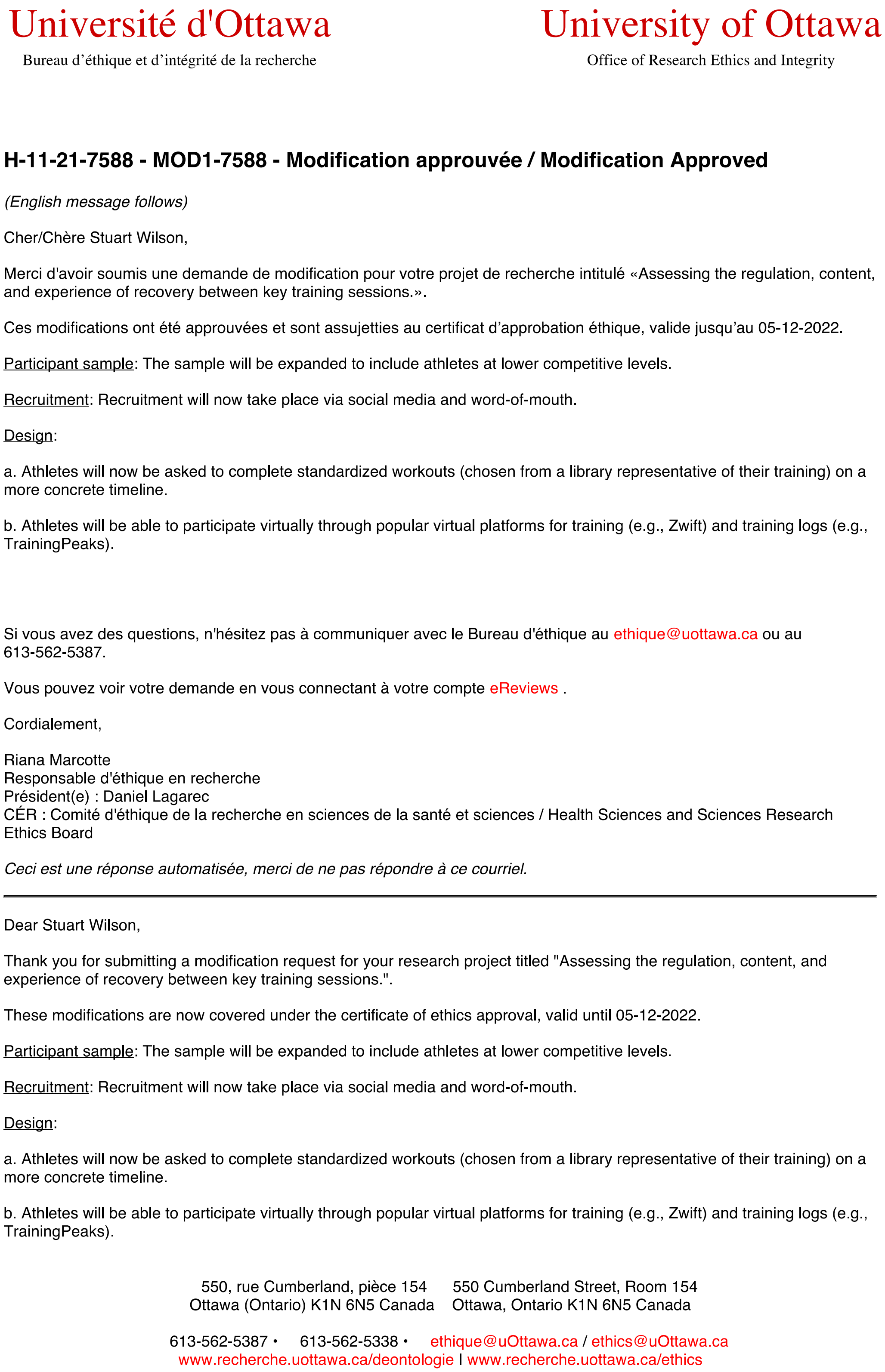
www.recherche.uottawa.ca/deontologie I www.recherche.uottawa.ca/ethics

Appendix C: Article 4 – Ethics Approval



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University of Ottawa
Office of Research Ethics and Integrity

H-11-21-7588 - MOD1-7588 - Modification approuvée / Modification Approved

(English message follows)

Cher/Chère Stuart Wilson,

Merci d'avoir soumis une demande de modification pour votre projet de recherche intitulé «Assessing the regulation, content, and experience of recovery between key training sessions.».

Ces modifications ont été approuvées et sont assujetties au certificat d'approbation éthique, valide jusqu'au 05-12-2022.

Participant sample: The sample will be expanded to include athletes at lower competitive levels.

Recruitment: Recruitment will now take place via social media and word-of-mouth.

Design:

a. Athletes will now be asked to complete standardized workouts (chosen from a library representative of their training) on a more concrete timeline.

b. Athletes will be able to participate virtually through popular virtual platforms for training (e.g., Zwift) and training logs (e.g., TrainingPeaks).

Si vous avez des questions, n'hésitez pas à communiquer avec le Bureau d'éthique au ethique@uottawa.ca ou au 613-562-5387.

Vous pouvez voir votre demande en vous connectant à votre compte eReviews .

Cordialement,

Riana Marcotte
Responsable d'éthique en recherche
Président(e) : Daniel Lagarec
CÉR : Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board

Ceci est une réponse automatisée, merci de ne pas répondre à ce courriel.

Dear Stuart Wilson,

Thank you for submitting a modification request for your research project titled "Assessing the regulation, content, and experience of recovery between key training sessions.".

These modifications are now covered under the certificate of ethics approval, valid until 05-12-2022.

Participant sample: The sample will be expanded to include athletes at lower competitive levels.

Recruitment: Recruitment will now take place via social media and word-of-mouth.

Design:

a. Athletes will now be asked to complete standardized workouts (chosen from a library representative of their training) on a more concrete timeline.

b. Athletes will be able to participate virtually through popular virtual platforms for training (e.g., Zwift) and training logs (e.g., TrainingPeaks).

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www.recherche.uottawa.ca/deontologie I www.recherche.uottawa.ca/ethics

If you have any questions, please contact the Ethics Office at ethics@uottawa.ca or 613-562-5387.

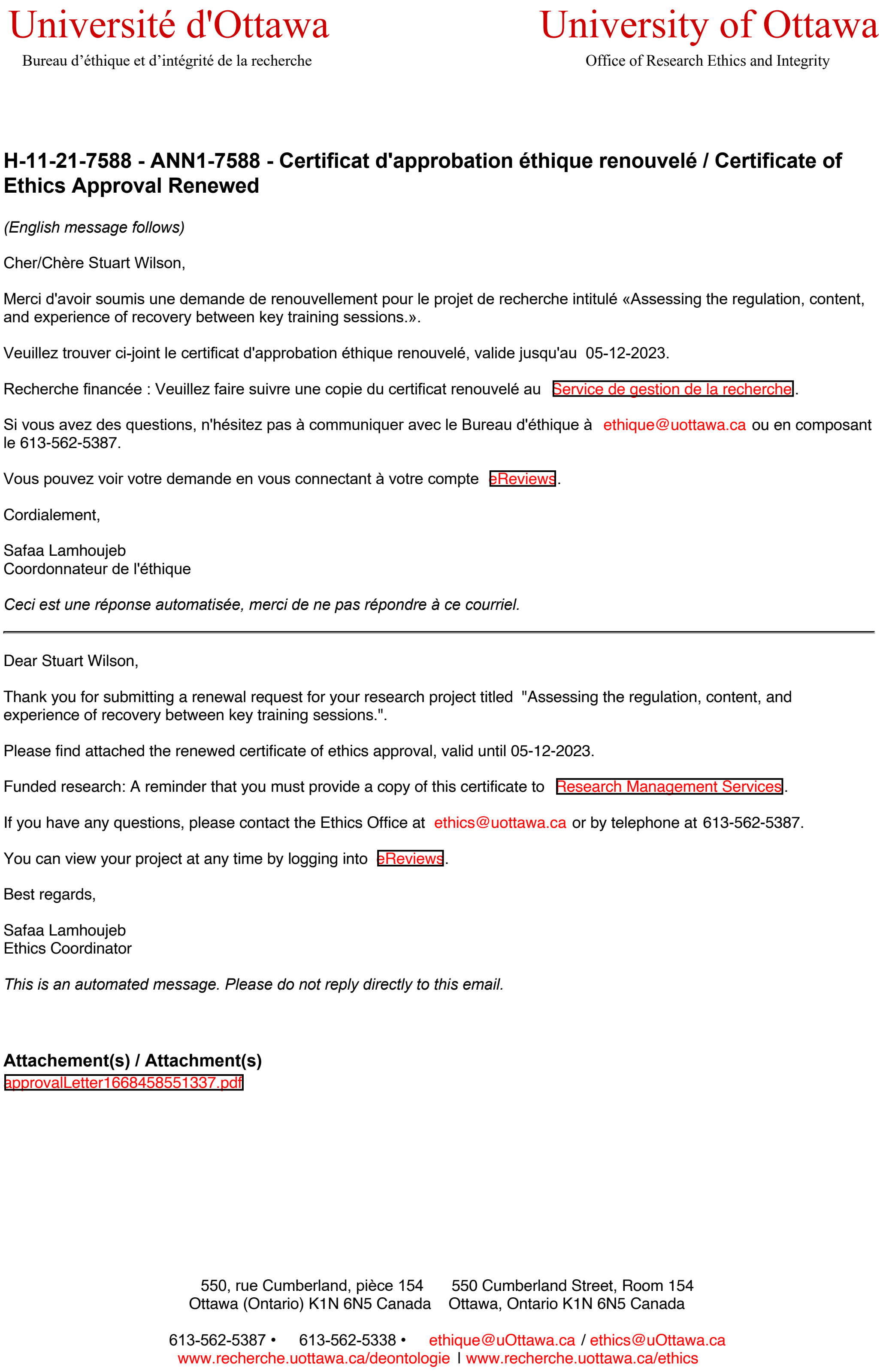
You can view your project at any time by logging into eReviews .

Best regards,

Riana Marcotte
Protocol Officer
Chair: Daniel Lagarec
REB: Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board

This is an automated message. Please do not reply directly to this email.

Attachement(s) / Attachment(s)



Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

H-11-21-7588 - ANN1-7588 - Certificat d'approbation éthique renouvelé / Certificate of Ethics Approval Renewed

(English message follows)

Cher/Chère Stuart Wilson,

Merci d'avoir soumis une demande de renouvellement pour le projet de recherche intitulé «Assessing the regulation, content, and experience of recovery between key training sessions.».

Veuillez trouver ci-joint le certificat d'approbation éthique renouvelé, valide jusqu'au 05-12-2023.

Recherche financée : Veuillez faire suivre une copie du certificat renouvelé au Service de gestion de la recherche.

Si vous avez des questions, n'hésitez pas à communiquer avec le Bureau d'éthique à ethique@uottawa.ca ou en composant le 613-562-5387.

Vous pouvez voir votre demande en vous connectant à votre compte eReviews.

Cordialement,

Safaa Lamhoujeb
Coordonnateur de l'éthique

Ceci est une réponse automatisée, merci de ne pas répondre à ce courriel.

Dear Stuart Wilson,

Thank you for submitting a renewal request for your research project titled "Assessing the regulation, content, and experience of recovery between key training sessions.".

Please find attached the renewed certificate of ethics approval, valid until 05-12-2023.

Funded research: A reminder that you must provide a copy of this certificate to Research Management Services.

If you have any questions, please contact the Ethics Office at ethics@uottawa.ca or by telephone at 613-562-5387.

You can view your project at any time by logging into eReviews.

Best regards,

Safaa Lamhoujeb
Ethics Coordinator

This is an automated message. Please do not reply directly to this email.

Attachement(s) / Attachment(s)
approvalLetter1668458551337.pdf

550, rue Cumberland, pièce 154 550 Cumberland Street, Room 154
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada

613-562-5387 • 613-562-5338 • ethique@uOttawa.ca / ethics@uOttawa.ca
www.recherche.uottawa.ca/deontologie I www.recherche.uottawa.ca/ethics

Appendix D: Articles 1 & 2 – Initial Consent Form

[Presented online through SurveyMonkey as first page of screening survey]
Athlete Questionnaire Consent Form

Title of the study: Perspectives of elite endurance athletes on the meanings, manifestations, and regulation of recovery

Principal investigator:
Stuart Wilson, PhD(c), School of Human Kinetics, Faculty of Health Sciences, University of Ottawa,
Phone: [redacted]
Email: [redacted]

Project supervisor:
Bradley W. Young, Ph.D., Full Professor, School of Human Kinetics, Faculty of Health Sciences, University of Ottawa, [redacted]
Email: [redacted]

You are invited to participate in a research study conducted by Stuart Wilson, Ph.D.(c) and Dr. Bradley Young, Ph.D., which seeks to explore the concept of recovery, as part of Mr. Wilson's Ph.D. dissertation.

Purpose of the Study: To describe the concept of recovery (from training) according to the perspectives of elite endurance-athletes, by interpreting what athletes say recovery means, how they say they experience it, and how athletes describe their activities and strategies in implementing and managing their recovery.

Participation: We are looking to recruit elite athletes, 18 years of age or older, who compete in an endurance sport from the Olympic family of sports and who have participated in at least one Olympics or Senior World Championships in the previous three years. You will be asked to complete a demographic questionnaire (5-10 minutes in length, in English) covering basic information about your age, gender, past sport participation and performance. Response to this questionnaire will be used to inform the selection of participants for subsequent interviews. Inclusion in these interviews will be based on ensuring variability across, gender, age, and sport to maximize the diversity of opinions, as well as those who respond earlier during recruitment. All questionnaire respondents will be contacted (using an email they provide in the questionnaire) to notify them of whether they are invited for continued participation in this study. For those who continue, they will be invited to participate in two interviews about how they recover from sport, separated a week apart, during which they complete an activity journal. Participants who are invited to continue will be provided with a letter of informed consent prior to the first interview.

Benefits: Participation in this study will greatly improve our understanding of what recovery is, and the details of its implementation. This area of research and practice is largely informed by academics and practitioners, and is missing the voices and perspectives of athletes. The information you provide will be used to create an athlete-informed definition and conceptualization of recovery that will inform how athletes can learn to optimize their recovery to improve training.

Risks: Participating in the interviews (should you be selected) will involve discussing your opinions on recovery and stress, as well as what you do to recover and cope with stress. There is a possibility that these topics, may make you feel uncomfortable or embarrassed. Should you experience any types of discomfort as a result, The Canadian Sport Helpline is a confidential listening and referral service for athletes wishing to share or obtain information about anything from dealing with stresses, to abuse, harassment, or discrimination in sport. Operated by the Canadian Centre for Mental Health and Sport, this line connects you with a team of practitioners with expertise in counselling, psychology, and sport. The toll-free Helpline is available from 8 a.m. to 8 p.m. (Eastern Time), seven days per week by telephone or text message at: 1-888-83SPORT or 1-888-837-7678. Alternatively, participants may contact the Mental Health Helpline at 1-866-531-2600 and on-line at http://www.mentalhealthhelpline.ca/.

Confidentiality and anonymity: Should you agree to participate, the information you provide will remain entirely confidential. Throughout the study, you are not required to respond to any questions or share any information that you would not like to. If you participate in interviews, any information you provide will be anonymized and grouped alongside others so as not to make any one participant accentuated or identifiable. Responses from those not selected for interviews will not be included in any research reports. All contact will be made through the email address that you provide, which will only be accessible to the principal investigator, and used for the purposes of this study. Participation is private, meaning your coaches and teammates will not receive any information about whether you participate or not, or about any of the information you provide. In order to minimize the risk of security breaches and to help ensure your confidentiality we recommend that you use standard safety measures such as signing out of your account, closing your browser and locking your screen or device when you are no longer using them / when you have completed the study.

Conservation of data: Electronic data, including consent forms and questionnaire responses, will be stored on a secure, password-protected computer. If you are not selected for subsequent interviews, the data you provide in your demographic questionnaire will be destroyed securely. If you are selected for subsequent interviews, your data will be kept for a period of 10 years, after which it will be destroyed (i.e., deleted or shredded).

Voluntary Participation: You are under no obligation to participate. If you choose to participate, you can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If you choose to withdraw by notifying one of the investigators, all data gathered until that point will destroyed, unless you indicate that it should be kept.

Prospective participants are encouraged to save and/or print a copy of this consent form for their own records.

Acceptance: I agree to voluntarily participate in this study, and acknowledge that I have been informed of the nature of the research, and recognize that now and at any time I can contact the investigators below if I have any questions.

I recognize that should I have any questions regarding the ethical conduct of this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street,
Room 154, Ottawa, ON K1N 6N5
Tel.: (613) 562-5387
Email: ethics@uottawa.ca

By clicking the *NEXT* link in the survey, I am indicating my informed consent to participate in this questionnaire.

Appendix E: Articles 1 & 2 – Screening Survey

Section 1 – Consent Form

(The athlete consent form [i.e., Appendix D] appeared on page 1 of this screening survey, preceding all following questions)

Section 2 – Demographics

First, could you please provide the following demographic information:

1. Age: [*dropdown menu*]
2. Gender [*multiple choice*]
    a. Man
    b. Woman
    c. I identify as...
        i. [*open text box*]

Section 3 – Sport Type

We are looking to speak with athletes training and competing in endurance sports, primarily in events lasting longer than 75 seconds. Below are some examples:

Sports included	Disciplines included	Events included
Athletics	Race-walking, Running (e.g., Track, Road, Cross-country)	800m and up
Biathlon	Skate and Classic	Super sprint and up
Sprint Canoe/Kayak	Canoe (C1, C2, C4) and Kayak (K1, K2, K4)	500m and up
Cycling	Mountain, Road, Track	Endurance events
Nordic skiing	Skate and Classic	Sprint and up
Rowing	All boats (One-, Two-, Four-, and Eight-person, both Scull and Sweep)	2000m
Speed skating	Long-track and Short-track	1500m and up
Swimming	Marathon and pool, All strokes	200m and up
Triathlon	Draft (e.g., Olympic), Non-draft (e.g., Ironman)	Sprint and up

1. What is your main sport? If applicable, please also list your main event(s) in that sport.
    - *[open text box]*
2. Does your main sport (and main event) fit the criterion as an endurance sport? (i.e., about 75 seconds or longer in duration). [*multiple choice*]
    - Yes
    - No
    - Maybe *[open ended textbox]*

3. How long (in approximate years/months) have you been training competitively for this sport? [*open text box*]
4. What is your current level of training, compared to what is normal for you during this phase of the training year? [*three choice scale for each*]
    - Training volume: Greater than usual / More or less normal / Less than usual
    - Training intensity: Greater than usual / More or less normal / Less than usual

Section 4 – National Team Participation

We would like to know a little bit about your history as a National Team athlete.

- What it means to be a "National Team athlete" changes from sport to sport, but might include:
    - Receiving funding through Sport Canada's Athlete Assistance Program (AAP)
        - i.e., being a "carded" athlete
    - Being selected to compete for your national team in an international championship/competition
- If you have not continuously been a national team member, feel free to note to these interruptions (i.e., when you were/weren't a member, for how long, etc.).
- If it's easier to write which years you were on the national team (instead of answering "how long"), feel free to answer that way.

1. How long (years/months) have you been a member of a national team? For this question, include all teams, such as junior, development, U23, senior, etc.
    - [*open text box*]
2. How long (years/months) have you been a member of a SENIOR national team?
    - [*open text box*]

Section 5 – Championship Participation

We are looking to recruit elite athletes, 18 years of age or older, who compete in a sport from the Olympic family of sports and who have participated in at least one Olympics or Senior World Championships in the previous two years.

1. Have you participated in at least one Olympics/Senior World Championships in 2018 or 2019?
    - Yes
    - No
    - I'm unsure... [*open textbox*]
2. In the series of open-ended text boxes, please type each of the Olympic and/or Senior World Championship competitions that you have attended, the month and year for each, and the competitive event(s) you participated in.
    - Example 1: Track and Field Worlds, October 2019, 5000m run
    - Example 2: Beijing Olympics, July 2008, C1 1000m and C2 1000m

- You do NOT need to fill all the boxes if you haven't been to 20 Olympic and/or Senior World Championships. If you've been to more than 20, feel free to double up within boxes.
- [*20 open text boxes*]

Section 6 – Contact Information

As mentioned before, we will be selecting participants to interview based on: 1) those who meet the criteria for sport type and competition experience; 2) maximum variability across sport, gender, and age; and 3) on somewhat of a first come, first serve basis.

The next step in this study is to provide your email so that, should you be selected to participate, the principal investigator (Stuart Wilson) can contact you to make arrangements. Please note that this email will only be used to make arrangements for interviews, or for notifying you if you have not been selected, and will not be used for any other purpose. If you are not selected for subsequent interviews, we will securely destroy the information you provided herein.

Email address: [*open text box*]

Thank you for agreeing to participate in this research! Please click on SUBMIT to finish, and Stuart will contact you shortly.

Appendix F: Articles 1 & 2 – Pre-Interview Consent Form

[Consent form emailed to participants before the interviews, and then shown on-screen while they are asked to read off the line indicating their informed consent (in italics)]

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de la santé
Pavillon Roger-Guindon

Faculty of Health Sciences
Roger Guindon Hall
☎ 613-562-5800 (5603)
613-562-5437
sante.uOttawa.ca
health.uOttawa.ca
451 Smyth
Ottawa ON K1H 8M5
Canada

Athlete Interview Consent Form

Title of the study: Perspectives of elite endurance athletes on the meanings, manifestations, and regulation of recovery

Principal investigator:
Stuart Wilson, PhD(c), School of Human Kinetics, Faculty of Health Sciences, University of Ottawa, Phone: REDACTED.
Email: REDACTED

Project supervisor:
Bradley W. Young, Ph.D., Full Professor, School of Human Kinetics, Faculty of Health Sciences, University of Ottawa, Ph: REDACTED.
Email: REDACTED.

You are invited to participate in a research study conducted by Stuart Wilson, Ph.D.(c) and Dr. Bradley Young, Ph.D., which seeks to explore the concept of recovery, as part of Mr. Wilson's Ph.D. dissertation.

Purpose of the Study: To describe the concept of recovery (from training) according to the perspectives of elite endurance-athletes, by interpreting what athletes say recovery means, how they say they experience it, and how athletes describe their activities and strategies in implementing and managing their recovery.

Participation: You are being invited to participate in the second phase of this study based on your responses to the initial demographic questionnaire you completed. We are looking to recruit elite athletes, 18 years of age or older, who compete in an endurance sport from the Olympic family of sports and who have participated in at least one Olympics or Senior World Championships in the previous two years. Invitations have been based on ensuring variability across, gender, age, and sport to maximize the diversity of opinions, and have been extended to those who responded to the demographic questionnaire earlier during.

Phase two involves participating in two 60-90-minute interviews with the principal investigator, conducted in English. Interviews will take place virtually over Zoom, and will be audio-recorded so that they can be analyzed at a later date. During these interviews you will be asked to discuss your perspectives on what recovery means, how you recover, and how you manage different aspects and strategies of your recovery. The two interviews will take place seven days apart (at a place and time of day of your choosing). At the end of the first interview, the principal investigator will introduce you to an activity journal, which you will be asked to complete for seven consecutive days, leading up to the second interview. You will be asked to make general notes in the journal about what you did over the course of the day, along with any details about feelings of stress or recovery that go along with those activities. This activity should take 15-20 minutes to complete each day. You will be asked to bring this journal to the second interview, to share what you have journaled with the interviewer, who will use it to prompt discussion to explore how you organize your recovery. After both interviews are complete, you will be sent a copy of the interview transcripts in case you would like to review and comment on them.

Benefits: Participation in this study will greatly improve our understanding of what recovery is, and the details of its implementation. This area of research and practice is largely informed by academics and practitioners, and is missing the voices and perspectives of athletes. The information you provide will be used to create an athlete-informed definition and conceptualization of recovery that will inform how athletes can learn to optimize their recovery to improve training.

Risks: Participating in the interviews will involve discussing your opinions on recovery and stress, as well as what you do to recover and cope with stress from hard training. There is a possibility that these topics, as well as discussion of comments you have noted in your activity journal, may make you feel uncomfortable or embarrassed. Should you experience any types of discomfort as a result, The Canadian Sport Helpline is a confidential listening and referral service for athletes wishing to share or obtain information about anything from dealing with stresses, to abuse, harassment, or discrimination in sport. Operated by the Canadian Centre for Mental Health and Sport, this line connects you with a team of practitioners with expertise in counselling, psychology, and sport. The toll-free Helpline is available from 8 a.m. to 8 p.m. (Eastern Time), seven days per week by telephone or text message at: 1-888-83SPORT or 1-888-837-7678. Alternatively, participants may contact the Mental Health Helpline at 1-866-531-2600 and on-line at http://www.mentalhealthhelpline.ca/. A copy of your transcript will be sent to the email that you provide for scheduling interviews, which may expose your transcript to the risks inherent in sending an unprotected document via email.

Confidentiality and anonymity: Should you agree to participate, the information you provide will remain entirely confidential. Throughout the study, you are not required to respond to any questions or share any information that you would not like to. All participants will be given pseudonyms in the written findings from the study so that any published data does not include identifiable information. Findings will be presented in group form, meaning for at least eight interviewees collectively, so as not to accentuate information from any one participant. All contact will be made through the email address that you provide, which will only be accessible to the principal investigator, and used for the purposes of this study. Participation is private, meaning your coaches and teammates will not receive any information about whether you participate or not, or about any of the information you provide. While being interviewed online or over the phone, someone around you may overhear what you are saying. It is therefore important to plan carefully for the interview in a location that provides you with a minimum of privacy.

Conservation of data: Electronic data, including consent forms, questionnaire responses, activity journals completed electronically, interview audio recordings and transcripts, will be stored on a secure, password-protected computer. All data will be kept for a period of 10 years, after which it will be destroyed (i.e., deleted or shredded).

Voluntary Participation: You are under no obligation to participate. If you choose to participate, you can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If you choose to withdraw by notifying one of the investigators, all data gathered until that point will destroyed, unless you indicate that it should be kept.

Prospective participants are encouraged to save and/or print a copy of this consent form for their own records.

Acceptance: Consent to participate in this study will be recorded verbally. If you agree to participate, please state the following aloud:

I agree to voluntarily participate in this study, and acknowledge that I have been informed of the nature of the research, and recognize that now and at any time I can contact the investigators below if I have any questions.

I recognize that should I have any questions regarding the ethical conduct of this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5
Tel.: (613) 562-5387
Email: ethics@uottawa.ca

Appendix G: Articles 1 & 2 – Interview 1 Guide

[*Below is the interview guide used for interview 1. It has been lightly edited to remove tertiary follow-up questions (e.g., "Can you provide an example of that?")*]

Introductory script: *This interview is the first of two which will explore your perspectives on recovery from training. Today we'll focus on understanding what recovery means to you, and how you go about it. The second interview, which we've scheduled for a week from now, will focus on the factors that go into managing recovery in your life. Between the interviews you'll fill out a brief journal to loosely track your activities over the week for the purpose of giving us some context to work from in the second interview.*

I really want to thank you for agreeing to do these interviews. No one really takes the opportunity to ask athletes about their opinions on this topic, so I'd really like to hear your personal experience. That may agree with what you've been told or what you hear others say; it may disagree. But because it's your experience, there are no right or wrong responses in this interview. What's right is what matters to you and what you find meaningful as an athlete.

Opening Questions

1. Can you tell me a bit about your history as an athlete?
    a. When and how did you get into [main sport]?
    b. When did you start training seriously for this sport?

2. Can you tell me about the training you do now?
    a. How hard are you training right now? [this week]
    b. Can you describe hard training to me?
        i. What does it mean to train hard?
        ii. What does it feel like?

Main Questions

We're operating under the premise that hard training takes recovery. Obviously recovery can refer to many things - When I say recovery, I'm not talking about returning to play from a huge catastrophic injury, or a mental health crisis or eating disorder. I'm talking more about recovery in the context of your improvement as an athlete, so that day-to-day or week-to-week experience.

1. With that in mind, what does recovery mean to you as an athlete?
    a. How would you, in your opinion, define recovery?

2. Why do you, as an athlete, recover?
    a. What is the purpose of recovery, or the purposes of recovery?

3. How important is recovery to your success as an athlete?
    a. Why is (isn't) recovery important to you as an athlete?

4. How do you know when you're recovered? (What does it mean to be recovered?)
    a. What does it feel like to be recovered? To not be recovered?
        i. Are there certain emotions?

        ii. What does your body feel like?
        iii. What is your mind like?
        iv. Are there different levels or gradients to this feeling?
    b. What do you like (or not like) about feeling recovered?

5. How do you like to recover?
    a. What are the most important forms of recovery for you?
    b. You've talked about recovery as doing (not doing) things; can it also involve not doing (doing) things?
    c. Is there a certain feeling associated with recovery?
    d. Are there stages to recovery?

6. What other forms of recovery are important to you?
    a. How else do you recover/ take a break / unwind / regenerate? (Use their words)

7. We've talked about recovery as a process you do or don't do, and we've also talked about recovery as a state you're trying to reach. Does one of those click better for you?
    a. Is recovery more about chasing a feeling or state, or is more about going through a specific process?

8. Are other people important for your recovery?
    a. What role do other people play?

Concluding Questions

1. Is there anything you feel that I have missed, or anything else you would like to comment upon?

Closing script: *Thank you for your time today. Our next interview will be seven days, where we'll review the activity log that you'll keep for the next week.*
[End Interview – Discuss instructions for activity diary]

Appendix H: Articles 1 & 2 – Interview 2 Guide

[Below is the interview guide used for interview 2. It has been lightly edited to remove tertiary follow-up questions (e.g., "Can you provide an example of that?")]

Introductory script: *Thank you for taking the time to sit down with me again. The purpose of this interview is to understand how your recovery is organized and implemented. First, we're going to review some of your answers from the last interview, just to get on the same page again. Then we're going to use the activity journal you kept over the past week to discuss the when, where, who and how of your recovery.*

Member Reflection

1. Last week you generally defined recovery as [share screen and read summary of their definition of recovery]. How do you feel about that definition now – is there anything you would add or change?

Opening Questions

2. Broadly speaking, how have you been over the past week?
    a. Has the past week been more or less stressful than usual? How come?

3. How has your training gone over the past week?
    a. How did it compare to usual? [volume, intensity, outcomes, feelings]

4. Using the activity journal, can you give me a rough outline of the past week?
    a. What were your major training-related events?
    b. What were the major events in your life outside of training?

Main Questions

Throughout the interview, feel free to come back the activity journal to give examples, even if that means comparing or contrasting with whatever you wrote in the activity journal.

1. Is recovery a priority for you? (Is it meaningful/important to you?)
    a. What determines how important recovery is?
        i. [Follow-up on feelings, thoughts, behaviours]

2. When is recovery a priority for you? (Are there conditions or times when it's more important/meaningful?)
    a. Can you show me an example in the journal?
        i. [Follow up at the scale of days, weeks, phases, year]
        ii. [Follow up on feelings, thoughts, behaviours]
    b. Why is it (was it) a greater priority at these times?
    c. Are there times when recovery is less of a priority/de-emphasized?

3. Are there specific situations that are important for your recovery?
    a. Are there situations that prompt or encourage recovery?
        i. What is it about these situations? [People, places, things]

   b. In your activity journal, can you show me a specific situation that was important for your recovery?
      i. Are there any other situations that stand out?
   c. Are there situations that discourage recovery, either this week or more broadly?
      i. What is it about these situations? [People, places, things]

4. How much is recovery your responsibility? How much is it the responsibility of others?
   a. (Option 2: How much does your recovery depend on your decisions, and how much does it depend on the decisions of others?)
   b. What is your responsibility?
      i. What do you do to act on that responsibility? Can you give examples?
   c. What are the responsibilities of others? Coaches, teammates, family etc.
      i. What do they do to act on those responsibilities? Can you give examples?

5. We've been talking in great detail about your recovery, but on a regular basis, how much do you actually think about how you're going to recover? Is it something you spend a lot of time thinking about?
   a. How much do you rely on other sources of information to prompt your recovery?

Journal-specific Follow-up Questions

Specific questions will be asked relating to the activities noted in the diary. Going day-by-day, questions will be asked within each day in relation to the following topics:

1. In relation to any specific notations/comments you made on recovery, stress or fatigue
2. In relation to any practice scheduling you noted which varies from that typically represented in the journal (e.g., a practice which is particularly long, short, early, or late)

Concluding Questions

1. Is there "something about you" (e.g., your body, your character, your background, your psychology, your personality) that influences recovery?

2. What have you learned about managing your recovery over your career?
   a. What do you do differently now for recovery that you didn't do then? Why?
   b. Do you manage your recovery more or less now? Why?
   c. Do you take more or less responsibility for your recovery now than you did earlier in your career? How did this come to be?
   d. Do you think about your recovery more or less than earlier in your career? Why?

3. Is there anything that you wish your coaches or support team knew or did better when it comes to your recovery? [If not...What do they do really well?]

4. Is there anything you feel that I have missed, or want to comment upon?

Appendix I: Articles 1 & 2 – Activity Journal Package

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Pen and Paper Activity Journal

Instructions: The purpose of the diary log is to give context to your recovery.

- If you would like to use the pen and paper copy of the activity journal, print off seven copies – one for each day.
- Record what you were doing during each of the time slots below.
  - Feel free to write multiple activities in one slot, or to draw a line across multiple time slots for a long activity.
- Use the margins, or the back of the page, to record any notes, thoughts and/or comments about your activities.
  - When making notes consider:
    - Relevant thoughts, feelings, and behaviours
      - Related to stress, fatigue, or recovery
    - Where, what, when, why, how, and with whom.
  - Feel free to make the journal as clean or as messy as you want
    - Use arrows, colours, shading, etc. – whatever is meaningful to you
    - Example: Consider highlighting activities that energize you in one colour, and activities that deplete you in another colour
- Bring your activity journal with you to Interview #2, regardless of how much or often you write in it

Page two of this document has an example of a completed activity journal page.

Page three is a blank activity journal page for you to complete.

- Print seven, one for each day.

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Canada

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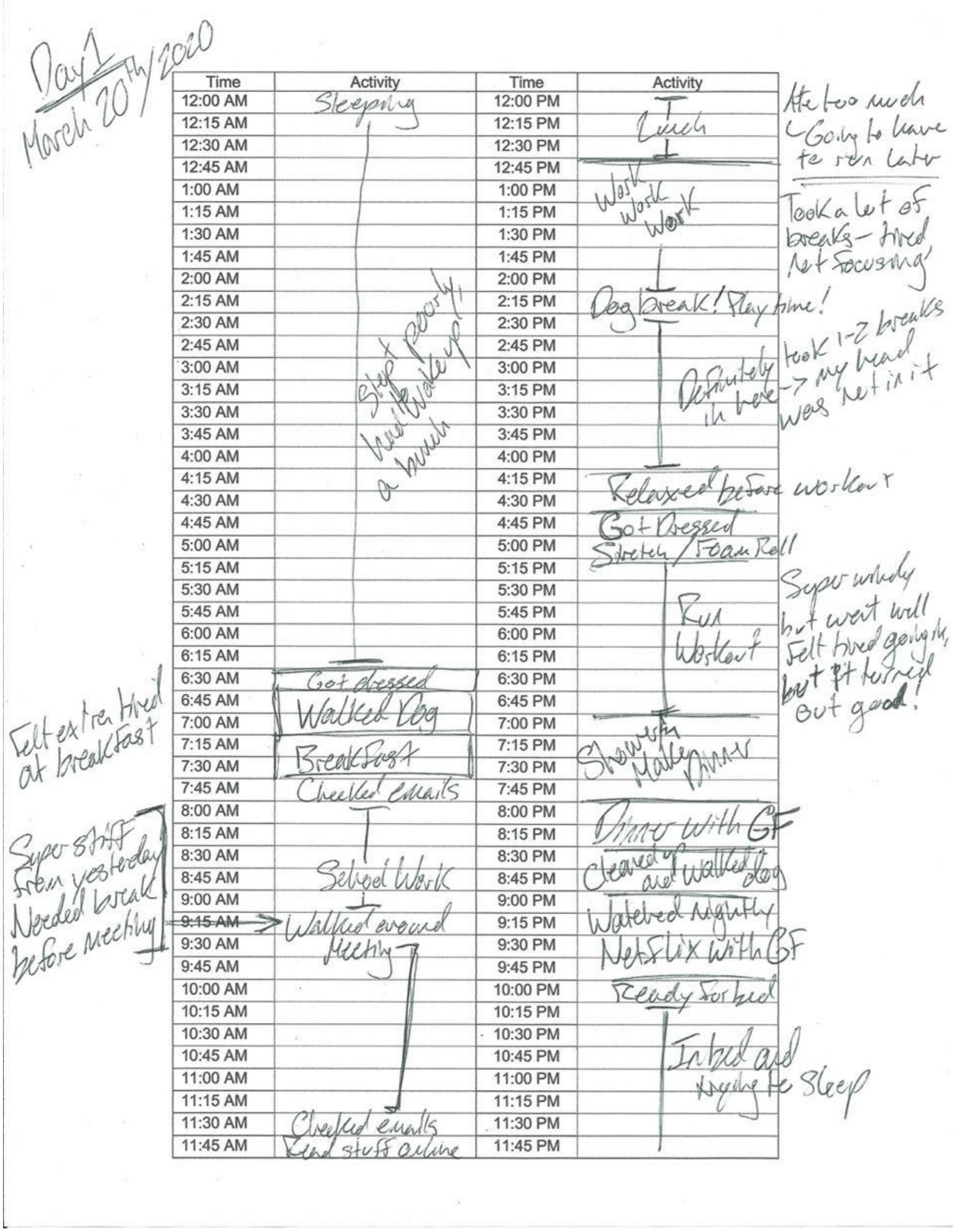
Here's an example of what a completed activity journal page might look like using the pen and paper template:



Day 1
March 20th/2020

Time	Activity	Time	Activity
12:00 AM	Sleeping	12:00 PM	
12:15 AM		12:15 PM	Lunch
12:30 AM		12:30 PM	
12:45 AM		12:45 PM	
1:00 AM		1:00 PM	Work work
1:15 AM		1:15 PM	work
1:30 AM		1:30 PM	
1:45 AM		1:45 PM	
2:00 AM		2:00 PM	
2:15 AM		2:15 PM	Dog break! Play time!
2:30 AM		2:30 PM	
2:45 AM		2:45 PM	
3:00 AM		3:00 PM	
3:15 AM	Slept poorly, had to wake up a bunch	3:15 PM	Definitely in here
3:30 AM		3:30 PM	
3:45 AM		3:45 PM	
4:00 AM		4:00 PM	
4:15 AM		4:15 PM	Relaxed before workout
4:30 AM		4:30 PM	
4:45 AM		4:45 PM	Got Dressed
5:00 AM		5:00 PM	Stretch / Foam Roll
5:15 AM		5:15 PM	
5:30 AM		5:30 PM	
5:45 AM		5:45 PM	Run
6:00 AM		6:00 PM	Workout
6:15 AM		6:15 PM	
6:30 AM	Got dressed	6:30 PM	
6:45 AM	Walked Dog	6:45 PM	
7:00 AM		7:00 PM	
7:15 AM	Breakfast	7:15 PM	Shower
7:30 AM		7:30 PM	Make Dinner
7:45 AM	Checked emails	7:45 PM	
8:00 AM		8:00 PM	
8:15 AM		8:15 PM	Dinner with GF
8:30 AM		8:30 PM	Cleaned up
8:45 AM	School Work	8:45 PM	and walked dog
9:00 AM		9:00 PM	
~~9:15 AM~~	Walked around	9:15 PM	Watched Mighty
9:30 AM	Meeting	9:30 PM	Netflix with GF
9:45 AM		9:45 PM	
10:00 AM		10:00 PM	Ready for bed
10:15 AM		10:15 PM	
10:30 AM		10:30 PM	
10:45 AM		10:45 PM	In bed and
11:00 AM		11:00 PM	trying to sleep
11:15 AM		11:15 PM	
11:30 AM	Checked emails	11:30 PM	
11:45 AM	Read stuff online	11:45 PM	

Felt extra tired at breakfast

Super stiff from yesterday
Needed break before meeting

Ate too much
↳ Going to have to run later

Took a lot of breaks – tired
Not focusing

took 1-2 breaks -> my head was not in it

Super windy but went well
Felt tired going in,
but it turned out good!

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When making notes consider:
- Relevant thoughts, feelings, and behaviours
  - Related to stress, fatigue, or recovery
- Where, what, when, why, how, and with whom.

Date:

Time	Activity	Time	Activity
12:00 AM		12:00 PM	
12:15 AM		12:15 PM	
12:30 AM		12:30 PM	
12:45 AM		12:45 PM	
1:00 AM		1:00 PM	
1:15 AM		1:15 PM	
1:30 AM		1:30 PM	
1:45 AM		1:45 PM	
2:00 AM		2:00 PM	
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10:30 AM		10:30 PM	
10:45 AM		10:45 PM	
11:00 AM		11:00 PM	
11:15 AM		11:15 PM	
11:30 AM		11:30 PM	
11:45 AM		11:45 PM	

Appendix J: Article 3 – Consent Form

Please read the following consent form carefully so that you understand the details of the study and what is being asked of you if you choose to participate. Please indicate you understand and consent to participate by filling out the information at the bottom of the page.

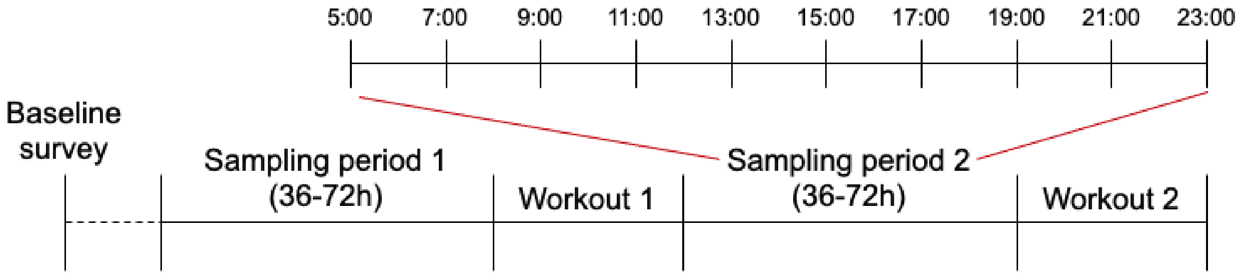
This study is formally titled "Assessing the regulation, content, and experience of recovery between key training sessions" and is led by Stuart G. Wilson as part of his PhD research program, and is supervised by Dr. Bradley W. Young at the University of Ottawa.

PURPOSE: To assess how elite endurance athletes self-regulate their recovery, and whether various skills and self-management strategies they use could provide a recovery advantage in training and performance.

PARTICIPANTS: To participate in this study, you must:

1. Be 17 years of age or older,
2. Be currently training to compete in an endurance sport,
3. Be a current member of a National Team affiliated with a National Training Institute/Centre,
4. Own a functioning smartphone that can be used to receive text messages and complete online surveys.

PROCEDURE: You will be asked to participate in two of your existing key workouts, scheduled 24-72 hours apart. We are not asking for any change to your training schedule; you should continue to train as usual. Around these two key workouts, you will be asked to complete several short surveys throughout each day. Please see the study timeline and explanation of what will happen at each time point below.



- Workouts 1 and 2 are the two existing key workouts that you'll participate in as part of your normally planned training. They should be very demanding, and you should be motivated to perform equally well in both. We will work with your coaches to identify a couple of potential workouts fitting the study, and you will confirm the exact time frame before beginning.
- Sampling Period 2 represents the 24-72 hours between Workouts 1 and 2, and Sampling Period 1 represents the 24-72 hours before Workout 1. The exact length of each will depend on your workout schedule. You will continue to participate in all other planned training during Sampling Periods 1 and 2.

- During Sampling Periods 1 and 2, you will receive a text message once every two hours with a link to a 2-minute survey. Text messages will be timed randomly within each two-hour block, and they will only be sent during waking hours (i.e., 5am to 11pm). The survey addresses your recovery-related actions, thoughts, and feelings at that moment. Normal text messaging rates will apply; you will only be receiving text messages, and will not be asked to answer any text messages.
- Please complete any surveys as soon as safely possible, within 30 minutes. If you cannot complete the survey within 30 minutes (i.e., you are sleeping, training, driving, or otherwise occupied), no worries! Please do not adjust your schedule in anticipation of receiving a text message.
- As part of this consent form, you will be asked to provide a phone number and email address we can contact you at. Your phone number will be used to send all surveys used during this study via text message. Your email will be a communication back-up.
- If you choose to participate, you will then be asked to answer some basic demographic questions.
- About one hour before Workouts 1 and 2 you will receive a slightly longer survey (approximately 10 minutes) containing questions about the forms of recovery you engaged in since the previous key workout (in addition to the regular questions about your recovery actions, thoughts and feelings).
- About 20 minutes after the end of Workout 1 you will receive a text message linking to a slightly longer survey (approximately 10 minutes) asking about your recovery plans before the next workout. This marks the beginning of Sampling Period 2.
- After Workout 2, you are done the study.

CONFIDENTIALITY AND ANONYMITY: Should you agree to participate, the information you provide will remain entirely confidential. Throughout the study, you are not required to respond to any questions or share any information that you would not like to. Your responses will be assigned an internal ID code to maintain your anonymity. Your name, phone number, email address and ID code will be stored in a separate Excel file from all survey results received during the study. Your organization and team staff (e.g., coaches, integrated support team) will not be informed of whether you choose to participate or not. Results will only be shared in an anonymized, summarized format. Text messages will be distributed using the online service Klaviyo (Klaviyo.com); only a list of anonymous ID codes and phone numbers will be uploaded to the platform, and will be securely deleted 24 hours after completing the study. To minimize the risk of security breaches and to help ensure your confidentiality, we recommend that you use standard safety measures such as signing out of your account, closing your browser and locking your screen or device when you are no longer using them / when you have completed the study.

RISKS: This study is built around two pre-existing key workouts that you would complete regardless of your participation in the study. You will likely experience physical discomfort from participating in the two key workouts, but you would experience this regardless of participation status so the study will not add any additional discomfort over and above your normal engagement in training. You will be asked to report what you are doing and thinking when you receive the text message throughout the day. You may feel psychological discomfort when reporting your actions or thoughts if you feel embarrassed about engaging in them, although responses will be confidential and anonymous, so any reported activities or thoughts cannot be connected to you, and it always remains your decision whether and what to report, as well as how to describe your thoughts and actions around recovery.

Should you experience any types of discomfort as a result of your participation, The Canadian Sport Helpline is a confidential listening and referral service for athletes wishing to share or obtain information about anything from dealing with stresses, to abuse, harassment, or discrimination in sport. Operated by the Canadian Centre for Mental Health and Sport, this line connects you with a team of practitioners with expertise in counselling, psychology, and sport. The toll-free Helpline is available from 8 a.m. to 8 p.m. (Eastern Time), seven days per week by telephone or text message at: 1-888-83SPORT or 1-888-837-7678. Alternatively, participants may contact the Mental Health Helpline at 1-866-531-2600 and on-line at http://www.mentalhealthhelpline.ca/.

Text messages will be distributed using the online service Klaviyo (Klaviyo.com), which is hosted in the United States and as such is subject to Patriot Act. Only your anonymous ID code and phone number will be uploaded to the platform, and no other identifying information.

CONSERVATION OF DATA: Electronic data, including consent forms and questionnaire responses, will be stored on the primary investigator's personal, password-protected computer. Your phone number will be removed from Klaviyo.com and deleted from all electronic files 24 hours after you complete the study. All other data will be kept for a period of 10 years, after which it will be destroyed.

VOLUNTARY PARTICIPATION: You are under no obligation to participate. If you choose to participate, you can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If you choose to withdraw by notifying one of the investigators, all data gathered until that point will destroyed, unless you indicate that it should be kept.

RESEARCHER CONTACT INFORMATION: You may contact the researchers at any time using the following information:

Stuart Wilson – Primary Investigator
PhD (c), School of Human Kinetics, Faculty of Health Sciences, University of Ottawa
Phone: [redacted]
Dr. Bradley W. Young – Supervisor
Professor, School of Human Kinetics, Faculty of Health Sciences, University of Ottawa
Phone: [redacted]

If you have any questions regarding the ethical conduct of this study, you may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5. Tel.: (613) 562-5387. Email: ethics@uottawa.ca

ACCEPTANCE: By providing your name, email address, and phone number in the online form, you are agreeing to voluntarily participate in this study, acknowledging that you have been informed of the nature of the research, and recognizing that now and at any time you can contact the investigators if you have any questions. The phone number and email you provide below will be used to contact you and distribute surveys during the study.

Appendix K: Article 3 – Sign-up Form

Section 1 – Participation Details

Welcome to the Recovery Regulation Study! Thank for your interest in participating. To set up the study, we need a couple details first.

When we introduced the study, we gave a couple options for key workouts you could choose to participate in. Please indicate the date, start time, and end time that you for your participation in those two workouts.

All text messages in this study are scheduled based on these times, so please be careful to enter accurate times that you will be likely to stick to.

- Workout 1 Start: [*open text box*]
- Workout 1 End: [*open text box*]
- Workout 2 Start: [*open text box*]
- Workout 2 End: [*open text box*]

Text messages will be sent according to your local time. Please select the time zone you will be in during the study:

- Pacific Time
- Mountain Time
- Central Time
- Eastern Time
- Atlantic Time

Text messages will only be sent during waking hours. The default "quiet hours" for this study are from 11pm to 5am. If you would like to extend those hours (i.e., you never wake up before 7am), please indicate your personal "quiet hours" below.

- Quiet hours Start (e.g., 11:00 PM): [*open text box*]
- Quiet hours End (e.g., 5:00 AM): [*open text box*]

Section 2 – Demographic Questions

Next we'd like to get a better understanding of you and your sport history.

What was your sex assigned at birth?

- Male
- Female

What is your gender?

- Man
- Woman
- I identify as... *[open textbox]*

What is your birth date? [*dropdown menus*]

What is your main sport? If applicable, please also list your main event(s) in that sport. *[open textbox]*

Approximately when did you start competitive training for this sport? Competitive training can involve anything more than recreational or casual engagement in the sport. *[drop down menu of years and months]*

Section 3 – Sport History

Now we would like to know a little bit about your sport history and performance level. Part of what makes this research meaningful is the high-level skills and experience you bring to the table, so we need to be able to accurately describe that.

We would like to know a little bit about your history as a National Team athlete. What it means to be a "National Team athlete" changes from sport to sport, but might include:

- Receiving funding through Sport Canada's Athlete Assistance Program (AAP) — i.e., being a "carded" athlete.
- Being selected to compete for your national team in an international championship/competition.

If applicable, approximately when did you first become a national team member?

- Member of any National team (e.g., Jr., U23, Sr.): *[drop down menus, years and months]*
- Senior National team member: *[drop down menus, years and months]*

Second, if your sport has measured performances, could you please share some details about **your top two performance marks in the past twelve months?** These can be from the same event type (e.g., top 2 1500m times for the year).

Please provide your performance mark (e.g., time in min:sec, place), the event type (e.g., 1500m), the month and year achieved (e.g., July 2021), and the competition (e.g., Senior World Champs). Each response should look like: 3:58.2, 1500m run, July 2021, Senior World Champs.

- Performance mark #1: [*open text box*]
- Performance mark #2: [*open text box*]

That's it! You have completed this survey. When you click "Done" you will see a blank white browser screen.

Appendix L: Article 3 – Regular Experience Sampling Form Items

Title: Brief Recovery Check-in

Page 1: Welcome!

As a reminder, what counts as recovery is up to you. In general, recovery...

- is whatever helps you absorb the work from your previous workouts, and prepares you for the work in your next workouts.
- can be mental, physical or a mix of both.
- can be more dialed-in and focused, or more dialed-out and relaxed.

Please rate your agreement with the following statements:

- What I've been doing over the past half-hour has been guided by my recovery.
    - Almost completely
    - Considerably
    - Somewhat
    - A little
    - Not at all
    - *[If participant answers anything but 0 they go to page 2]*
- During the past half-hour, I thought about my recovery.
    - Almost all the time
    - Considerably
    - Somewhat
    - A little
    - Not at all
    - *[If participant answers anything but 0 they go to page 2]*
- Have you done a physical training session since you last completed a survey? (e.g., easy workouts, shakeout jogs, strength training, cross-training, etc.).
    - Yes / No *[Answer yes shows question about training on last page]*
- Have you had to miss or skip a survey since the last one you completed?
    - Yes / No *[Answer yes shows question about missed survey on last page]*

Page 2: [Self-Regulation follow-up]

[All rated on 5-pt. Likert-scale from Almost all the time to Not at all]

- Please rate your agreement with the following statements:
    - During the past half-hour, I was aware of how recovered I felt.
    - During the past half-hour, I checked in on how recovered I felt.
    - During the past half-hour, I compared how recovered I felt with how I expected to feel.
    - During the past half-hour, I purposefully adjusted my current or planned recovery.

Page 3: Current recovery state

(Recovery scale adapted from the Short Recovery and Stress Scale; Kölling & Kellmann, 2019)

[All rated on a 7-pt. Likert scale from 0, "Not at all", to 6, "Fully applies"]

- The statements below describe different aspects of your current state of recovery. Rate how you feel right now compared to your best ever recovery state.

  - Physically, I feel... strong, physically capable, energetic, powerful
  - Mentally, I feel... attentive, receptive, mentally alert, concentrated
  - Emotionally, I feel... pleased, stable, in a good mood, like I have everything under control
  - Overall, I feel... recovered, rested, relaxed
    - (Piloting removed physically and muscularly from relaxed)

Page 4: Current stress state
(Stress scale adapted from the Short Recovery and Stress Scale; Kölling & Kellmann, 2019)
[All rated on a 7-pt. Likert scale from 0, "Not at all", to 6, "Fully applies"]

- The statements below describe different aspects of your current state of stress. Rate how you feel right now in relation to your highest ever stress state.
  - Physically, my muscles feel... exhausted, fatigued, sore, stiff
  - Mentally, I feel... unmotivated, sluggish, unenthusiastic, like I'm lacking energy
  - Emotionally I feel... stressed, annoyed, short tempered, like I'm feeling down
  - Overall, I feel... tired, worn-out, overloaded, exhausted
    - (Piloting removed physically from exhausted)

Page 5: Housekeeping

- You indicated that you completed a training session since your last survey. Please select the approximate start and end time for that session.
  - Session Start time *[drop down list]*
  - Session End time *[drop down list]*
- You indicated that you had to miss or skip a survey since the last one you answered. Please consider providing the general reason, just to give a fuller picture of your recovery.
  - *[Dropdown menu of reasons: Sleeping, Practice/Training, Family/Friends time, Driving, Other]*
  - Last survey missed
  - 2nd last survey missed
  - 3rd last survey missed
- That's it! You have completed this survey. When you click "Done" you will see a blank white browser screen.

Appendix M: Article 3 – Post-Key Workout 1 Experience Sampling Form Items

[Presented in SurveyMonkey]

Page 1: Your workouts

- As a reminder, your "key workouts" are the one you just completed, and the one happening in 2-3 days that you selected before beginning the study.
- How was the workout you just completed?
  Please give a *global* rating for the difficulty of your *entire* training session. Consider how hard it was for *you*, not how hard it should have been or might have been for others.
  - *[Modified Rating of Perceived Exertion Scale (Foster et al., 2001)]*
  - 0 – Rest
  - 1 – Very, very easy
  - 2 – Easy
  - 3 – Moderate
  - 4 – Somewhat hard
  - 5 – Hard
  - 6
  - 7 – Very hard
  - 8
  - 9
  - 10 – Maximal
- How motivated are you to perform well in your next key workout? *[5-pt. Likert scale]*
  - 1 – Not at all
  - 2 – Somewhat motivated
  - 3 – Moderately motivated
  - 4 – Motivated
  - 5 – Very motivated

Page 2: Recovery plans

[Not analyzed in this dissertation]

As a reminder, what counts as recovery is up to you. In general, recovery...

- is whatever helps you absorb the work from your previous workouts, and prepares you for the work in your next workouts.
- can be mental, physical or a mix of both.
- can be more dialed-in and focused, or more dialed-out and relaxed.

- Please rate your agreement with the following statements: *[All rated on 7 pt. Likert-scale from Agree strongly to Disagree strongly]*
  - I know how fatigued I expect to feel between now and my next key workout.
  - I know what I need to do to recover for my next key workout.
  - I never know how my body will react to a hard workout.
  - I have specific plan(s) in mind for what I need to do to recover physically for my next key workout.
  - I have specific plan(s) in mind for what I need to do to recover mentally for my next key workout.
  - I do not have plans for my recovery.

  - I have specific routines to help my physical recovery before my next key workout.
  - I have specific routines to help my mental recovery before my next key workout.
  - I do not use routines to structure my recovery.

Page 3: Current recovery state

(Recovery scale adapted from the Short Recovery and Stress Scale; Kölling & Kellmann, 2019)

[All rated on a 7-pt. Likert scale from 0, "Not at all", to 6, "Fully applies"]

- The statements below describe different aspects of your current state of recovery. Rate how you feel right now compared to your best ever recovery state.
  - Physically, I feel... strong, physically capable, energetic, powerful
  - Mentally, I feel... attentive, receptive, mentally alert, concentrated
  - Emotionally, I feel... pleased, stable, in a good mood, like I have everything under control
  - Overall, I feel... recovered, rested, relaxed
    - (Piloting removed physically and muscularly from relaxed)

Page 4: Current stress state

(Stress scale adapted from the Short Recovery and Stress Scale; Kölling & Kellmann, 2019)

[All rated on a 7-pt. Likert scale from 0, "Not at all", to 6, "Fully applies"]

- The statements below describe different aspects of your current state of stress. Rate how you feel right now in relation to your highest ever stress state.
  - Physically, my muscles feel... exhausted, fatigued, sore, stiff
  - Mentally, I feel... unmotivated, sluggish, unenthusiastic, like I'm lacking energy
  - Emotionally I feel... stressed, annoyed, short tempered, like I'm feeling down
  - Overall, I feel... tired, worn-out, overloaded, exhausted
    - (Piloting removed physically from exhausted)

Page 5

That's it! You have completed this survey. When you click "Done" you will see a blank white browser screen.

Appendix N: Article 3 – Multilevel Models of Self-Regulatory Processes Over Time

Models of Engagement with Recovery over Time

Table 1: Engagement with recovery-related thoughts in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.500	1.249 – 1.752	<0.001	1.225	0.879 – 1.571	<0.001	1.342	0.907 – 1.777	<0.001
Linear TTW1				0.012	0.002 – 0.022	0.022	-0.002	-0.036 – 0.032	0.891
Quadratic TTW1							0.000	-0.000 – 0.001	0.383
Random Effects									
σ^2	1.20			1.17			1.16		
τ_{00}	0.23_{id}			0.24_{id}			0.24_{id}		
ICC	0.16			0.17			0.17		
N	22_{id}			22_{id}			22_{id}		
Observations	230			230			230		
log-Likelihood	-358.916			-356.293			-355.913		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 2: Engagement with recovery-related thoughts in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.672	1.378 – 1.966	<0.001	1.631	1.249 – 2.013	<0.001	1.556	1.098 – 2.014	<0.001
Linear TTW1				0.001	-0.007 – 0.010	0.737	0.009	-0.017 – 0.034	0.511
Quadratic TTW1							-0.000	-0.001 – 0.000	0.563
Random Effects									
σ^2	1.04			1.03			1.03		
τ_{00}	0.36_{id}			0.36_{id}			0.36_{id}		
ICC	0.26			0.26			0.26		
N	22_{id}			22_{id}			22_{id}		
Observations	208			208			208		
log-Likelihood	-314.297			-314.241			-314.074		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 3: Engagement with recovery-related thoughts in relation to the elapsed time since workout 1

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.672	1.378 – 1.966	<0.001	1.751	1.388 – 2.113	<0.001	1.772	1.324 – 2.220	<0.001
Linear TTW1				-0.003	-0.012 – 0.006	0.472	-0.005	-0.033 – 0.022	0.699
Quadratic TTW1							0.000	-0.000 – 0.000	0.871
Random Effects									
σ^2	1.04			1.03			1.03		
τ_{00}	0.36 $_{id}$			0.35 $_{id}$			0.36 $_{id}$		
ICC	0.26			0.26			0.26		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	208			208			208		
log-Likelihood	-314.297			-314.039			-314.026		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 4: Engagement with recovery-related actions in relation to the remaining time to workout 1

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.685	1.440 – 1.929	<0.001	1.493	1.111 – 1.875	<0.001	1.600	1.095 – 2.104	<0.001
Linear TTW1				0.008	-0.004 – 0.021	0.200	-0.005	-0.047 – 0.038	0.825
Quadratic TTW1							0.000	-0.001 – 0.001	0.526
Random Effects									
σ^2	1.84			1.82			1.82		
τ_{00}	0.15 $_{id}$			0.15 $_{id}$			0.15 $_{id}$		
ICC	0.08			0.08			0.08		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	230			230			230		
log-Likelihood	-402.952			-402.129			-401.928		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 5: Engagement with recovery-related actions in relation to the remaining time to workout 2

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.956	1.660 – 2.252	<0.001	1.939	1.534 – 2.344	<0.001	1.700	1.203 – 2.197	<0.001
Linear TTW1				0.001	-0.009 – 0.010	0.904	0.023	-0.006 – 0.053	0.121
Quadratic TTW1							-0.000	-0.001 – 0.000	0.110
Random Effects									
σ^2	1.37			1.37			1.35		
τ_{00}	0.33 $_{id}$			0.33 $_{id}$			0.32 $_{id}$		
ICC	0.19			0.20			0.19		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	208			208			208		
log-Likelihood	-340.432			-340.425			-339.142		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 6: Engagement with recovery-related actions in relation to the elapsed time since workout 1

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.956	1.660 – 2.252	<0.001	2.010	1.624 – 2.395	<0.001	2.098	1.609 – 2.587	<0.001
Linear TTW1				-0.002	-0.013 – 0.008	0.670	-0.011	-0.043 – 0.021	0.493
Quadratic TTW1							0.000	-0.000 – 0.001	0.563
Random Effects									
σ^2	1.37			1.37			1.37		
τ_{00}	0.33 $_{id}$			0.33 $_{id}$			0.33 $_{id}$		
ICC	0.19			0.19			0.19		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	208			208			208		
log-Likelihood	-340.432			-340.341			-340.173		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Models of Recovery Self-Regulation Over Time

Table 7: Self-awareness of recovery in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.696	1.416 – 1.977	<0.001	1.550	1.177 – 1.923	<0.001	1.739	1.278 – 2.200	<0.001
Linear TTW1				0.006	-0.004 – 0.017	0.241	-0.017	-0.052 – 0.018	0.348
Quadratic TTW1							0.000	-0.000 – 0.001	0.175
Random Effects									
σ^2	1.24			1.23			1.22		
τ_{00}	0.31_{id}			0.31_{id}			0.31_{id}		
ICC	0.20			0.20			0.20		
N	22_{id}			22_{id}			22_{id}		
Observations	228			228			228		
log-Likelihood	-361.892			-361.203			-360.282		

Note. TTW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 8: Self-awareness of recovery in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.844	1.575 – 2.112	<0.001	2.016	1.662 – 2.370	<0.001	2.018	1.586 – 2.449	<0.001
Linear TTW1				-0.006	-0.014 – 0.002	0.147	-0.006	-0.031 – 0.019	0.616
Quadratic TTW1							0.000	-0.000 – 0.000	0.988
Random Effects									
σ^2	0.97			0.96			0.96		
τ_{00}	0.29_{id}			0.28_{id}			0.28_{id}		
ICC	0.23			0.23			0.23		
N	22_{id}			22_{id}			22_{id}		
Observations	207			207			207		
log-Likelihood	-304.628			-303.576			-303.576		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 9: Self-awareness of recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.844	1.575 – 2.112	<0.001	1.733	1.390 – 2.076	<0.001	1.913	1.486 – 2.341	<0.001
Linear TTW1				0.005	-0.004 – 0.013	0.294	-0.013	-0.040 – 0.013	0.330
Quadratic TTW1							0.000	-0.000 – 0.001	0.164
Random Effects									
σ^2	0.97			0.96			0.95		
τ_{00}	0.29_{id}			0.30_{id}			0.31_{id}		
ICC	0.23			0.24			0.25		
N	22_{id}			22_{id}			22_{id}		
Observations	207			207			207		
log-Likelihood	-304.628			-304.081			-303.113		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 10: Checking-in on recovery in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.429	1.137 – 1.721	<0.001	1.289	0.924 – 1.653	<0.001	1.478	1.040 – 1.916	<0.001
Linear TTW1				0.006	-0.004 – 0.016	0.212	-0.017	-0.049 – 0.014	0.287
Quadratic TTW1							0.000	-0.000 – 0.001	0.130
Random Effects									
σ^2	1.00			0.99			0.98		
τ_{00}	0.37_{id}			0.37_{id}			0.37_{id}		
ICC	0.27			0.27			0.27		
N	22_{id}			22_{id}			22_{id}		
Observations	228			228			228		
log-Likelihood	-340.024			-339.243			-338.093		

Note. TTW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 11: Checking-in on recovery in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.643	1.331 – 1.956	<0.001	1.830	1.451 – 2.209	<0.001	1.814	1.374 – 2.255	<0.001
Linear TTW1				-0.007	-0.014 – 0.001	0.093	-0.005	-0.028 – 0.018	0.657
Quadratic TTW1							-0.000	-0.000 – 0.000	0.891
Random Effects									
σ^2	0.82			0.81			0.81		
τ_{00}	0.45 $_{id}$			0.44 $_{id}$			0.44 $_{id}$		
ICC	0.35			0.35			0.35		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	207			207			207		
log-Likelihood	-292.701			-291.290			-291.281		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 12: Checking-in on recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.643	1.331 – 1.956	<0.001	1.513	1.142 – 1.883	<0.001	1.634	1.195 – 2.073	<0.001
Linear TTW1				0.006	-0.002 – 0.014	0.177	-0.007	-0.031 – 0.018	0.603
Quadratic TTW1							0.000	-0.000 – 0.001	0.310
Random Effects									
σ^2	0.82			0.81			0.81		
τ_{00}	0.45 $_{id}$			0.46 $_{id}$			0.47 $_{id}$		
ICC	0.35			0.36			0.37		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	207			207			207		
log-Likelihood	-292.701			-291.792			-291.276		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 13: Interpretation of recovery in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.318	1.013 – 1.623	<0.001	1.130	0.751 – 1.509	<0.001	1.378	0.926 – 1.830	<0.001
Linear TTW1				0.008	-0.002 – 0.018	0.106	-0.022	-0.055 – 0.010	0.179
Quadratic TTW1							0.001	-0.000 – 0.001	0.054
Random Effects									
σ^2	1.07			1.06			1.04		
τ_{00}	0.41_{id}			0.40_{id}			0.39_{id}		
ICC	0.28			0.28			0.27		
N	22_{id}			22_{id}			22_{id}		
Observations	228			228			228		
log-Likelihood	-348.224			-346.914			-345.056		

Note. TTW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 14: Interpretation of recovery in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.379	1.046 – 1.711	<0.001	1.567	1.169 – 1.965	<0.001	1.646	1.186 – 2.105	<0.001
Linear TTW1				-0.007	-0.015 – 0.001	0.096	-0.014	-0.038 – 0.009	0.227
Quadratic TTW1							0.000	-0.000 – 0.000	0.496
Random Effects									
σ^2	0.84			0.83			0.83		
τ_{00}	0.52_{id}			0.51_{id}			0.52_{id}		
ICC	0.38			0.38			0.39		
N	22_{id}			22_{id}			22_{id}		
Observations	207			207			207		
log-Likelihood	-296.508			-295.121			-294.890		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 15: Interpretation of recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.379	1.046 – 1.711	<0.001	1.234	0.847 – 1.621	<0.001	1.372	0.918 – 1.826	<0.001
Linear TTW1				0.006	-0.002 – 0.014	0.143	-0.008	-0.033 – 0.017	0.550
Quadratic TTW1							0.000	-0.000 – 0.001	0.256
Random Effects									
σ^2	0.84			0.83			0.83		
τ_{00}	0.52_{id}			0.53_{id}			0.53_{id}		
ICC	0.38			0.39			0.39		
N	22_{id}			22_{id}			22_{id}		
Observations	207			207			207		
log-Likelihood	-296.508			-295.435			-294.788		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 16: Adjustments of recovery in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.837	0.580 – 1.093	<0.001	0.589	0.255 – 0.923	0.001	0.575	0.162 – 0.989	0.007
Linear TTW1				0.011	0.001 – 0.020	0.026	0.012	-0.019 – 0.044	0.436
Quadratic TTW1							-0.000	-0.001 – 0.001	0.912
Random Effects									
σ^2	0.99			0.97			0.97		
τ_{00}	0.26_{id}			0.26_{id}			0.26_{id}		
ICC	0.21			0.21			0.21		
N	22_{id}			22_{id}			22_{id}		
Observations	227			227			227		
log-Likelihood	-335.258			-332.786			-332.780		

Note. TTW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 17: Adjustments of recovery in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.812	0.509 – 1.114	<0.001	0.887	0.523 – 1.251	<0.001	0.745	0.327 – 1.163	0.001
Linear TTW1				-0.003	-0.010 – 0.005	0.465	0.011	-0.010 – 0.032	0.304
Quadratic TTW1							-0.000	-0.001 – 0.000	0.174
Random Effects									
σ^2	0.69			0.69			0.68		
τ_{00}	0.43_{id}			0.43_{id}			0.44_{id}		
ICC	0.38			0.39			0.39		
N	22_{id}			22_{id}			22_{id}		
Observations	207			207			207		
log-Likelihood	-275.623			-275.356			-274.430		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 18: Adjustments of recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.812	0.509 – 1.114	<0.001	0.746	0.395 – 1.096	<0.001	0.726	0.314 – 1.139	0.001
Linear TTW1				0.003	-0.005 – 0.010	0.461	0.005	-0.018 – 0.027	0.685
Quadratic TTW1							-0.000	-0.000 – 0.000	0.860
Random Effects									
σ^2	0.69			0.69			0.69		
τ_{00}	0.43_{id}			0.43_{id}			0.43_{id}		
ICC	0.38			0.39			0.39		
N	22_{id}			22_{id}			22_{id}		
Observations	207			207			207		
log-Likelihood	-275.623			-275.351			-275.335		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Appendix O: Article 3 – Multilevel Models of Perceived Recovery and Stress Over Time

Models of Perceived Recovery Over Time

Table 1: Perceived *physical* recovery in relation to the remaining time to workout 1

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.091	-0.188 – 0.006	0.065	0.222	0.041 – 0.404	0.016	0.202	-0.052 – 0.456	0.119
Linear TTW1				-0.013	-0.020 – -0.007	<0.001	-0.011	-0.033 – 0.011	0.343
Quadratic TTW1							-0.000	-0.000 – 0.000	0.819
Random Effects									
σ^2	0.55			0.51			0.51		
τ_{00}	0.00 $_{\text{id}}$			0.00 $_{\text{id}}$			0.00 $_{\text{id}}$		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			228		
log-Likelihood	-254.809			-247.159			-247.133		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 2: Perceived *physical* recovery in relation to the remaining time to workout 2

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.085	-0.025 – 0.194	0.129	0.222	0.015 – 0.428	0.035	0.052	-0.242 – 0.346	0.729
Linear TTW1				-0.005	-0.010 – 0.001	0.125	0.010	-0.009 – 0.029	0.294
Quadratic TTW1							-0.000	-0.000 – 0.000	0.113
Random Effects									
σ^2	0.68			0.68			0.67		
τ_{00}	0.00 $_{\text{id}}$			0.00 $_{\text{id}}$			0.00 $_{\text{id}}$		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	222			222			222		
log-Likelihood	-272.969			-271.787			-270.527		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 3: Perceived *physical* recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.085	-0.025 – 0.194	0.129	0.017	-0.169 – 0.204	0.854	-0.193	-0.432 – 0.047	0.114
Linear TTW1				0.003	-0.004 – 0.009	0.383	0.027	0.008 – 0.046	0.005
Quadratic TTW1							-0.000	-0.001 – -0.000	0.007
Random Effects									
σ^2	0.68			0.68			0.66		
τ_{00}	0.00_{id}			0.00_{id}			0.00_{id}		
N	22_{id}			22_{id}			22_{id}		
Observations	222			222			222		
log-Likelihood	-272.969			-272.589			-268.997		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 4: Perceived *mental* recovery in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.154	-0.295 – -0.013	0.032	0.150	-0.087 – 0.387	0.213	0.039	-0.281 – 0.358	0.812
Linear TTW1				-0.013	-0.021 – -0.005	0.002	0.001	-0.027 – 0.028	0.971
Quadratic TTW1							-0.000	-0.001 – 0.000	0.311
Random Effects									
σ^2	0.79			0.76			0.76		
τ_{00}	0.03_{id}			0.04_{id}			0.03_{id}		
ICC	0.04			0.04			0.04		
N	22_{id}			22_{id}			22_{id}		
Observations	228			228			228		
log-Likelihood	-300.914			-296.118			-295.605		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 5: Perceived *mental* recovery in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.158	-0.005 – 0.322	0.058	0.205	-0.064 – 0.473	0.135	0.245	-0.116 – 0.607	0.183
Linear TTW1				-0.002	-0.009 – 0.006	0.669	-0.005	-0.028 – 0.018	0.653
Quadratic TTW1							0.000	-0.000 – 0.000	0.739
Random Effects									
σ^2	0.92			0.92			0.92		
τ_{00}	0.06_{id}			0.05_{id}			0.05_{id}		
ICC	0.06			0.05			0.06		
N	22_{id}			22_{id}			22_{id}		
Observations	222			222			222		
log-Likelihood	-311.097			-311.007			-310.952		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 6: Perceived *mental* recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.158	-0.005 – 0.322	0.058	0.177	-0.064 – 0.417	0.149	-0.019	-0.315 – 0.278	0.902
Linear TTW1				-0.001	-0.009 – 0.007	0.836	0.022	-0.001 – 0.044	0.056
Quadratic TTW1							-0.000	-0.001 – -0.000	0.035
Random Effects									
σ^2	0.92			0.92			0.91		
τ_{00}	0.06_{id}			0.06_{id}			0.05_{id}		
ICC	0.06			0.06			0.05		
N	22_{id}			22_{id}			22_{id}		
Observations	222			222			222		
log-Likelihood	-311.097			-311.075			-308.861		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 7: Perceived *emotional* recovery in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.193	-0.289 – -0.096	<0.001	-0.010	-0.194 – 0.175	0.918	0.085	-0.173 – 0.342	0.519
Linear TTW1				-0.008	-0.014 – -0.001	0.024	-0.019	-0.041 – 0.004	0.099
Quadratic TTW1							0.000	-0.000 – 0.001	0.304
Random Effects									
σ^2	0.54			0.53			0.53		
τ_{00}	0.00 $_{id}$			0.00 $_{id}$			0.00 $_{id}$		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			227		
log-Likelihood	-252.550			-249.985			-249.457		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 8: Perceived *emotional* recovery in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.195	0.081 – 0.310	0.001	0.278	0.063 – 0.494	0.012	0.224	-0.085 – 0.533	0.154
Linear TTW1				-0.003	-0.009 – 0.003	0.374	0.002	-0.018 – 0.022	0.848
Quadratic TTW1							-0.000	-0.000 – 0.000	0.630
Random Effects									
σ^2	0.74			0.74			0.74		
τ_{00}	0.00 $_{id}$			0.00 $_{id}$			0.00 $_{id}$		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	222			222			222		
log-Likelihood	-282.093			-281.696			-281.579		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 9: Perceived *emotional* recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.195	0.081 – 0.310	0.001	0.188	-0.007 – 0.384	0.058	0.005	-0.246 – 0.256	0.970
Linear TTW1				0.000	-0.007 – 0.007	0.931	0.022	0.002 – 0.041	0.033
Quadratic TTW1							-0.000	-0.001 – -0.000	0.025
Random Effects									
σ^2	0.74			0.74			0.73		
τ_{00}	0.00 $_{id}$			0.00 $_{id}$			0.00 $_{id}$		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	222			222			222		
log-Likelihood	-282.093			-282.089			-279.585		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 10: Perceived *overall* recovery in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.008	-0.119 – 0.103	0.892	0.354	0.145 – 0.562	0.001	0.401	0.108 – 0.694	0.007
Linear TTW1				-0.015	-0.023 – -0.008	<0.001	-0.021	-0.047 – 0.005	0.112
Quadratic TTW1							0.000	-0.000 – 0.001	0.650
Random Effects									
σ^2	0.72			0.67			0.67		
τ_{00}	0.00 $_{id}$			0.00 $_{id}$			0.00 $_{id}$		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			227		
log-Likelihood	-284.973			-277.337			-277.234		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 11: Perceived *overall* recovery in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.005	-0.115 – 0.125	0.935	0.170	-0.056 – 0.396	0.139	0.008	-0.314 – 0.330	0.961
Linear TTW1				-0.005	-0.012 – 0.001	0.091	0.009	-0.012 – 0.030	0.421
Quadratic TTW1							-0.000	-0.001 – 0.000	0.168
Random Effects									
σ^2	0.82			0.81			0.81		
τ_{00}	0.00_{id}			0.00_{id}			0.00_{id}		
N	22_{id}			22_{id}			22_{id}		
Observations	222			222			222		
log-Likelihood	-293.487			-292.058			-291.106		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 12: Perceived *overall* recovery in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.005	-0.115 – 0.125	0.935	-0.117	-0.321 – 0.088	0.262	-0.414	-0.673 – -0.155	0.002
Linear TTW1				0.005	-0.002 – 0.012	0.150	0.040	0.019 – 0.060	<0.001
Quadratic TTW1							-0.001	-0.001 – -0.000	<0.001
Random Effects									
σ^2	0.82			0.82			0.77		
τ_{00}	0.00_{id}			0.00_{id}			0.00_{id}		
N	22_{id}			22_{id}			22_{id}		
Observations	222			222			222		
log-Likelihood	-293.487			-292.448			-286.372		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Models of Perceived Stress Over Time

Table 13: Perceived *physical* stress in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.027	-0.157 – 0.103	0.685	-0.511	-0.806 – -0.217	0.001	-0.475	-0.858 – -0.092	0.015
Linear TTW1				0.021	0.010 – 0.031	<0.001	0.016	-0.015 – 0.047	0.304
Quadratic TTW1							0.000	-0.000 – 0.001	0.759
Random Effects									
σ^2	1.00			0.88			0.87		
τ_{00}	0.00 $_{\text{id}}$			0.16 $_{\text{id}}$			0.16 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.ttw1}}$			0.00 $_{\text{id.ttw1}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			228		
log-Likelihood	-322.947			-312.922			-312.878		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 14: Perceived *physical* stress in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.037	-0.096 – 0.170	0.584	-0.333	-0.695 – 0.030	0.072	-0.198	-0.644 – 0.247	0.381
Linear TTW1				0.012	0.001 – 0.023	0.029	0.000	-0.025 – 0.026	0.981
Quadratic TTW1							0.000	-0.000 – 0.001	0.295
Random Effects									
σ^2	1.01			0.84			0.83		
τ_{00}	0.00 $_{\text{id}}$			0.40 $_{\text{id}}$			0.41 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.ttw2}}$			0.00 $_{\text{id.ttw2}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
ICC							0.15		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	222			222			222		
log-Likelihood	-316.055			-304.885			-304.382		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 15: Perceived *physical* stress in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.037	-0.096 – 0.170	0.584	0.344	0.047 – 0.641	0.024	0.488	0.143 – 0.834	0.006
Linear TTW1				-0.014	-0.026 – -0.001	0.030	-0.033	-0.058 – -0.009	0.008
Quadratic TTW1							0.000	-0.000 – 0.001	0.061
Random Effects									
σ^2	1.01			0.82			0.81		
τ_{00}	0.00 $_{\text{id}}$			0.22 $_{\text{id}}$			0.25 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.tsw1}}$			0.00 $_{\text{id.tsw1}}$		
ρ_{01}				-0.91 $_{\text{id}}$			-0.95 $_{\text{id}}$		
ICC				0.17			0.17		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	222			222			222		
log-Likelihood	-316.055			-306.047			-304.387		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 16: Perceived *mental* stress in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.133	-0.002 – 0.269	0.054	-0.166	-0.500 – 0.168	0.328	-0.102	-0.523 – 0.318	0.632
Linear TTW1				0.012	0.000 – 0.024	0.046	0.004	-0.028 – 0.037	0.793
Quadratic TTW1							0.000	-0.000 – 0.001	0.629
Random Effects									
σ^2	1.08			0.98			0.98		
τ_{00}	0.00 $_{\text{id}}$			0.26 $_{\text{id}}$			0.25 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.ttw1}}$			0.00 $_{\text{id.ttw1}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			228		
log-Likelihood	-332.376			-326.986			-326.871		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 17: Perceived *mental* stress in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.118	-0.266 – 0.030	0.116	-0.035	-0.428 – 0.357	0.859	0.153	-0.332 – 0.639	0.534
Linear TTW1				-0.001	-0.012 – 0.009	0.772	-0.018	-0.042 – 0.007	0.163
Quadratic TTW1							0.000	-0.000 – 0.001	0.154
Random Effects									
σ^2	1.01			0.89			0.87		
τ_{00}	0.02_{id}			0.51_{id}			0.57_{id}		
τ_{11}				$0.00_{\text{id.ttw2}}$			$0.00_{\text{id.ttw2}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
ICC	0.02								
N	22_{id}			22_{id}			22_{id}		
Observations	222			222			222		
log-Likelihood	-318.584			-311.781			-310.812		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 18: Perceived *mental* stress in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.118	-0.266 – 0.030	0.116	-0.254	-0.502 – -0.006	0.045	-0.133	-0.431 – 0.166	0.382
Linear TTW1				0.006	-0.007 – 0.018	0.381	-0.010	-0.035 – 0.015	0.429
Quadratic TTW1							0.000	-0.000 – 0.001	0.154
Random Effects									
σ^2	1.01			0.88			0.87		
τ_{00}	0.02_{id}			0.06_{id}			0.06_{id}		
τ_{11}				$0.00_{\text{id.tsw1}}$			$0.00_{\text{id.tsw1}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
ICC	0.02								
N	22_{id}			22_{id}			22_{id}		
Observations	222			222			222		
log-Likelihood	-318.584			-312.215			-311.195		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 19: Perceived *emotional* stress in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.166	0.064 – 0.268	0.002	-0.072	-0.331 – 0.186	0.583	-0.091	-0.411 – 0.230	0.578
Linear TTW1				0.009	-0.002 – 0.020	0.091	0.012	-0.014 – 0.037	0.366
Quadratic TTW1							-0.000	-0.001 – 0.000	0.846
Random Effects									
σ^2	0.61			0.52			0.51		
τ_{00}	0.00_{id}			0.17_{id}			0.17_{id}		
τ_{11}				$0.00_{\text{id.ttw1}}$			$0.00_{\text{id.ttw1}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
N	22_{id}			22_{id}			22_{id}		
Observations	228			228			228		
log-Likelihood	-267.770			-257.387			-257.368		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 20: Perceived *emotional* stress in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.163	-0.256 – -0.069	0.001	-0.141	-0.411 – 0.129	0.305	-0.077	-0.408 – 0.254	0.647
Linear TTW1				0.000	-0.006 – 0.007	0.901	-0.005	-0.022 – 0.012	0.558
Quadratic TTW1							0.000	-0.000 – 0.000	0.477
Random Effects									
σ^2	0.50			0.43			0.43		
τ_{00}	0.00_{id}			0.23_{id}			0.25_{id}		
τ_{11}				$0.00_{\text{id.ttw2}}$			$0.00_{\text{id.ttw2}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
N	22_{id}			22_{id}			22_{id}		
Observations	221			221			221		
log-Likelihood	-236.252			-230.871			-230.641		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 21: Perceived *emotional* stress in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.163	-0.256 – -0.069	0.001	-0.119	-0.360 – 0.121	0.330	0.020	-0.237 – 0.277	0.879
Linear TTW1				-0.002	-0.012 – 0.008	0.716	-0.020	-0.038 – -0.003	0.023
Quadratic TTW1							0.000	0.000 – 0.001	0.013
Random Effects									
σ^2	0.50			0.40			0.39		
τ_{00}	0.00 $_{\text{id}}$			0.19 $_{\text{id}}$			0.17 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.tsw1}}$			0.00 $_{\text{id.tsw1}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	221			221			221		
log-Likelihood	-236.252			-224.157			-221.051		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 22: Perceived *overall* stress in relation to the remaining time to workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.004	-0.131 – 0.123	0.951	-0.249	-0.503 – 0.005	0.055	-0.182	-0.509 – 0.146	0.275
Linear TTW1				0.010	0.002 – 0.018	0.013	0.002	-0.023 – 0.028	0.856
Quadratic TTW1							0.000	-0.000 – 0.001	0.517
Random Effects									
σ^2	0.69			0.65			0.64		
τ_{00}	0.02 $_{\text{id}}$			0.12 $_{\text{id}}$			0.13 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.ttw1}}$			0.00 $_{\text{id.ttw1}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
ICC	0.03								
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			228		
log-Likelihood	-283.571			-278.879			-278.670		

Note. TTW1 = remaining Time To Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 23: Perceived *overall* stress in relation to the remaining time to workout 2

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.001	-0.130 – 0.132	0.988	0.058	-0.289 – 0.404	0.743	0.292	-0.136 – 0.720	0.180
Linear TTW1				-0.000	-0.009 – 0.008	0.920	-0.020	-0.041 – 0.000	0.053
Quadratic TTW1							0.000	0.000 – 0.001	0.032
Random Effects									
σ^2	0.71			0.63			0.61		
τ_{00}	0.02 $_{id}$			0.42 $_{id}$			0.50 $_{id}$		
τ_{11}				0.00 $_{id.ttw2}$			0.00 $_{id.ttw2}$		
ρ_{01}				-1.00 $_{id}$			-1.00 $_{id}$		
ICC	0.03								
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	222			222			222		
log-Likelihood	-280.501			-274.545			-272.452		

Note. TTW2 = remaining Time To Workout 2, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 24: Perceived *overall* stress in relation to the elapsed time since workout 1

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.001	-0.130 – 0.132	0.988	-0.103	-0.363 – 0.157	0.436	0.099	-0.190 – 0.387	0.502
Linear TTW1				0.004	-0.007 – 0.015	0.455	-0.022	-0.043 – -0.001	0.036
Quadratic TTW1							0.001	0.000 – 0.001	0.004
Random Effects									
σ^2	0.71			0.61			0.60		
τ_{00}	0.02 $_{id}$			0.18 $_{id}$			0.16 $_{id}$		
τ_{11}				0.00 $_{id.tsw1}$			0.00 $_{id.tsw1}$		
ρ_{01}				-0.90 $_{id}$			-0.92 $_{id}$		
ICC	0.03			0.17			0.15		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	222			222			222		
log-Likelihood	-280.501			-274.059			-270.067		

Note. TSW1 = remaining Time Since Workout 1, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Appendix P: Article 3 – Multilevel Models of Self-Regulatory Processes Predicted by Perceived Recovery and Stress

Multilevel Models of Recovery Self-Regulation Through Self-Awareness in Relation to Perceived Recovery or Stress

Table 1: Self-awareness of recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.70	1.42 – 1.98	<0.001	1.68	1.40 – 1.97	<0.001	1.85	1.58 – 2.11	<0.001	1.89	1.62 – 2.15	<0.001
Physical recovery				-0.17	-0.37 – 0.04	0.108				-0.25	-0.43 – -0.08	0.004
Random Effects												
σ^2	1.24			1.23			0.98			0.93		
τ_{00}	0.31_{id}			0.32_{id}			0.28_{id}			0.28_{id}		
ICC	0.20			0.21			0.22			0.23		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-361.892			-360.602			-302.218			-298.100		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 2: Self-awareness of recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.70	1.42 – 1.98	<0.001	1.67	1.38 – 1.96	<0.001	1.85	1.58 – 2.11	<0.001	1.88	1.62 – 2.15	<0.001
Mental recovery				-0.22	-0.39 – -0.06	0.009				-0.20	-0.34 – -0.06	0.006
Random Effects												
σ2	1.24			1.20			0.98			0.94		
τ00	0.31_{id}			0.34_{id}			0.28_{id}			0.28_{id}		
ICC	0.20			0.22			0.22			0.23		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-361.892			-358.519			-302.218			-298.375		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 3: Self-awareness of recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.71	1.43 – 1.99	<0.001	1.69	1.40 – 1.97	<0.001	1.85	1.58 – 2.11	<0.001	1.86	1.59 – 2.12	<0.001
Emotional recovery				-0.10	-0.30 – 0.10	0.330				-0.06	-0.22 – 0.10	0.469
Random Effects												
σ2	1.23			1.23			0.98			0.97		
τ00	0.31 $_{id}$			0.32 $_{id}$			0.28 $_{id}$			0.28 $_{id}$		
ICC	0.20			0.21			0.22			0.22		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			205			205		
log-Likelihood	-359.653			-359.180			-302.218			-301.955		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 4: Self-awareness of recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.69	1.41 – 1.97	<0.001	1.69	1.41 – 1.97	<0.001	1.85	1.58 – 2.11	<0.001	1.86	1.59 – 2.12	<0.001
Overall recovery				-0.04	-0.22 – 0.14	0.655				-0.12	-0.28 – 0.04	0.149
Random Effects												
σ2	1.24			1.24			0.98			0.97		
τ00	0.31 $_{id}$			0.31 $_{id}$			0.28 $_{id}$			0.28 $_{id}$		
ICC	0.20			0.20			0.22			0.22		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			205			205		
log-Likelihood	-360.444			-360.344			-302.218			-301.177		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 5: Self-awareness of recovery in relation to one's perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.70	1.42 – 1.98	<0.001	1.71	1.43 – 1.99	<0.001	1.84	1.57 – 2.11	<0.001	1.86	1.60 – 2.12	<0.001
Physical stress				0.24	0.09 – 0.39	0.002				0.34	0.20 – 0.48	<0.001
Random Effects												
σ2	1.24			1.19			0.98			0.87		
τ00	0.31 $_{id}$			0.31 $_{id}$			0.29 $_{id}$			0.29 $_{id}$		
ICC	0.20			0.21			0.23			0.25		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	228			228			205			205		
log-Likelihood	-361.892			-356.925			-302.432			-291.969		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 6: Self-awareness of recovery in relation to one's perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.70	1.42 – 1.98	<0.001	1.69	1.41 – 1.97	<0.001	1.84	1.57 – 2.11	<0.001	1.86	1.59 – 2.13	<0.001
Mental stress				0.05	-0.09 – 0.20	0.479				0.20	0.07 – 0.34	0.004
Random Effects												
σ2	1.24			1.24			0.98			0.93		
τ00	0.31 $_{id}$			0.31 $_{id}$			0.29 $_{id}$			0.29 $_{id}$		
ICC	0.20			0.20			0.23			0.24		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	228			228			205			205		
log-Likelihood	-361.892			-361.640			-302.432			-298.221		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 7: Self-awareness of recovery in relation to one’s perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.70	1.42 – 1.98	<0.001	1.67	1.39 – 1.96	<0.001	1.84	1.57 – 2.10	<0.001	1.86	1.59 – 2.12	<0.001
Emotional stress				0.14	-0.05 – 0.33	0.144				0.15	-0.05 – 0.34	0.141
Random Effects												
σ2	1.24			1.23			0.98			0.97		
τ00	0.31 $_{\text{id}}$			0.32 $_{\text{id}}$			0.28 $_{\text{id}}$			0.27 $_{\text{id}}$		
ICC	0.20			0.21			0.22			0.22		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			204			204		
log-Likelihood	-361.892			-360.826			-301.430			-300.347		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 8: Self-awareness of recovery in relation to one’s perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.70	1.42 – 1.98	<0.001	1.70	1.42 – 1.98	<0.001	1.84	1.57 – 2.11	<0.001	1.85	1.58 – 2.11	<0.001
Overall stress				0.16	-0.02 – 0.34	0.088				0.29	0.13 – 0.46	0.001
Random Effects												
σ2	1.24			1.22			0.98			0.92		
τ00	0.31 $_{\text{id}}$			0.31 $_{\text{id}}$			0.29 $_{\text{id}}$			0.29 $_{\text{id}}$		
ICC	0.20			0.20			0.23			0.24		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			205			205		
log-Likelihood	-361.892			-360.435			-302.432			-296.583		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Multilevel Models of Recovery Self-Regulation Through Checking-In in Relation to Perceived Recovery or Stress

Table 9: Checking-in on recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.43	1.14 – 1.72	<0.001	1.42	1.13 – 1.72	<0.001	1.64	1.33 – 1.95	<0.001	1.66	1.35 – 1.97	<0.001
Physical recovery				-0.09	-0.27 – 0.10	0.347				-0.09	-0.26 – 0.07	0.252
Random Effects												
σ2	1.00			0.99			0.83			0.82		
τ00	0.37_{id}			0.38_{id}			0.44_{id}			0.44_{id}		
ICC	0.27			0.28			0.35			0.35		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-340.024			-339.581			-290.599			-289.941		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 10: Checking-in on recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.43	1.14 – 1.72	<0.001	1.42	1.12 – 1.71	<0.001	1.64	1.33 – 1.95	<0.001	1.67	1.36 – 1.98	<0.001
Mental recovery				-0.08	-0.23 – 0.07	0.271				-0.12	-0.26 – 0.01	0.067
Random Effects												
σ2	1.00			0.99			0.83			0.81		
τ00	0.37_{id}			0.38_{id}			0.44_{id}			0.44_{id}		
ICC	0.27			0.28			0.35			0.35		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-340.024			-339.422			-290.599			-288.924		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 11: Checking-in on recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.44	1.15 – 1.73	<0.001	1.43	1.14 – 1.72	<0.001	1.64	1.33 – 1.95	<0.001	1.66	1.35 – 1.97	<0.001
Emotional recovery				-0.04	-0.22 – 0.15	0.690				-0.06	-0.21 – 0.09	0.420
Random Effects												
σ2	1.00			0.99			0.83			0.83		
τ00	0.37 $_{id}$			0.37 $_{id}$			0.44 $_{id}$			0.44 $_{id}$		
ICC	0.27			0.27			0.35			0.34		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			205			205		
log-Likelihood	-338.350			-338.271			-290.599			-290.274		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 12: Checking-in on recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.43	1.14 – 1.72	<0.001	1.43	1.14 – 1.72	<0.001	1.64	1.33 – 1.95	<0.001	1.65	1.34 – 1.96	<0.001
Overall recovery				0.03	-0.13 – 0.19	0.709				-0.06	-0.21 – 0.09	0.441
Random Effects												
σ2	1.00			1.00			0.83			0.83		
τ00	0.38 $_{id}$			0.38 $_{id}$			0.44 $_{id}$			0.44 $_{id}$		
ICC	0.27			0.27			0.35			0.35		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			205			205		
log-Likelihood	-338.802			-338.732			-290.599			-290.301		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 13: Checking-in on recovery in relation to one's perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.43	1.14 – 1.72	<0.001	1.44	1.15 – 1.73	<0.001	1.64	1.32 – 1.95	<0.001	1.65	1.34 – 1.96	<0.001
Physical stress				0.20	0.07 – 0.33	0.003				0.15	0.01 – 0.29	0.034
Random Effects												
σ2	1.00			0.96			0.83			0.81		
τ00	0.37 $_{id}$			0.36 $_{id}$			0.45 $_{id}$			0.44 $_{id}$		
ICC	0.27			0.28			0.35			0.35		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	228			228			205			205		
log-Likelihood	-340.024			-335.681			-290.517			-288.256		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 14: Checking-in on recovery in relation to one's perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.43	1.14 – 1.72	<0.001	1.43	1.14 – 1.72	<0.001	1.64	1.32 – 1.95	<0.001	1.65	1.34 – 1.96	<0.001
Mental stress				-0.01	-0.14 – 0.12	0.890				0.13	0.00 – 0.26	0.046
Random Effects												
σ2	1.00			1.00			0.83			0.81		
τ00	0.37 $_{id}$			0.37 $_{id}$			0.45 $_{id}$			0.45 $_{id}$		
ICC	0.27			0.27			0.35			0.36		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	228			228			205			205		
log-Likelihood	-340.024			-340.014			-290.517			-288.520		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 15: Checking-in on recovery in relation to one’s perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.43	1.14 – 1.72	<0.001	1.42	1.13 – 1.71	<0.001	1.64	1.32 – 1.95	<0.001	1.65	1.34 – 1.96	<0.001
Emotional stress				0.05	-0.12 – 0.22	0.541				0.14	-0.04 – 0.32	0.135
Random Effects												
σ2	1.00			0.99			0.83			0.82		
τ00	0.37 $_{\text{id}}$			0.38 $_{\text{id}}$			0.45 $_{\text{id}}$			0.43 $_{\text{id}}$		
ICC	0.27			0.28			0.35			0.34		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			204			204		
log-Likelihood	-340.024			-339.837			-289.514			-288.397		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 16: Checking-in on recovery in relation to one’s perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.43	1.14 – 1.72	<0.001	1.43	1.14 – 1.72	<0.001	1.64	1.32 – 1.95	<0.001	1.64	1.33 – 1.95	<0.001
Overall stress				0.13	-0.04 – 0.29	0.129				0.12	-0.04 – 0.28	0.145
Random Effects												
σ2	1.00			0.99			0.83			0.82		
τ00	0.37 $_{\text{id}}$			0.37 $_{\text{id}}$			0.45 $_{\text{id}}$			0.45 $_{\text{id}}$		
ICC	0.27			0.27			0.35			0.35		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	228			228			205			205		
log-Likelihood	-340.024			-338.866			-290.517			-289.450		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

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Table 17: Interpretation of recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.32	1.01 – 1.62	<0.001	1.32	1.01 – 1.62	<0.001	1.38	1.05 – 1.71	<0.001	1.39	1.06 – 1.72	<0.001
Physical recovery				-0.00	-0.19 – 0.19	0.984				-0.08	-0.24 – 0.09	0.346
Random Effects												
σ2	1.07			1.07			0.85			0.85		
τ00	0.41_{id}			0.41_{id}			0.51_{id}			0.51_{id}		
ICC	0.28			0.28			0.37			0.38		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-348.224			-348.224			-294.332			-293.887		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 18: Interpretation of recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.32	1.01 – 1.62	<0.001	1.31	1.00 – 1.62	<0.001	1.38	1.05 – 1.71	<0.001	1.41	1.08 – 1.74	<0.001
Mental recovery				-0.05	-0.21 – 0.10	0.506				-0.16	-0.30 – -0.03	0.019
Random Effects												
σ2	1.07			1.07			0.85			0.82		
τ00	0.41_{id}			0.42_{id}			0.51_{id}			0.51_{id}		
ICC	0.28			0.28			0.37			0.38		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-348.224			-348.004			-294.332			-291.572		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 19: Interpretation of recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.32	1.02 – 1.63	<0.001	1.33	1.03 – 1.64	<0.001	1.38	1.05 – 1.71	<0.001	1.38	1.05 – 1.71	<0.001
Emotional recovery				0.04	-0.15 – 0.23	0.662				-0.01	-0.16 – 0.14	0.908
Random Effects												
σ2	1.07			1.07			0.85			0.85		
τ00	0.40_{id}			0.40_{id}			0.51_{id}			0.51_{id}		
ICC	0.27			0.27			0.37			0.37		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	227			227			205			205		
log-Likelihood	-346.813			-346.718			-294.332			-294.325		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 20: Interpretation of recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.31	1.01 – 1.62	<0.001	1.31	1.01 – 1.62	<0.001	1.38	1.05 – 1.71	<0.001	1.39	1.06 – 1.72	<0.001
Overall recovery				0.13	-0.03 – 0.29	0.114				-0.10	-0.25 – 0.05	0.177
Random Effects												
σ2	1.07			1.06			0.85			0.84		
τ00	0.40_{id}			0.41_{id}			0.51_{id}			0.51_{id}		
ICC	0.27			0.28			0.37			0.38		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	227			227			205			205		
log-Likelihood	-346.617			-345.363			-294.332			-293.420		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 21: Interpretation of recovery in relation to one’s perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.32	1.01 – 1.62	<0.001	1.33	1.03 – 1.64	<0.001	1.38	1.05 – 1.70	<0.001	1.39	1.06 – 1.71	<0.001
Physical stress				0.23	0.10 – 0.37	0.001				0.19	0.05 – 0.33	0.007
Random Effects												
σ2	1.07			1.01			0.85			0.82		
τ00	0.41_{id}			0.42_{id}			0.50_{id}			0.50_{id}		
ICC	0.28			0.29			0.37			0.38		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-348.224			-342.792			-294.168			-290.549		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 22: Interpretation of recovery in relation to one’s perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.32	1.01 – 1.62	<0.001	1.31	1.01 – 1.62	<0.001	1.38	1.05 – 1.70	<0.001	1.39	1.06 – 1.73	<0.001
Mental stress				0.05	-0.08 – 0.19	0.420				0.16	0.04 – 0.29	0.012
Random Effects												
σ2	1.07			1.06			0.85			0.82		
τ00	0.41_{id}			0.41_{id}			0.50_{id}			0.51_{id}		
ICC	0.28			0.28			0.37			0.39		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	228			228			205			205		
log-Likelihood	-348.224			-347.898			-294.168			-291.009		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 23: Interpretation of recovery in relation to one's perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.32	1.01 – 1.62	<0.001	1.30	0.99 – 1.61	<0.001	1.37	1.05 – 1.70	<0.001	1.41	1.09 – 1.73	<0.001
Emotional stress				0.10	-0.07 – 0.27	0.261				0.28	0.10 – 0.46	0.002
Random Effects												
σ2	1.07			1.06			0.85			0.81		
τ00	0.41 $_{id}$			0.42 $_{id}$			0.50 $_{id}$			0.48 $_{id}$		
ICC	0.28			0.28			0.37			0.37		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	228			228			204			204		
log-Likelihood	-348.224			-347.593			-293.002			-288.389		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 24: Interpretation of recovery in relation to one's perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.32	1.01 – 1.62	<0.001	1.32	1.02 – 1.63	<0.001	1.38	1.05 – 1.70	<0.001	1.38	1.05 – 1.70	<0.001
Overall stress				0.18	0.02 – 0.35	0.030				0.20	0.04 – 0.35	0.016
Random Effects												
σ2	1.07			1.04			0.85			0.83		
τ00	0.41 $_{id}$			0.43 $_{id}$			0.50 $_{id}$			0.49 $_{id}$		
ICC	0.28			0.29			0.37			0.37		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	228			228			205			205		
log-Likelihood	-348.224			-345.883			-294.168			-291.284		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Multilevel Models of Recovery Self-Regulation Through Adjustments in Relation to Perceived Recovery or Stress

Table 25: Adjusting recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.84	0.58 – 1.09	<0.001	0.84	0.58 – 1.09	<0.001	0.81	0.51 – 1.11	<0.001	0.83	0.53 – 1.13	<0.001
Physical recovery				0.00	-0.18 – 0.18	0.999				-0.13	-0.28 – 0.02	0.086
Random Effects												
σ2	0.99			0.99			0.69			0.68		
τ00	0.26_{id}			0.26_{id}			0.42_{id}			0.43_{id}		
ICC	0.21			0.21			0.38			0.39		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	227			227			205			205		
log-Likelihood	-335.258			-335.258			-273.713			-272.239		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 26: Adjusting recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.84	0.58 – 1.09	<0.001	0.83	0.57 – 1.09	<0.001	0.81	0.51 – 1.11	<0.001	0.83	0.54 – 1.13	<0.001
Mental recovery				-0.05	-0.20 – 0.10	0.538				-0.13	-0.25 – -0.00	0.044
Random Effects												
σ2	0.99			0.99			0.69			0.68		
τ00	0.26_{id}			0.27_{id}			0.42_{id}			0.40_{id}		
ICC	0.21			0.21			0.38			0.37		
N	22_{id}			22_{id}			22_{id}			22_{id}		
Observations	227			227			205			205		
log-Likelihood	-335.258			-335.069			-273.713			-271.675		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 27: Adjusting recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.85	0.58 – 1.11	<0.001	0.88	0.61 – 1.14	<0.001	0.81	0.51 – 1.11	<0.001	0.85	0.56 – 1.15	<0.001
Emotional recovery				0.15	-0.03 – 0.33	0.099				-0.21	-0.35 – -0.08	0.002
Random Effects												
σ2	0.98			0.97			0.69			0.66		
τ00	0.29 $_{id}$			0.28 $_{id}$			0.42 $_{id}$			0.40 $_{id}$		
ICC	0.23			0.22			0.38			0.38		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	226			226			205			205		
log-Likelihood	-333.013			-331.654			-273.713			-269.077		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 28: Adjusting recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.84	0.58 – 1.10	<0.001	0.84	0.58 – 1.11	<0.001	0.81	0.51 – 1.11	<0.001	0.82	0.52 – 1.12	<0.001
Overall recovery				0.01	-0.14 – 0.17	0.888				-0.06	-0.20 – 0.07	0.350
Random Effects												
σ2	0.98			0.98			0.69			0.69		
τ00	0.28 $_{id}$			0.28 $_{id}$			0.42 $_{id}$			0.42 $_{id}$		
ICC	0.22			0.22			0.38			0.38		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	226			226			205			205		
log-Likelihood	-332.886			-332.876			-273.713			-273.276		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 29: Adjusting recovery in relation to one’s perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.84	0.58 – 1.09	<0.001	0.85	0.59 – 1.10	<0.001	0.81	0.51 – 1.12	<0.001	0.82	0.52 – 1.12	<0.001
Physical stress				0.19	0.05 – 0.32	0.006				0.09	-0.04 – 0.22	0.167
Random Effects												
σ2	0.99			0.96			0.70			0.69		
τ00	0.26 $_{id}$			0.27 $_{id}$			0.43 $_{id}$			0.42 $_{id}$		
ICC	0.21			0.22			0.38			0.38		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			205			205		
log-Likelihood	-335.258			-331.484			-273.889			-272.932		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 30: Adjusting recovery in relation to one’s perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.84	0.58 – 1.09	<0.001	0.82	0.57 – 1.08	<0.001	0.81	0.51 – 1.12	<0.001	0.83	0.54 – 1.13	<0.001
Mental stress				0.15	0.03 – 0.28	0.018				0.17	0.06 – 0.29	0.003
Random Effects												
σ2	0.99			0.97			0.70			0.67		
τ00	0.26 $_{id}$			0.27 $_{id}$			0.43 $_{id}$			0.41 $_{id}$		
ICC	0.21			0.22			0.38			0.38		
N	22 $_{id}$			22 $_{id}$			22 $_{id}$			22 $_{id}$		
Observations	227			227			205			205		
log-Likelihood	-335.258			-332.466			-273.889			-269.538		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 31: Adjusting recovery in relation to one's perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.84	0.58 – 1.09	<0.001	0.83	0.58 – 1.09	<0.001	0.81	0.51 – 1.11	<0.001	0.84	0.55 – 1.14	<0.001
Emotional stress				0.01	-0.16 – 0.18	0.881				0.26	0.10 – 0.43	0.002
Random Effects												
σ2	0.99			0.99			0.70			0.67		
τ00	0.26 $_{\text{id}}$			0.26 $_{\text{id}}$			0.42 $_{\text{id}}$			0.39 $_{\text{id}}$		
ICC	0.21			0.21			0.38			0.37		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	227			227			204			204		
log-Likelihood	-335.258			-335.247			-272.766			-267.860		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Table 32: Adjusting recovery in relation to one's perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.84	0.58 – 1.09	<0.001	0.84	0.59 – 1.10	<0.001	0.81	0.51 – 1.12	<0.001	0.82	0.52 – 1.11	<0.001
Overall stress				0.19	0.03 – 0.35	0.018				0.23	0.09 – 0.37	0.002
Random Effects												
σ2	0.99			0.96			0.70			0.66		
τ00	0.26 $_{\text{id}}$			0.27 $_{\text{id}}$			0.43 $_{\text{id}}$			0.41 $_{\text{id}}$		
ICC	0.21			0.22			0.38			0.38		
N	22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$			22 $_{\text{id}}$		
Observations	227			227			205			205		
log-Likelihood	-335.258			-332.466			-273.889			-268.928		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants).

Appendix Q: Article 4 – Consent Form

[*Presented in SurveyMonkey*]
Title: The Recovery Skills Study – Sign-up Form

Page 1: Welcome to The Recovery Skills Study Sign-up Form!

Project Summary. Participants in this study will be asked to do two workouts on Zwift, 48 hours apart. In the 48 hours before each workout, you will be asked to fill out a series of short forms throughout the day on our study app. Outside of the two key workouts, please feel free to train however, whenever, and as much or little as you would like.

This is the sign-up form for The Recovery Skills Study. The following pages hold a consent form, a detailed explanation of the study procedures, and some questions about you and your sport involvement.

To participate in the study, please read through and complete each page.

Page 2: Informed Consent Form

Please read the following consent form carefully so that you understand the details of the study and what is being asked of you if you choose to participate. Please indicate you understand and consent to participate by filling out the information at the bottom of the page.

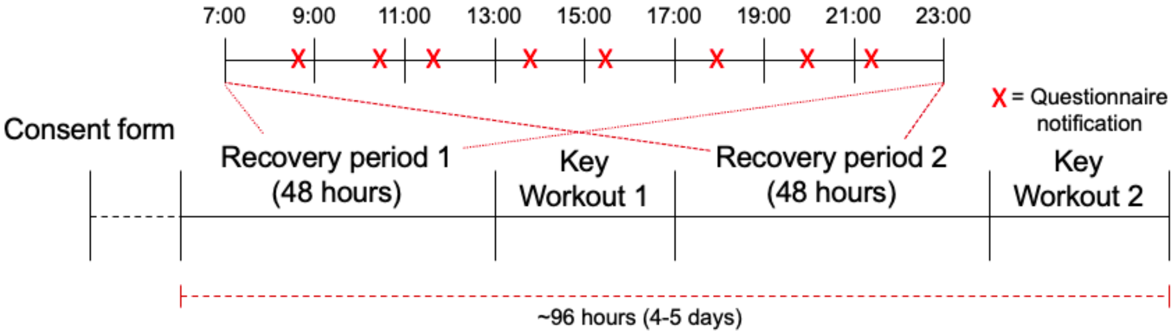
PURPOSE: To assess how competitive endurance athletes self-regulate their recovery, and whether the skills and strategies they use could provide a recovery advantage in training and performance.

This study is formally titled “Assessing the regulation, content, and experience of recovery between key training sessions” and is led by Stuart G. Wilson as part of his PhD research program, and is supervised by Dr. Bradley W. Young at the University of Ottawa.

OVERVIEW: In this study, participants will be asked to complete two specific workouts on Zwift, 48 hours apart.

- In the 48 hours before each workout, participants will be asked to complete a 1-minute survey on their phone, once every two hours asking about their recovery thoughts, feelings, and actions.
- Both key workouts will be done on Zwift: Workout 1 will be the Zwift FTP test (short version). Workout 2 will the Zwift Ramp (or Ramp Lite) test. Otherwise, participants should train as usual.
- Participants will be asked to share their workout data with us during the study. The easiest way to do this is by connecting their account TrainingPeaks with the study's "Coach" account (only for the duration of the study), although we have several options to make this work for all participants.

Please see the study timeline and explanation of what will happen at each time point below.



DETAILED PROCEDURE.

- As part of this sign-up form, you will be asked to answer some administrative and demographic questions which are needed to set up the study.
- Once we have confirmed your sign-up information, we will send an email with detailed instructions asking you to complete three steps:
    1. Download the study app on your phone and log in with your participant ID. You will receive an emailed invitation with your Participant ID and instructions on how to download the app.
    2. Connect your TrainingPeaks account with the study's "Coach" account. This will allows us to see summary data about your workouts during the study. The email will describe how to connect the accounts as well as several alternatives if you do not have a TrainingPeaks account or do not want to connect accounts.
    3. Sync your Zwift account with your TrainingPeaks account. This will automatically share your workout data with TrainingPeaks, allowing us to record it for the study.
    4. Once you have successfully completed all three steps, we will email you with details about the two key workouts on Zwift and confirm when you would like to complete them.
- *Key Workout 1* will be Zwift's "FTP test (shorter)". The goal of Workout 1 is to establish your baseline performance level for the study; it takes 45 minutes total to complete (including warm-up and cooldown). *Key Workout 2* will be Zwift's Ramp (or Ramp Lite) test. The goal of Workout 2 is to assess your recovery; it takes less than 45 minutes total to complete.
    1. You will be asked to participate in these workouts in the afternoon/evening at a time you chose, in any location you choose (i.e., wherever your Zwift setup is; e.g., the comfort of your own home).
    2. Before each workout, we will share specific details about how to set up the workout. You can find specific details about each workout on our study website.
    3. Your Zwift workouts will be automatically synced with TrainingPeaks, which we will use to record summary data about your workouts during the study.
- Recovery periods 1 and 2 represent the 48 hours before Workouts 1 and 2 respectively. You should continue to participate in all other regular planned training during both recovery periods 1 and 2. This training does not need to be completed on Zwift, but

should be recorded in TrainingPeaks, either manually or through other connected devices (e.g., Bike computer; GPS watch).
    1. During both Recovery periods 1 and 2, the study app will notify you to complete a "Brief Recovery Check-in" once randomly within each two-hour block during waking hours (e.g., once between 9:00 am and 11:00 am, once between 11:00 am and 1:00 pm, etc.).
    2. The "Brief Recovery Check-in" is a short questionnaire (less than 1 min to complete on average) hosted on the study app addressing your recovery-related actions, thoughts, and feelings at that moment.
    3. When you receive a notification, please complete the linked questionnaire as soon as safely possible. Notifications will expire after 30 minutes. Please do not adjust your schedule in anticipation of receiving a notification.
- Before and after both Key Workouts, the questionnaires will be slightly longer (5-10 minutes), with added questions about your recovery and workouts.
    1. The PRE Key Workout Questionnaire will arrive 60 minutes before each key workout.
    2. The POST Key Workout Questionnaire will arrive 60 minutes after the scheduled start of each key workout.
    3. Please complete these questionnaires within 30 minutes.
    4. These PRE and POST questionnaires are very important - please make every effort to complete them.
- After completing the POST Key Workout 2 Questionnaire, you are done the study.
    1. Within 24 hours, we will send you an individual report and delete the connection between TrainingPeaks accounts.
    2. You can also delete the study app.

PARTICIPANTS. To participate in this study, please confirm that you meet the following criteria: [*check boxes*]

(1) I am 17 years of age or older.
(2) I am currently engaging in regular endurance training, 3 times per week or more.
(3) I own a functioning smartphone that can connect to wifi or data (Once you log in to the study app, no wifi/data is required to participate in the study).
(4) I have an active account on Zwift and the appropriate equipment to complete workouts on the platform (e.g., a *smart* cycling trainer and/or power meter). Both key workouts will take place on Zwift.
(5) I have previously completed a race on Zwift. This ensures a baseline fitness and performance level.
(6) I have previously completed a Functional Threshold Power (FTP) Test on Zwift. This includes any of the four types of FTP tests available on Zwift.
(7) I am willing to share my workout data during the study with the lead researcher, either by connecting my TrainingPeaks account with the study’s Coach account for the duration of the study, or by sending my Zwift workout file to the lead researcher. This will allow the lead researcher to record summary details about workouts during the study.

BENEFITS. Participating in this study will help bring awareness to your levels of stress and recovery throughout the day, the actions and thoughts that contribute to regulating them, and the impact they have on your performance in practice. This research is a significant step in expanding our knowledge of how athletes can use and improve their skills of recovery self-regulation to optimize their health and performance.

CONFIDENTIALITY AND ANONYMITY. Should you agree to participate, the information you provide will remain entirely confidential.

- Throughout the study, you are not required to respond to any questions or share any information that you would not like to. Your responses will be assigned an internal ID code to maintain your anonymity. Results will only be shared in an anonymized, summarized format.
- This study uses two apps, depending on your location. Participants in North America will use the SEMA3 app; participants in Oceania will use the m-path app.
    - The SEMA3 app platform was designed by researchers at The University of Melbourne, Australian Catholic University and Orygen – The National Centre of Excellence in Youth Mental Health and is developed and maintained by the Melbourne eResearch Group. We will only upload anonymous email addresses to the platform, which assigns each address a unique participant ID and then permanently deletes the address.
    - The m-path app platform was designed and is maintained by researchers from the university KU Leuven. We will provide you with a unique participant ID to use as your "nickname" on the platform; otherwise, your participation on the app is completely confidential.
- The connection between athlete and Coach accounts on TrainingPeaks will only be used to record summary details about the key workouts (workout time of day, duration, average heart rate, average power, average speed, and perceived exertion) and will be deleted within 24 hours of your completing the study.
- To minimize the risk of security breaches and to help ensure your confidentiality, we recommend that you use standard safety measures such as signing out of your account, closing your browser, and locking your screen or device when you are no longer using them / when you have completed the study.

RISKS. This study centers on two key workouts. These workouts are hard, and participants will likely experience some fatigue and soreness discomfort from engaging in them, but they should mimic your regular training so the study should not add any significant additional discomfort over and above your normal engagement in training.

Participants will be asked to report what they are doing and thinking when they receive the study's notifications during the day. Responses will be confidential and anonymous, so any reported activities or thoughts cannot be connected to you, and it always remains your decision whether and what to report, as well as how to describe your thoughts and actions around recovery. Participants will be also asked to connect their TrainingPeaks account with the study's Coach account during the study, allowing the principal investigator to view their training. You may feel psychological discomfort by making your training viewable, however the principal investigator will only record the following details from workouts within the 96-hour period of the study: workout time of day, duration, average heart rate, average power, average speed, and perceived exertion.

Should you experience any types of discomfort as a result of your participation, The Canadian Sport Helpline is a confidential listening and referral service for athletes wishing to share or obtain information about anything from dealing with stress, to abuse, harassment, or discrimination in sport. Operated by the Canadian Centre for Mental Health and Sport, this line connects you with a team of practitioners with expertise in counselling, psychology, and sport. The toll-free Helpline is available from 8 a.m. to 8 p.m. (Eastern Time), seven days per week by telephone or text message at: 1-888-83SPORT or 1-888-837-7678. Alternatively, participants may contact the Mental Health Helpline at 1-866-531-2600 and online at http://www.mentalhealthhelpline.ca/.

Data collected via the SEMA3 app are securely transferred to a central server hosted by the University of Melbourne and managed by the Melbourne eResearch Group (MeG). Raw data collected are stored on local University of Melbourne servers and are only accessible by admins of the study and members of the MeG development team. Data collected via the m-path app are securely transferred to a central server at KU Leuven and managed by the m-path team. This data is only accessible by the study administrator and members of the development team.

CONSERVATION OF DATA. Electronic data, including consent forms and questionnaire responses, will be stored on a secure, password-protected computer. The connection between your TrainingPeaks account and the study's Coach account will be deleted within 24 hours of your completing the study. All other data will be kept for 10 years, after which it will be destroyed.

VOLUNTARY PARTICIPATION. You are under no obligation to participate. If you choose to participate, you can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If you choose to withdraw by notifying one of the investigators, all data gathered until that point will be destroyed, unless you indicate that it should be kept.

RESEARCHER CONTACT INFORMATION. You may contact the researchers at any time using the following information:

Stuart Wilson – Primary Investigator
    PhD (c), School of Human Kinetics, Faculty of Health Sciences, University of Ottawa
    Phone: [redacted]
Dr. Bradley W. Young – Supervisor
    Professor, School of Human Kinetics, Faculty of Health Sciences, University of Ottawa
    Phone: [redacted]

If you have any questions regarding the ethical conduct of this study, you may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5
Tel.: (613) 562-5387
Email: ethics@uottawa.ca

ACCEPTANCE. By providing your name and email address below, you are agreeing to voluntarily participate in this study, acknowledging that you have been informed of the nature of the research, and recognizing that now and at any time you can contact the investigators if you have any questions. Your email will be used to contact you during the study.

Appendix R: Article 4 – Sign-up Form

[*Presented in SurveyMonkey*]
Title: The Recovery Skills Study – Sign-up Form

Page 1: Welcome to The Recovery Skills Study Sign-up Form! [*see Appendix Q*]
Page 2: Informed Consent Form [*see Append Q*]
Page 3: Participation Details

Welcome to The Recovery Skills Study! Thank you for your interest in participating.
To set up the study, we need a couple details.

First, please select the date and time when you would like to participate in your Key Workouts. We use these times to schedule all the notifications during the study.

1) Workout 1 should be at least 7 days from now, which gives us time to set up the study for you.
2) Please choose a time in the afternoon/evening.
3) Workout 2 will be scheduled to start 48 hours after Workout 1 began (i.e., the same time of day, 2 days later).

We will follow up with you to confirm that these workout times are a fit.

- When would you like to start Workout 1?
    - (Workout 2 will be scheduled for the same time, 2 days later).
    - *[dropdown menus for Date, time]*

Second, please select your time zone during the study.
(All study notifications are sent according to your local time)
[Dropdown menu of global timezones]

[Page 4] Demographic Details
What was your sex assigned at birth?
- Male
- Female

What is your gender?
- Man
- Woman
- I identify as... *[open textbox]*

What is your birth date?
[*dropdown menus for year, month, day*]

[Page 5] Use of Zwift

We have a couple questions addressing how familiar you are with cycling on Zwift. As a reminder, we are not affiliated with Zwift in any way – these questions help us understand the people participating in our study.

What is your **current suggested racing category** on Zwift?
This category is based on your FTP. To find it, sign in to your account on Zwift.com, click on "Activity Feed", and scroll down to "Fitness" where your "Suggested Category" will be listed.

- A
- B
- C
- D
- I don’t have a racing category
- I don’t know
- Other: [text box]

Approximately when did you **last complete a cycling FTP test** on Zwift?
(This includes any of the four types of FTP tests that Zwift offers).

- Approximate date of last test: [Year, Month, Day]

What is your approximate **current weight**? We divide your FTP by weight to get a measure of relative power, which helps contextualize you cycling ability (see here for more details on why we use relative power).

- Option A) Weight in kg [open text box]
- Option B) Weight in lbs [open text box]

To participate in this study, you must use an indoor trainer with a valid and reliable way of transmitting power data.
Please indicate which **brand of indoor trainer** and (if applicable) which **brand of power meter** you use:

- Indoor trainer: [text box]
    - (e.g., Wahoo Snap, TacX Neo)
- Power meter: [text box]
    - (e.g., Quarq, SRAM)
- Other source of power data: [text box]

Approximately when did you first start **cycling on Zwift**?
(i.e., How long have you been using Zwift, on cycling mode?)

- Date*: [drop down menu of years and months]*

Approximately when did you first start **competing in bike races on Zwift**?
(i.e., When did you enter your first cycling race on Zwift?)

- Date*: [drop down menu of years and months]*

Approximately **how many races** have you completed **on Zwift** in the last 6 months?
(Please enter a whole number: e.g., 0, 1, 2, 3, etc.)

- *[text box]*

What is your main sport? If applicable, please also list your main event(s) in that sport. *[open textbox]*

Approximately when did you start competitive training for this sport?
(Feel free to define competitive training as anything more than recreational or casual engagement in the sport)
[drop down menu of years and months]

[Page 6] Sport History
Lastly, we'd like to get a quick idea of your training history.

First, we'd like an idea of your training going into the study. Please indicate roughly **how much time you spent training** in each of the past four weeks.

This can include any cycling and/or non-cycling training activities (on Zwift or not) that you engaged in to improve your fitness or performance.
[Dropdown menus of sessions, hours, minutes for:]

- Training in the past week (or 7 days):
- Two weeks ago (or 8-14 days ago):
- Three weeks ago (or 15-21 days ago):
- Four weeks ago (or 22-28 days ago):

How long have you been **training competitively in any sport**?
Competitive training involves any training/practice done to improve performance. It can involve anything beyond recreational or casual engagement in a sport.

- Competitive training: [*Dropdown menus of years and months]*

What was the **highest level that you competed at** during that time for any sport?

- Recreational or House league participation
- City / Regional Championship level or equivalent
- Provincial / State Championship level or equivalent
- National Championship level or equivalent
- International Championship level
  (e.g., World Championships, Olympics)
- My sport didn't/doesn’t really have championships
  (e.g., Mass participation road running races)

What **sport** did you reach that level in?
If applicable, please also list your main event(s) in that sport (e.g., Swimming, 100 and 200 Backstroke).
[*open text box*]

Could you please **describe your best performance in that sport** (i.e., highest placing, fastest, highest ranking, etc.)? Please provide the competition, the event, the month and year, and the performance mark (e.g., time, place).

For example:
Competition: Boston Marathon
Event: Marathon
Month & Year: April 2018
Performance: 2:30:45

- Competition:
- Event:
- Month & Year:
- Performance:

[Page 7] Finished

We will contact you to confirm your participation in the study, the date/time of your workouts, and to provide technical details to set up the study.
That's all for now! When you click "Done" you will see a blank white browser screen.

Appendix S: Article 4 – Regular Experience Sampling Form Items

Items are presented in the SEMA3 app for North American participants, and in the m-path app for Oceanic participants. Each prompt or item is presented on a separate page in the app. Items, response formats, and the associated logic of presentation are identical between platforms.

- We're going to ask you to rate your agreement with a couple statements about recovery.
    - As a reminder, what exactly counts as recovery is up to you.
    - In general, recovery is whatever helps you absorb the work from your previous workouts, and prepares you for the work in your next workouts.
    - It can be mental, physical or a mix of both.
    - It can be more dialed-in and focused, or more dialed-out and relaxed.

[Following 2 items rated on a 5-pt. scale: Not at all, A little, Somewhat, Considerably, Almost completely]

- [Actions] During the past half-hour, what I've been doing has been guided by my recovery.
- [Thoughts] During the past half-hour, what I've been thinking about has been guided by my recovery.

- Please rate your agreement with the following statements:
    - *[Following 6 items rated on a 5-pt. scale: Not at all, A little, Occasionally, Often, Almost all the time] [First two items were not analyzed in this dissertation]*
- [Self-know] I know what I need to do over the next few hours for my recovery.
- [Plan] I have a plan for my recovery over the next few hours.
- [Aware] During the past half-hour, I was aware of how recovered I felt.
- [Check] During the past half-hour, I checked in on how recovered I felt.
- [Interpret] During the past half-hour, I compared how recovered I felt with how I expected to feel.
- [Adjust] During the past half-hour, I purposefully adjusted my current or planned recovery.

- The following statements describe different aspects of your current state of recovery. Rate how you feel right now, compared to your best ever recovery state.
    - *[Following 4 items rated on a 7-pt. slider, anchored at ends by "Not at all" and "Fully applies"]*
- [Rec_phys] Physically, I feel: strong, physically capable, energetic, powerful.
- [Rec_ment] Mentally, I feel: attentive, receptive, mentally alert, concentrated.
- [Rec_emo] Emotionally, I feel: pleased, stable, in a good mood, like I have everything under control.
- [Rec_gen] Overall, I feel: recovered, rested, relaxed.

- The following statements describe different aspects of your current state of stress/fatigue. Please rate how you feel right now, compared to your highest ever stress state.

  - *[Following 4 items rated on a 7-pt. slider, anchored at ends by "Not at all" and "Fully applies"]*
- [Str_phys] Physically, my muscles feel: exhausted, fatigued, sore, stiff.
- [Str_ment] Mentally, I feel: unmotivated, sluggish, unenthusiastic, like I'm lacking energy.
- [Str_emo] Emotionally, I feel: stressed, annoyed, short tempered, like I'm feeling down.
- [Str_gen] Overall, I feel: tired, worn out, overloaded, exhausted.

- Have you missed or skipped a check-in questionnaire since you last completed one?
  - Yes / No
  - [If yes] For the most recent questionnaire you missed, roughly when did it arrive?
  - [If yes] For the most recent questionnaire you missed, what was the general reason?

Appendix T: Article 4 – Post-Key Workout 1 Experience Sampling Form Items

Items are presented in the SEMA3 app for North American participants, and in the m-path app for Oceanic participants. Each prompt or item is presented on a separate page in the app. Items, response formats, and the associated logic of presentation are identical between platforms.

- How hard was the workout you just completed?
  - Please give a global rating for the difficulty of your entire training session.
  - *[Response on RPE scale from 0 to 10, anchored at appropriate points]*

- How motivated are you to perform well in your next key workout?
  - *[Not at all motivated, A little motivated, Somewhat motivated, Motivated, Very motivated]*

- Next, we're going to ask you to rate your agreement with a couple statements about recovery.
  - As a reminder, what exactly counts as recovery is up to you.
  - In general, recovery is whatever helps you absorb the work from your previous workouts, and prepares you for the work in your next workouts.
  - It can be mental, physical or a mix of both.
  - It can be more dialed-in and focused, or more dialed-out and relaxed.

[Following 9 items rated on 7-pt Likert, anchored at each point from Disagree strongly to Agree strongly] [These 9 items were not analyzed in this dissertation]

- [Know1] I know how fatigued I expect to feel between now and my next key workout.
- [Know2] I know what I need to do to recover for my next key workout.
- [Know3_neg] I have no idea how my body will react to this past workout over the next few days until my next key workout.
- [Plan1] I have specific plan(s) in mind for what I need to do to recover physically for my next key workout.
- [Plan2] I have specific plan(s) in mind for what I need to do to recover mentally for my next key workout.
- [Plan3_neg] I do not have any set plans for how I will recover for my next key workout.
- [Routine1] I have specific routines to help my physical recovery before my next key workout.
- [Routine2] I have specific routines to help my mental recovery before my next key workout.
- [Routine3_neg] I do not use routines to structure my recovery.

- The following statements describe different aspects of your current state of recovery. Rate how you feel right now, compared to your best ever recovery state.
  - *[Following 4 items rated on a 7-pt. slider, anchored at ends by "Not at all" and "Fully applies"]*
- [Rec_phys] Physically, I feel: strong, physically capable, energetic, powerful
- [Rec_ment] Mentally, I feel: attentive, receptive, mentally alert, concentrated.

- [Rec_emo] Emotionally, I feel: pleased, stable, in a good mood, like I have everything under control.
- [Rec_gen] Overall, I feel: recovered, rested, relaxed.

- The following statements describe different aspects of your current state of stress/fatigue. Please rate how you feel right now, compared to your highest ever stress state.
    - *[Following 4 items rated on a 7-pt. slider, anchored at ends by "Not at all" and "Fully applies"]*
- [Str_phys] Physically, my muscles feel: exhausted, fatigued, sore, stiff.
- [Str_ment] Mentally, I feel: unmotivated, sluggish, unenthusiastic, like I'm lacking energy.
- [Str_emo] Emotionally, I feel: stressed, annoyed, short tempered, like I'm feeling down.
- [Str_gen] Overall, I feel: tired, worn out, overloaded, exhausted.

- Have you missed or skipped a check-in questionnaire since you last completed one?
    - Yes / No
    - [If yes] For the most recent questionnaire you missed, roughly when did it arrive?
    - [If yes] For the most recent questionnaire you missed, what was the general reason?

Appendix U: Article 4 – Multilevel Models of Self-Regulatory Processes Over Time

Models of Engagement With Recovery Over Time

Table 1: Engagement with recovery-related thoughts in relation to time in the baseline period

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.079	0.777 – 1.381	<0.001	1.290	0.887 – 1.694	<0.001	1.512	1.039 – 1.986	<0.001
Linear TTW1				0.011	-0.001 – 0.022	0.065	0.045	0.007 – 0.082	0.020
Quadratic TTW1							0.001	-0.000 – 0.002	0.061
Random Effects									
σ^2	1.10			1.07			1.04		
τ_{00}	0.26_{id}			0.36_{id}			0.39_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				1.00_{id}			1.00_{id}		
ICC	0.19								
N	16_{id}			16_{id}			16_{id}		
Observations	169			169			169		
log-Likelihood	-257.756			-255.746			-254.018		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 2: Engagement with recovery-related thoughts in relation to time in the inter-workout period

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.273	0.895 – 1.651	<0.001	1.657	1.160 – 2.155	<0.001	1.766	1.181 – 2.352	<0.001
Linear TTW1				-0.015	-0.027 – -0.004	0.008	-0.029	-0.069 – 0.011	0.160
Quadratic TTW1							0.000	-0.001 – 0.001	0.494
Random Effects									
σ^2	1.08			1.02			1.02		
τ_{00}	0.48_{id}			0.63_{id}			0.62_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-0.56_{id}			-0.53_{id}		

ICC	0.31			0.33			0.33		
N	16_{id}			16_{id}			16_{id}		
Observations	179			179			179		
log-Likelihood	-275.376			-271.235			-271.002		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 3: Engagement with recovery-related actions in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.137	0.815 – 1.459	<0.001	1.381	0.926 – 1.836	<0.001	1.632	1.103 – 2.162	<0.001
Linear TTW1				0.012	-0.003 – 0.027	0.107	0.051	0.010 – 0.092	0.015
Quadratic TTW1							0.001	0.000 – 0.002	0.045
Random Effects									
σ^2	1.30			1.21			1.18		
τ_{00}	0.29_{id}			0.48_{id}			0.54_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				0.62_{id}			0.71_{id}		
ICC	0.18			0.23			0.23		
N	16_{id}			16_{id}			16_{id}		
Observations	169			169			169		
log-Likelihood	-271.217			-268.752			-266.788		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 4: Engagement with recovery-related actions in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.377	0.998 – 1.755	<0.001	1.857	1.386 – 2.329	<0.001	1.891	1.316 – 2.467	<0.001
Linear TTW1				-0.019	-0.030 – -0.008	0.001	-0.023	-0.066 – 0.019	0.275
Quadratic TTW1							0.000	-0.001 – 0.001	0.840

Random Effects			
σ^2	1.23	1.15	1.15
τ_{00}	0.47 $_{\text{id}}$	0.49 $_{\text{id}}$	0.48 $_{\text{id}}$
τ_{11}		0.00 $_{\text{id.timeline}}$	0.00 $_{\text{id.timeline}}$
ρ_{01}		-1.00 $_{\text{id}}$	-1.00 $_{\text{id}}$
ICC	0.28		
N	16 $_{\text{id}}$	16 $_{\text{id}}$	16 $_{\text{id}}$
Observations	180	180	180
log-Likelihood	-287.399	-281.794	-281.773

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Models of Recovery Self-Regulation Over Time

Table 5: Self-awareness of recovery in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.589	1.136 – 2.043	<0.001	1.737	1.242 – 2.232	<0.001	1.770	1.243 – 2.296	<0.001
Linear TTW1				0.007	-0.006 – 0.021	0.289	0.013	-0.018 – 0.044	0.420
Quadratic TTW1							0.000	-0.001 – 0.001	0.711
Random Effects									
σ^2	0.67			0.60			0.60		
τ_{00}	0.77 $_{\text{id}}$			0.81 $_{\text{id}}$			0.82 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				0.28 $_{\text{id}}$			0.29 $_{\text{id}}$		
ICC	0.53			0.58			0.58		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	166			166			166		
log-Likelihood	-222.589			-219.710			-219.642		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 6: Self-awareness of recovery in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.820	1.483 – 2.157	<0.001	2.203	1.779 – 2.626	<0.001	2.306	1.794 – 2.818	<0.001
Linear TTW1				-0.015	-0.025 – -0.005	0.003	-0.028	-0.066 – 0.010	0.143
Quadratic TTW1							0.000	-0.000 – 0.001	0.486
Random Effects									
σ^2	0.95			0.90			0.90		
τ_{00}	0.37_{id}			0.39_{id}			0.39_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-1.00_{id}			-0.12_{id}		
ICC	0.28						0.30		
N	16_{id}			16_{id}			16_{id}		
Observations	177			177			177		
log-Likelihood	-259.963			-255.508			-255.268		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 7: Checking-in on recovery in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.248	0.820 – 1.676	<0.001	1.636	1.099 – 2.174	<0.001	1.821	1.244 – 2.398	<0.001
Linear TTW1				0.020	0.002 – 0.038	0.031	0.049	0.018 – 0.081	0.003
Quadratic TTW1							0.001	0.000 – 0.001	0.026
Random Effects									
σ^2	0.71			0.54			0.52		
τ_{00}	0.67_{id}			1.00_{id}			1.08_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				0.55_{id}			0.61_{id}		
ICC	0.49			0.62			0.63		
N	16_{id}			16_{id}			16_{id}		
Observations	167			167			167		
log-Likelihood	-227.064			-216.729			-214.293		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 8: Checking-in on recovery in relation to time in the inter-workout period

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.546	1.255 – 1.836	<0.001	2.045	1.608 – 2.483	<0.001	2.256	1.731 – 2.782	<0.001
Linear TTW1				-0.020	-0.030 – -0.009	<0.001	-0.046	-0.084 – -0.008	0.018
Quadratic TTW1							0.001	-0.000 – 0.001	0.162
Random Effects									
σ^2	1.03			0.93			0.92		
τ_{00}	0.25_{id}			0.42_{id}			0.42_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
ICC	0.19								
N	16_{id}			16_{id}			16_{id}		
Observations	177			177			177		
log-Likelihood	-264.141			-256.390			-255.412		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 9: Interpreting recovery in relation to time in the baseline period

	Basic model			Linear model			Quadratic model		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.357	0.919 – 1.796	<0.001	1.580	1.031 – 2.130	<0.001	1.791	1.194 – 2.388	<0.001
Linear TTW1				0.011	-0.006 – 0.027	0.201	0.044	0.011 – 0.078	0.010
Quadratic TTW1							0.001	0.000 – 0.001	0.022
Random Effects									
σ^2	0.77			0.66			0.62		
τ_{00}	0.70_{id}			1.02_{id}			1.12_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				0.54_{id}			0.61_{id}		
ICC	0.48			0.56			0.58		
N	16_{id}			16_{id}			16_{id}		
Observations	165			165			165		
log-Likelihood	-231.051			-226.402			-223.864		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 10: Interpreting recovery in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	1.539	1.215 – 1.862	<0.001	1.998	1.616 – 2.379	<0.001	2.148	1.678 – 2.617	<0.001
Linear TTW1				-0.018	-0.028 – -0.009	<0.001	-0.037	-0.073 – -0.001	0.042
Quadratic TTW1							0.000	-0.000 – 0.001	0.284
Random Effects									
σ^2	0.89			0.82			0.81		
τ_{00}	0.34_{id}			0.29_{id}			0.28_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				1.00_{id}			1.00_{id}		
ICC	0.28								
N	16_{id}			16_{id}			16_{id}		
Observations	176			176			176		
log-Likelihood	-252.874			-245.940			-245.365		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 11: Adjusting recovery in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.612	0.374 – 0.849	<0.001	0.707	0.417 – 0.997	<0.001	0.741	0.392 – 1.089	<0.001
Linear TTW1				0.005	-0.005 – 0.015	0.322	0.010	-0.022 – 0.042	0.532
Quadratic TTW1							0.000	-0.001 – 0.001	0.735
Random Effects									
σ^2	0.76			0.76			0.76		
τ_{00}	0.15_{id}			0.12_{id}			0.12_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
ICC	0.16								
N	16_{id}			16_{id}			16_{id}		
Observations	165			165			165		
log-Likelihood	-220.315			-219.756			-219.699		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 12: Adjusting recovery in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.685	0.430 – 0.940	<0.001	0.910	0.404 – 1.416	0.001	1.116	0.549 – 1.683	<0.001
Linear TTW1				-0.009	-0.023 – 0.005	0.201	-0.034	-0.068 – 0.000	0.051
Quadratic TTW1							0.001	-0.000 – 0.001	0.117
Random Effects									
σ^2	0.75			0.63			0.62		
τ_{00}	0.20 $_{id}$			0.80 $_{id}$			0.80 $_{id}$		
τ_{11}				0.00 $_{id.timeline}$			0.00 $_{id.timeline}$		
ρ_{01}				-0.89 $_{id}$			-0.89 $_{id}$		
ICC	0.21			0.34			0.34		
N	16 $_{id}$			16 $_{id}$			16 $_{id}$		
Observations	177			177			177		
log-Likelihood	-235.966			-229.265			-228.033		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope

Appendix U: Article 4 – Multilevel Models of Perceived Recovery and Stress Over Time

Models of Perceived Recovery Over Time

Table 1: Perceived *physical* recovery in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.092	-0.049 – 0.232	0.198	0.088	-0.415 – 0.590	0.731	0.311	-0.214 – 0.837	0.243
Linear TTW1				0.001	-0.019 – 0.022	0.899	0.037	0.004 – 0.071	0.030
Quadratic TTW1							0.001	0.000 – 0.001	0.009
Random Effects									
σ^2	0.83			0.61			0.59		
τ_{00}	0.00_{id}			0.83_{id}			0.81_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				1.00_{id}			1.00_{id}		
N	16_{id}			16_{id}			16_{id}		
Observations	164			164			164		
log-Likelihood	-217.171			-206.313			-202.913		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 2: Perceived *physical* recovery in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.078	-0.196 – 0.039	0.190	-0.250	-0.614 – 0.114	0.177	-0.360	-0.763 – 0.044	0.080
Linear TTW1				0.007	-0.006 – 0.021	0.290	0.024	-0.005 – 0.052	0.100
Quadratic TTW1							-0.000	-0.001 – 0.000	0.192
Random Effects									
σ^2	0.68			0.54			0.53		
τ_{00}	0.00_{id}			0.39_{id}			0.40_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
N	16_{id}			16_{id}			16_{id}		
Observations	192			192			192		
log-Likelihood	-235.667			-224.460			-223.613		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 3: Perceived *mental* recovery in relation to time in the baseline period

		Basic model			**Linear model**			**Quadratic model**	
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.030	-0.102 – 0.163	0.650	0.058	-0.229 – 0.346	0.689	0.267	-0.064 – 0.598	0.113
Linear TTW1				0.002	-0.011 – 0.014	0.765	0.036	0.005 – 0.067	0.024
Quadratic TTW1							0.001	0.000 – 0.001	0.019
Random Effects									
σ^2	0.74			0.69			0.68		
τ_{00}	0.00 $_{\text{id}}$			0.13 $_{\text{id}}$			0.11 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				1.00 $_{\text{id}}$			1.00 $_{\text{id}}$		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	164			164			164		
log-Likelihood	-207.512			-207.010			-204.315		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 4: Perceived *mental* recovery in relation to time in the inter-workout period

		Basic model			**Linear model**			**Quadratic model**	
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.026	-0.145 – 0.092	0.665	-0.164	-0.502 – 0.174	0.339	-0.187	-0.566 – 0.192	0.331
Linear TTW1				0.006	-0.007 – 0.019	0.395	0.009	-0.020 – 0.038	0.531
Quadratic TTW1							-0.000	-0.001 – 0.000	0.786
Random Effects									
σ^2	0.69			0.57			0.57		
τ_{00}	0.00 $_{\text{id}}$			0.31 $_{\text{id}}$			0.31 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	192			192			192		
log-Likelihood	-237.220			-228.559			-228.522		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 5: Perceived *emotional* recovery in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.040	-0.126 – 0.206	0.636	0.024	-0.133 – 0.181	0.763	0.066	-0.134 – 0.265	0.517
Linear TTW1				-0.001	-0.011 – 0.008	0.766	0.006	-0.017 – 0.028	0.628
Quadratic TTW1							0.000	-0.000 – 0.001	0.493
Random Effects									
σ^2	0.35			0.33			0.33		
τ_{00}	0.07 $_{\text{id}}$			0.00 $_{\text{id}}$			0.00 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
ICC	0.17			0.24					
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	163			163			163		
log-Likelihood	-155.736			-151.109			-150.880		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 6: Perceived *emotional* recovery in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.023	-0.161 – 0.116	0.747	-0.010	-0.307 – 0.287	0.947	0.062	-0.270 – 0.393	0.714
Linear TTW1				-0.001	-0.012 – 0.011	0.892	-0.012	-0.036 – 0.013	0.353
Quadratic TTW1							0.000	-0.000 – 0.001	0.329
Random Effects									
σ^2	0.52			0.43			0.43		
τ_{00}	0.03 $_{\text{id}}$			0.24 $_{\text{id}}$			0.24 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				-0.91 $_{\text{id}}$			-0.92 $_{\text{id}}$		
ICC	0.06			0.23			0.22		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	192			192			192		
log-Likelihood	-213.660			-206.167			-205.698		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 7: Perceived *overall* recovery in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.112	-0.063 – 0.286	0.207	0.145	-0.115 – 0.405	0.273	0.363	0.035 – 0.691	0.030
Linear TTW1				0.002	-0.008 – 0.012	0.735	0.036	0.003 – 0.069	0.031
Quadratic TTW1							0.001	0.000 – 0.002	0.031
Random Effects									
σ^2	0.81			0.81			0.78		
τ_{00}	0.04_{id}			0.04_{id}			0.05_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-0.03_{id}			-1.00_{id}		
ICC	0.05			0.05					
N	16_{id}			16_{id}			16_{id}		
Observations	162			162			162		
log-Likelihood	-215.923			-215.867			-213.556		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 8: Perceived *overall* recovery in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.096	-0.245 – 0.053	0.206	-0.552	-1.020 – -0.084	0.021	-0.740	-1.248 – -0.232	0.005
Linear TTW1				0.020	0.002 – 0.038	0.026	0.048	0.014 – 0.082	0.006
Quadratic TTW1							-0.001	-0.001 – 0.000	0.056
Random Effects									
σ^2	1.10			0.75			0.73		
τ_{00}	0.00_{id}			0.69_{id}			0.70_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-0.99_{id}			-0.99_{id}		
ICC				0.26			0.27		
N	16_{id}			16_{id}			16_{id}		
Observations	192			192			192		
log-Likelihood	-281.587			-259.323			-257.508		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Models of Perceived Stress Over Time

Table 9: Perceived *physical* stress in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.124	-0.290 – 0.042	0.141	-0.317	-0.653 – 0.019	0.064	-0.386	-0.763 – -0.009	0.045
Linear TTW1				-0.016	-0.037 – 0.005	0.144	-0.028	-0.066 – 0.010	0.145
Quadratic TTW1							-0.000	-0.001 – 0.000	0.417
Random Effects									
σ^2	1.01			0.80			0.81		
τ_{00}	0.01_{id}			0.19_{id}			0.17_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				0.91_{id}			0.91_{id}		
ICC	0.01			0.30			0.26		
N	16_{id}			16_{id}			16_{id}		
Observations	162			162			162		
log-Likelihood	-231.530			-224.610			-224.326		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 10: Perceived *physical* stress in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.106	-0.052 – 0.264	0.187	0.734	0.370 – 1.099	<0.001	0.868	0.440 – 1.297	<0.001
Linear TTW1				-0.027	-0.041 – -0.013	<0.001	-0.047	-0.083 – -0.012	0.009
Quadratic TTW1							0.000	-0.000 – 0.001	0.221
Random Effects									
σ^2	1.23			0.94			0.93		
τ_{00}	0.00_{id}			0.28_{id}			0.30_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
N	16_{id}			16_{id}			16_{id}		
Observations	192			192			192		
log-Likelihood	-292.381			-273.542			-272.798		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 11: Perceived *mental* stress in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.028	-0.128 – 0.183	0.725	-0.177	-0.480 – 0.126	0.251	-0.236	-0.603 – 0.131	0.205
Linear TTW1				-0.011	-0.026 – 0.004	0.141	-0.021	-0.058 – 0.016	0.266
Quadratic TTW1							-0.000	-0.001 – 0.001	0.570
Random Effects									
σ^2	1.00			0.92			0.92		
τ_{00}	0.00_{id}			0.09_{id}			0.09_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				1.00_{id}			1.00_{id}		
N	16_{id}			16_{id}			16_{id}		
Observations	162			162			162		
log-Likelihood	-230.044			-227.480			-227.319		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 12: Perceived *mental* stress in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.024	-0.150 – 0.103	0.714	-0.015	-0.342 – 0.311	0.926	-0.031	-0.406 – 0.345	0.872
Linear TTW1				-0.000	-0.013 – 0.013	0.989	0.002	-0.028 – 0.033	0.886
Quadratic TTW1							-0.000	-0.001 – 0.001	0.870
Random Effects									
σ^2	0.78			0.68			0.68		
τ_{00}	0.00_{id}			0.24_{id}			0.24_{id}		
τ_{11}				$0.00_{\text{id.timeline}}$			$0.00_{\text{id.timeline}}$		
ρ_{01}				-1.00_{id}			-1.00_{id}		
N	16_{id}			16_{id}			16_{id}		
Observations	191			191			191		
log-Likelihood	-247.699			-242.841			-242.827		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 13: Perceived *emotional* stress in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.036	-0.167 – 0.095	0.591	-0.093	-0.282 – 0.096	0.331	-0.006	-0.242 – 0.229	0.958
Linear TTW1				-0.003	-0.010 – 0.004	0.402	0.011	-0.013 – 0.034	0.374
Quadratic TTW1							0.000	-0.000 – 0.001	0.226
Random Effects									
σ^2	0.41			0.41			0.40		
τ_{00}	0.03 $_{\text{id}}$			0.03 $_{\text{id}}$			0.03 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
ICC	0.06								
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			162		
log-Likelihood	-161.940			-161.599			-160.871		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 14: Perceived *emotional* stress in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.038	-0.080 – 0.156	0.525	0.050	-0.213 – 0.312	0.709	0.034	-0.282 – 0.349	0.833
Linear TTW1				-0.000	-0.011 – 0.010	0.936	0.002	-0.026 – 0.030	0.891
Quadratic TTW1							-0.000	-0.001 – 0.001	0.858
Random Effects									
σ^2	0.68			0.62			0.62		
τ_{00}	0.00 $_{\text{id}}$			0.11 $_{\text{id}}$			0.11 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	191			191			191		
log-Likelihood	-234.165			-231.629			-231.613		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 15: Perceived *overall* stress in relation to time in the baseline period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	-0.117	-0.248 – 0.015	0.081	-0.070	-0.294 – 0.154	0.537	-0.204	-0.495 – 0.087	0.168
Linear TTW1				0.002	-0.007 – 0.012	0.611	-0.019	-0.049 – 0.012	0.233
Quadratic TTW1							-0.000	-0.001 – 0.000	0.158
Random Effects									
σ^2	0.71			0.71			0.70		
τ_{00}	0.00 $_{\text{id}}$			0.00 $_{\text{id}}$			0.00 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				1.00 $_{\text{id}}$			1.00 $_{\text{id}}$		
ICC	0.00								
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			162		
log-Likelihood	-202.196			-202.067			-201.066		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 16: Perceived *overall* stress in relation to time in the inter-workout period

	Basic model			**Linear model**			**Quadratic model**		
Predictors	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*	*Estimates*	*95% C.I.*	*p*
Intercept	0.099	-0.022 – 0.221	0.109	0.300	-0.046 – 0.646	0.089	0.335	-0.052 – 0.721	0.089
Linear TTW1				-0.008	-0.022 – 0.006	0.243	-0.013	-0.043 – 0.016	0.363
Quadratic TTW1							0.000	-0.000 – 0.001	0.684
Random Effects									
σ^2	0.72			0.58			0.58		
τ_{00}	0.00 $_{\text{id}}$			0.33 $_{\text{id}}$			0.33 $_{\text{id}}$		
τ_{11}				0.00 $_{\text{id.timeline}}$			0.00 $_{\text{id.timeline}}$		
ρ_{01}				-1.00 $_{\text{id}}$			-1.00 $_{\text{id}}$		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	191			191			191		
log-Likelihood	-240.205			-229.221			-229.139		

Note. Time in hours, anchored to key workout 1 (0 = start of KW1). σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Appendix V: Article 4 – Multilevel Models of Self-Regulatory Processes Predicted by Perceived Recovery and Stress

Multilevel Models of Recovery Self-Regulation Through Self-Awareness in Relation to Perceived Recovery or Stress

Table 1: Self-awareness of recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.05	<0.001	1.61	1.15 – 2.06	<0.001	1.82	1.48 – 2.16	<0.001	1.82	1.48 – 2.15	<0.001
Physical recovery				-0.21	-0.35 – -0.07	0.004				-0.08	-0.29 – 0.14	0.474
Random Effects												
σ2	0.68			0.64			0.96			0.95		
τ00	0.77_{id}			0.78_{id}			0.38_{id}			0.38_{id}		
ICC	0.53			0.55			0.28			0.28		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	164			164			176			176		
log-Likelihood	-220.976			-216.921			-258.954			-258.697		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 2: Self-awareness of recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.05	<0.001	1.59	1.13 – 2.04	<0.001	1.82	1.48 – 2.16	<0.001	1.82	1.48 – 2.15	<0.001
Mental recovery				0.11	-0.11 – 0.34	0.316				-0.06	-0.29 – 0.17	0.611
Random Effects												
σ2	0.68			0.68			0.96			0.95		
τ00	0.77_{id}			0.77_{id}			0.38_{id}			0.37_{id}		
ICC	0.53			0.53			0.28			0.28		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	163			163			176			176		
log-Likelihood	-220.063			-219.559			-258.954			-258.824		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 3: Self-awareness of recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.05	<0.001	1.59	1.13 – 2.04	<0.001	1.82	1.48 – 2.16	<0.001	1.82	1.48 – 2.15	<0.001
Emotional recovery				0.11	-0.11 – 0.34	0.316				-0.06	-0.29 – 0.17	0.611
Random Effects												
σ2	0.68			0.68			0.96			0.95		
τ00	0.77_{id}			0.77_{id}			0.38_{id}			0.37_{id}		
ICC	0.53			0.53			0.28			0.28		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	163			163			176			176		
log-Likelihood	-220.063			-219.559			-258.954			-258.824		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 4: Self-awareness of recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.04	<0.001	1.60	1.15 – 2.05	<0.001	1.82	1.48 – 2.16	<0.001	1.82	1.48 – 2.16	<0.001
Overall recovery				-0.13	-0.28 – 0.01	0.077				-0.18	-0.35 – -0.00	0.045
Random Effects												
σ2	0.69			0.67			0.96			0.93		
τ00	0.76_{id}			0.76_{id}			0.38_{id}			0.38_{id}		
ICC	0.53			0.53			0.28			0.29		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	162			162			176			176		
log-Likelihood	-218.948			-217.382			-258.954			-256.950		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 5: Self-awareness of recovery in relation to one's perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.04	<0.001	1.61	1.15 – 2.06	<0.001	1.82	1.48 – 2.16	<0.001	1.82	1.48 – 2.15	<0.001
Physical stress				0.15	0.02 – 0.29	0.022				0.25	0.10 – 0.39	0.001
Random Effects												
σ2	0.69			0.66			0.96			0.89		
τ00	0.76 $_{\text{id}}$			0.77 $_{\text{id}}$			0.38 $_{\text{id}}$			0.38 $_{\text{id}}$		
ICC	0.53			0.54			0.28			0.30		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			176			176		
log-Likelihood	-218.948			-216.308			-258.954			-253.449		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 6: Self-awareness of recovery in relation to one's perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.04	<0.001	1.59	1.13 – 2.04	<0.001	1.83	1.49 – 2.17	<0.001	1.83	1.49 – 2.17	<0.001
Mental stress				0.06	-0.07 – 0.19	0.351				0.06	-0.11 – 0.23	0.474
Random Effects												
σ2	0.69			0.68			0.94			0.94		
τ00	0.76 $_{\text{id}}$			0.76 $_{\text{id}}$			0.38 $_{\text{id}}$			0.38 $_{\text{id}}$		
ICC	0.53			0.53			0.29			0.29		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			175			175		
log-Likelihood	-218.948			-218.512			-256.114			-255.857		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 7: Self-awareness of recovery in relation to one's perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.04	<0.001	1.59	1.14 – 2.04	<0.001	1.83	1.49 – 2.17	<0.001	1.83	1.49 – 2.17	<0.001
Emotional stress				0.09	-0.12 – 0.30	0.393				-0.02	-0.20 – 0.17	0.871
Random Effects												
σ2	0.69			0.68			0.94			0.94		
τ00	0.76 $_{id}$			0.76 $_{id}$			0.38 $_{id}$			0.38 $_{id}$		
ICC	0.53			0.53			0.29			0.29		
N	16 $_{id}$			16 $_{id}$			16 $_{id}$			16 $_{id}$		
Observations	162			162			175			175		
log-Likelihood	-218.948			-218.581			-256.114			-256.101		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 8: Self-awareness of recovery in relation to one's perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.59	1.14 – 2.04	<0.001	1.60	1.15 – 2.06	<0.001	1.83	1.49 – 2.17	<0.001	1.82	1.48 – 2.16	<0.001
Overall stress				0.12	-0.04 – 0.28	0.128				0.11	-0.07 – 0.29	0.229
Random Effects												
σ2	0.69			0.67			0.94			0.93		
τ00	0.76 $_{id}$			0.78 $_{id}$			0.38 $_{id}$			0.37 $_{id}$		
ICC	0.53			0.53			0.29			0.29		
N	16 $_{id}$			16 $_{id}$			16 $_{id}$			16 $_{id}$		
Observations	162			162			175			175		
log-Likelihood	-218.948			-217.788			-256.114			-255.388		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Multilevel Models of Recovery Self-Regulation Through Checking-In in Relation to Perceived Recovery or Stress

Table 9: Checking-in on recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.25	0.82 – 1.68	<0.001	1.55	1.26 – 1.84	<0.001	1.54	1.26 – 1.83	<0.001
Physical recovery				-0.04	-0.25 – 0.17	0.721				-0.10	-0.32 – 0.12	0.373
Random Effects												
σ2	0.72			0.64			1.04			1.03		
τ00	0.68 $_{\text{id}}$			0.68 $_{\text{id}}$			0.25 $_{\text{id}}$			0.24 $_{\text{id}}$		
τ_{11}				0.07 $_{\text{id.rp\_cntrP}}$								
ρ_{01}				-0.23 $_{\text{id}}$								
ICC	0.48			0.53			0.19			0.19		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	164			164			176			176		
log-Likelihood	-224.127			-219.992			-263.130			-262.733		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 10: Checking-in on recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.25	0.82 – 1.68	<0.001	1.55	1.26 – 1.84	<0.001	1.55	1.26 – 1.84	<0.001
Mental recovery				-0.04	-0.20 – 0.12	0.617				-0.13	-0.35 – 0.08	0.224
Random Effects												
σ2	0.72			0.72			1.04			1.03		
τ00	0.68 $_{\text{id}}$			0.68 $_{\text{id}}$			0.25 $_{\text{id}}$			0.24 $_{\text{id}}$		
ICC	0.48			0.49			0.19			0.19		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	164			164			176			176		
log-Likelihood	-224.127			-224.002			-263.130			-262.389		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 11: Checking-in on recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.25	0.82 – 1.68	<0.001	1.55	1.26 – 1.84	<0.001	1.55	1.26 – 1.84	<0.001
Emotional recovery				-0.00	-0.23 – 0.23	0.980				0.12	-0.12 – 0.35	0.334
Random Effects												
σ2	0.72			0.72			1.04			1.03		
τ00	0.68 $_{id}$			0.68 $_{id}$			0.25 $_{id}$			0.26 $_{id}$		
ICC	0.48			0.48			0.19			0.20		
N	16 $_{id}$			16 $_{id}$			16 $_{id}$			16 $_{id}$		
Observations	163			163			176			176		
log-Likelihood	-223.139			-223.138			-263.130			-262.664		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 12: Checking-in on recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.26	0.83 – 1.69	<0.001	1.55	1.26 – 1.84	<0.001	1.55	1.26 – 1.84	<0.001
Overall recovery				-0.08	-0.23 – 0.08	0.332				-0.15	-0.33 – 0.03	0.109
Random Effects												
σ2	0.72			0.72			1.04			1.02		
τ00	0.69 $_{id}$			0.68 $_{id}$			0.25 $_{id}$			0.24 $_{id}$		
ICC	0.49			0.49			0.19			0.19		
N	16 $_{id}$			16 $_{id}$			16 $_{id}$			16 $_{id}$		
Observations	162			162			176			176		
log-Likelihood	-221.962			-221.491			-263.130			-261.841		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 13: Checking-in on recovery in relation to one's perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.27	0.84 – 1.70	<0.001	1.55	1.26 – 1.84	<0.001	1.55	1.26 – 1.84	<0.001
Physical stress				0.18	0.05 – 0.32	0.008				0.26	0.12 – 0.41	0.001
Random Effects												
σ2	0.72			0.69			1.04			0.96		
τ00	0.69 $_{\text{id}}$			0.69 $_{\text{id}}$			0.25 $_{\text{id}}$			0.26 $_{\text{id}}$		
ICC	0.49			0.50			0.19			0.21		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			176			176		
log-Likelihood	-221.962			-218.413			-263.130			-257.221		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 14: Checking-in on recovery in relation to one's perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.25	0.82 – 1.68	<0.001	1.56	1.26 – 1.85	<0.001	1.56	1.27 – 1.85	<0.001
Mental stress				0.04	-0.10 – 0.17	0.605				0.08	-0.10 – 0.26	0.381
Random Effects												
σ2	0.72			0.72			1.02			1.02		
τ00	0.69 $_{\text{id}}$			0.69 $_{\text{id}}$			0.26 $_{\text{id}}$			0.25 $_{\text{id}}$		
ICC	0.49			0.49			0.20			0.20		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			175			175		
log-Likelihood	-221.962			-221.828			-260.646			-260.262		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 15: Checking-in on recovery in relation to one's perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.26	0.82 – 1.69	<0.001	1.56	1.26 – 1.85	<0.001	1.56	1.27 – 1.85	<0.001
Emotional stress				0.18	-0.04 – 0.39	0.104				-0.12	-0.31 – 0.07	0.221
Random Effects												
σ2	0.72			0.71			1.02			1.01		
τ00	0.69_{id}			0.68_{id}			0.26_{id}			0.25_{id}		
ICC	0.49			0.49			0.20			0.20		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	162			162			175			175		
log-Likelihood	-221.962			-220.637			-260.646			-259.894		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 16: Checking-in on recovery in relation to one's perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.25	0.82 – 1.68	<0.001	1.26	0.83 – 1.70	<0.001	1.56	1.26 – 1.85	<0.001	1.55	1.26 – 1.84	<0.001
Overall stress				0.10	-0.06 – 0.27	0.218				0.05	-0.13 – 0.24	0.570
Random Effects												
σ2	0.72			0.71			1.02			1.02		
τ00	0.69_{id}			0.70_{id}			0.26_{id}			0.25_{id}		
ICC	0.49			0.49			0.20			0.19		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	162			162			175			175		
log-Likelihood	-221.962			-221.204			-260.646			-260.486		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

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Table 17: Interpreting recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.35	0.91 – 1.78	<0.001	1.36	0.93 – 1.80	<0.001	1.54	1.22 – 1.86	<0.001	1.54	1.22 – 1.86	<0.001
Physical recovery				-0.15	-0.38 – 0.08	0.197				-0.06	-0.26 – 0.15	0.590
Random Effects												
σ2	0.76			0.63			0.89			0.89		
τ00	0.70_{id}			0.70_{id}			0.34_{id}			0.34_{id}		
τ_{11}				$0.10_{\text{id.rp\_cntrP}}$								
ρ_{01}				-0.27_{id}								
ICC	0.48			0.55			0.28			0.28		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	164			164			176			176		
log-Likelihood	-228.755			-219.396			-252.874			-252.728		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 18: Interpreting recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.35	0.91 – 1.78	<0.001	1.35	0.91 – 1.79	<0.001	1.54	1.22 – 1.86	<0.001	1.54	1.22 – 1.86	<0.001
Mental recovery				-0.13	-0.30 – 0.03	0.110				-0.10	-0.30 – 0.11	0.351
Random Effects												
σ2	0.76			0.75			0.89			0.89		
τ00	0.70_{id}			0.71_{id}			0.34_{id}			0.33_{id}		
ICC	0.48			0.49			0.28			0.27		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	164			164			176			176		
log-Likelihood	-228.755			-227.474			-252.874			-252.438		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 19: Interpreting recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.34	0.90 – 1.78	<0.001	1.34	0.90 – 1.78	<0.001	1.54	1.22 – 1.86	<0.001	1.54	1.21 – 1.87	<0.001
Emotional recovery				0.09	-0.14 – 0.33	0.426				0.08	-0.14 – 0.30	0.459
Random Effects												
σ2	0.76			0.76			0.89			0.89		
τ00	0.70_{id}			0.70_{id}			0.34_{id}			0.35_{id}		
ICC	0.48			0.48			0.28			0.28		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	163			163			176			176		
log-Likelihood	-227.646			-227.329			-252.874			-252.601		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 20: Interpreting recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.34	0.90 – 1.78	<0.001	1.36	0.92 – 1.79	<0.001	1.54	1.22 – 1.86	<0.001	1.54	1.22 – 1.86	<0.001
Overall recovery				-0.17	-0.32 – -0.01	0.036				-0.15	-0.31 – 0.02	0.086
Random Effects												
σ2	0.77			0.75			0.89			0.88		
τ00	0.70_{id}			0.69_{id}			0.34_{id}			0.34_{id}		
ICC	0.48			0.48			0.28			0.28		
N	16_{id}			16_{id}			16_{id}			16_{id}		
Observations	162			162			176			176		
log-Likelihood	-226.801			-224.595			-252.874			-251.392		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 21: Interpreting recovery in relation to one's perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.34	0.90 – 1.78	<0.001	1.36	0.92 – 1.81	<0.001	1.54	1.22 – 1.86	<0.001	1.54	1.21 – 1.86	<0.001
Physical stress				0.14	-0.07 – 0.35	0.177				0.19	0.05 – 0.33	0.009
Random Effects												
σ2	0.77			0.62			0.89			0.86		
τ00	0.70 $_{\text{id}}$			0.73 $_{\text{id}}$			0.34 $_{\text{id}}$			0.35 $_{\text{id}}$		
τ_{11}				0.07 $_{\text{id.sp\_cntrP}}$								
ρ_{01}				0.22 $_{\text{id}}$								
ICC	0.48			0.56			0.28			0.29		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			176			176		
log-Likelihood	-226.801			-216.267			-252.874			-249.480		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 22: Interpreting recovery in relation to one's perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.34	0.90 – 1.78	<0.001	1.33	0.90 – 1.77	<0.001	1.55	1.22 – 1.88	<0.001	1.55	1.22 – 1.88	<0.001
Mental stress				0.13	-0.00 – 0.27	0.058				0.00	-0.16 – 0.17	0.981
Random Effects												
σ2	0.77			0.75			0.87			0.87		
τ00	0.70 $_{\text{id}}$			0.70 $_{\text{id}}$			0.36 $_{\text{id}}$			0.35 $_{\text{id}}$		
ICC	0.48			0.48			0.29			0.29		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			175			175		
log-Likelihood	-226.801			-224.998			-249.889			-249.888		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 23: Interpreting recovery in relation to one's perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.34	0.90 – 1.78	<0.001	1.34	0.91 – 1.78	<0.001	1.55	1.22 – 1.88	<0.001	1.55	1.23 – 1.88	<0.001
Emotional stress				0.15	-0.07 – 0.37	0.178				-0.10	-0.27 – 0.08	0.269
Random Effects												
σ2	0.77			0.76			0.87			0.87		
τ00	0.70 $_{id}$			0.69 $_{id}$			0.36 $_{id}$			0.35 $_{id}$		
ICC	0.48			0.47			0.29			0.29		
N	16 $_{id}$			16 $_{id}$			16 $_{id}$			16 $_{id}$		
Observations	162			162			175			175		
log-Likelihood	-226.801			-225.892			-249.889			-249.276		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 24: Interpreting recovery in relation to one's perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	1.34	0.90 – 1.78	<0.001	1.36	0.92 – 1.81	<0.001	1.55	1.22 – 1.88	<0.001	1.55	1.22 – 1.87	<0.001
Overall stress				0.24	0.07 – 0.40	0.006				0.02	-0.16 – 0.19	0.855
Random Effects												
σ2	0.77			0.73			0.87			0.87		
τ00	0.70 $_{id}$			0.73 $_{id}$			0.36 $_{id}$			0.35 $_{id}$		
ICC	0.48			0.50			0.29			0.29		
N	16 $_{id}$			16 $_{id}$			16 $_{id}$			16 $_{id}$		
Observations	162			162			175			175		
log-Likelihood	-226.801			-222.960			-249.889			-249.872		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

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Table 25: Adjusting recovery in relation to one's perceived state of *physical* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.60	0.37 – 0.83	<0.001	0.69	0.43 – 0.94	<0.001	0.71	0.46 – 0.96	<0.001
Physical recovery				0.11	-0.05 – 0.26	0.171				-0.09	-0.37 – 0.19	0.513
Random Effects												
σ2	0.77			0.76			0.75			0.65		
τ00	0.15 $_{\text{id}}$			0.14 $_{\text{id}}$			0.19 $_{\text{id}}$			0.19 $_{\text{id}}$		
τ_{11}										0.17 $_{\text{id.rp\_cntrP}}$		
ρ_{01}										0.66 $_{\text{id}}$		
ICC	0.16			0.15			0.20			0.29		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	164			164			176			176		
log-Likelihood	-219.475			-218.547			-235.085			-228.062		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 26: Adjusting recovery in relation to one's perceived state of *mental* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.61	0.38 – 0.84	<0.001	0.69	0.43 – 0.94	<0.001	0.73	0.47 – 0.98	<0.001
Mental recovery				0.13	-0.04 – 0.29	0.124				0.05	-0.20 – 0.30	0.715
Random Effects												
σ2	0.77			0.76			0.75			0.68		
τ00	0.15 $_{\text{id}}$			0.13 $_{\text{id}}$			0.19 $_{\text{id}}$			0.20 $_{\text{id}}$		
τ_{11}										0.12 $_{\text{id.rm\_cntrP}}$		
ρ_{01}										0.82 $_{\text{id}}$		
ICC	0.16			0.15			0.20			0.28		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	164			164			176			176		
log-Likelihood	-219.475			-218.314			-235.085			-230.037		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 27: Adjusting recovery in relation to one's perceived state of *emotional* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.61	0.38 – 0.83	<0.001	0.69	0.43 – 0.94	<0.001	0.69	0.43 – 0.94	<0.001
Emotional recovery				0.13	-0.10 – 0.36	0.260				-0.05	-0.25 – 0.15	0.612
Random Effects												
σ2	0.77			0.77			0.75			0.75		
τ00	0.15 $_{\text{id}}$			0.13 $_{\text{id}}$			0.19 $_{\text{id}}$			0.19 $_{\text{id}}$		
ICC	0.16			0.15			0.20			0.20		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	163			163			176			176		
log-Likelihood	-218.643			-218.032			-235.085			-234.958		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 28: Adjusting recovery in relation to one's perceived state of *overall* recovery

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.60	0.37 – 0.84	<0.001	0.69	0.43 – 0.94	<0.001	0.72	0.47 – 0.97	<0.001
Overall recovery				0.10	-0.06 – 0.25	0.220				-0.11	-0.33 – 0.11	0.328
Random Effects												
σ2	0.77			0.77			0.75			0.67		
τ00	0.15 $_{\text{id}}$			0.14 $_{\text{id}}$			0.19 $_{\text{id}}$			0.19 $_{\text{id}}$		
τ_{11}										0.09 $_{\text{id.ro\_cntrP}}$		
ρ_{01}										0.63 $_{\text{id}}$		
ICC	0.16			0.16			0.20			0.28		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			176			176		
log-Likelihood	-217.375			-216.622			-235.085			-230.150		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 29: Adjusting recovery in relation to one’s perceived state of *physical* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.62	0.38 – 0.86	<0.001	0.69	0.43 – 0.94	<0.001	0.69	0.43 – 0.94	<0.001
Physical stress				0.06	-0.08 – 0.20	0.364				0.13	0.00 – 0.26	0.049
Random Effects												
σ2	0.77			0.77			0.75			0.73		
τ00	0.15 $_{\text{id}}$			0.15 $_{\text{id}}$			0.19 $_{\text{id}}$			0.20 $_{\text{id}}$		
ICC	0.16			0.16			0.20			0.21		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			176			176		
log-Likelihood	-217.375			-216.962			-235.085			-233.141		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 30: Adjusting recovery in relation to one’s perceived state of *mental* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.61	0.37 – 0.85	<0.001	0.69	0.44 – 0.95	<0.001	0.69	0.43 – 0.95	<0.001
Mental stress				-0.01	-0.15 – 0.13	0.874				-0.01	-0.17 – 0.14	0.859
Random Effects												
σ2	0.77			0.77			0.75			0.74		
τ00	0.15 $_{\text{id}}$			0.15 $_{\text{id}}$			0.20 $_{\text{id}}$			0.20 $_{\text{id}}$		
ICC	0.16			0.16			0.21			0.21		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			175			175		
log-Likelihood	-217.375			-217.362			-233.407			-233.391		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 31: Adjusting recovery in relation to one’s perceived state of *emotional* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.62	0.37 – 0.86	<0.001	0.69	0.44 – 0.95	<0.001	0.69	0.44 – 0.95	<0.001
Emotional stress				0.10	-0.12 – 0.32	0.357				-0.04	-0.20 – 0.12	0.631
Random Effects												
$\sigma2$	0.77			0.77			0.75			0.75		
$\tau00$	0.15 $_{\text{id}}$			0.13 $_{\text{id}}$			0.19 $_{\text{id}}$			0.19 $_{\text{id}}$		
ICC	0.16			0.15			0.20			0.20		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	163			163			176			176		
log-Likelihood	-218.643			-218.032			-235.085			-234.958		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.

Table 32: Adjusting recovery in relation to one’s perceived state of *overall* stress

	BSL Basic model			**BSL Linear model**			**IW Basic model**			**IW Basic model**		
Predictors	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*	*Est.*	*95% C.I.*	*p*
Intercept	0.61	0.37 – 0.85	<0.001	0.61	0.37 – 0.85	<0.001	0.69	0.44 – 0.95	<0.001	0.71	0.44 – 0.97	<0.001
Overall stress				-0.03	-0.19 – 0.14	0.749				0.11	-0.12 – 0.33	0.355
Random Effects												
$\sigma2$	0.77			0.77			0.75			0.66		
$\tau00$	0.15 $_{\text{id}}$			0.15 $_{\text{id}}$			0.20 $_{\text{id}}$			0.22 $_{\text{id}}$		
τ_{11}										0.10 $_{\text{id.so\_cntrP}}$		
ρ_{01}										-0.72 $_{\text{id}}$		
ICC	0.16			0.16			0.21			0.29		
N	16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$			16 $_{\text{id}}$		
Observations	162			162			175			175		
log-Likelihood	-217.375			-217.324			-233.407			-227.647		

Note. BSL = Baseline period, IW = Inter-workout period, σ^2 = residual variance, τ_{00} = variance between intercepts (i.e., participants), τ_{11} = variance between slopes, ρ_{01} = correlation between intercept and slope.