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The "Underrecovery Trap": When Physical Fatigue Impairs the Physical and Mental Recovery Process

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Detachment from sport refers to refraining from sport-related activities (physical detachment) as well as disengaging from sport-related thoughts and emotions during time in recovery (cognitive and emotional detachment). Detachment is associated with improved physical and mental recovery from sport demands. However, research conducted among nonathletes shows that high demands are actually linked with lower detachment. Our understanding of whether such paradoxical effects also exist in elite sport is currently limited. Therefore, the aim of this daily diary study was to investigate within-person associations between daily physical, cognitive, and emotional sport demands and daily physical, cognitive, and emotional detachment. In addition, we examined whether physical fatigue, cognitive liveliness, and positive affect mediate the association between daily sport demands and daily detachment. Eighty-five elite athletes (56 males, 29 females) active at the national or international level completed a daily survey at 2 time points over a maximum of 2 weeks. Mostly in line with our hypotheses, findings revealed that high daily physical and emotional sport demands were associated with increased physical fatigue after training and competition. In turn, high physical fatigue was associated with lower physical and cognitive detachment after training/competition. More importantly, physical fatigue mediated the association between physical and emotional sport demands and physical and cognitive detachment. These findings point toward an "underrecovery trap," in which high levels of physical fatigue can interfere with athletes' physical and mental recovery. Using postperformance strategies to alleviate physical fatigue will likely benefit physical as well as mental recovery processes.

Keywords: detachment, elite athletes, health, well-being, recovery paradox

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Nowadays, the physical and mental demands of training and competing at the elite level are high, and expectations are that they will even increase further (Soligard et al., 2016). These demands may increase elite athletes' risk of experiencing high physical and mental strain (Balk, de Jonge, Oerlemans, & Geurts, 2020; DeFreese & Smith, 2013). It has, however, been suggested that excessive strain in athletes is not necessarily caused by high demands, but rather caused by a lack of recovery that leads to a state of "underrecovery" (Kellmann, 2002; Kellmann

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et al., 2018). The importance of recovery from high demands has also been put forward by stress theories such as the cognitive activation theory of stress (Ursin & Eriksen, 2004) and the allostatic load theory (McEwen, 1998). According to these theories, it is not the acute reaction to demands that is detrimental to health and well-being, but rather the sustained activation, even when demands are no longer present. Over time, this sustained activation can cause chronic strain (Kellmann, 2002; McEwen, 1998).

Recent studies have pointed toward the important role of detachment from sport for athletes' recovery (Balk, de Jonge, Oerlemans, & Geurts, 2017; Eccles & Kazmier, 2019). Detachment provides athletes with a break from the physical and mental demands of sport (Balk et al., 2017). Yet, research conducted among employees shows that, paradoxically, recovery experiences such as detachment actually tend to be impaired when the need for recovery is high (Sonnentag, 2018). That is, high job demands are generally associated with lower levels of detachment from work (Bennett, Bakker, & Field, 2018). Whether such paradoxical effects also exist in sport and what might explain them is currently unknown. More insight into the psychological aspects of rest and recovery could have important implications for how the precarious balance between performance demands and recovery is achieved (Eccles, Balk, Gretton, & Harris, 2020). Therefore, the present study uses a daily diary design to investigate within-person associations between daily sport demands, resulting physical and mental states, and detachment among a sample of elite athletes.

Detachment as a Recovery Experience

For athletes, *adequate* recovery largely depends on getting a break from sport-related demands (Kellmann, 2002). Moreover, recovery can be considered a multidimensional construct, which implies that *complete* recovery is accomplished when physical and mental (i.e., cognitive and emotional) systems have been replenished (Balk et al., 2017; Kellmann, 2002). Both adequate and complete recovery are vital in dealing with the demands of elite sport and for preserving the health and well-being of elite athletes (Jeffreys, 2005; Kellmann, 2002). Consequently, it is recommended that athletes physically and mentally detach from sport demands during the recovery phase (Jeffreys, 2005; Kenttä & Hassmén, 1998).

Detachment from sport can be considered as a central strategy as far as recovery from sport-related demands is concerned (Eccles & Kazmier, 2019). Detachment from sport is a recovery experience defined as refraining from sport-related activities (i.e., physical detachment) as well as disengaging mentally from sport and sport-related issues (i.e., cognitive and emotional detachment; Balk et al., 2017; Sonnentag & Fritz, 2015). According to the stressor–detachment model of Sonnentag and Fritz (2015), detachment can attenuate (i.e., buffer) the adverse effects of high demands on health and well-being. This implies that high sport-related demands will result in poor health and well-being, unless athletes are able to temporarily distance themselves physically, cognitively, and/or emotionally from sport-related demands. Physical detachment refers to getting a break from the physical exertion from training or competition (e.g., through ceasing sport-related activity). Cognitive detachment means putting all thoughts about one's sport aside. A lack of cognitive detachment interferes with recovery as stress-related thoughts intrude into consciousness, thereby prolonging psychophysiological activation (Brosschot, Gerin, & Thayer, 2006). Conversely, sufficient cognitive detachment enables an individual to recover from sport-related efforts, as there are no intrusive thoughts related to the past or future (Beckmann, 2002). Finally, emotional detachment refers to distancing oneself from negative emotions experienced during the day. So, by allowing a physical, cognitive, and/or emotional break from sport-related demands, detachment enables athletes to restore depleted physical and mental resources.

A recent study among Dutch elite athletes found both direct and buffering effects of physical and emotional detachment, but not cognitive detachment, in the prediction of elite athletes' daily physical, cognitive, and emotional recovery (Balk et al., 2017). However, in line with the *recovery paradox* as put forward by Sonnentag (2018), higher sport-related demands tend to be associated with lower levels of detachment. For instance, in the study by Balk et al. (2017), higher physical sport demands were correlated with less physical detachment, whereas high emotional sport demands correlated with less emotional detachment. Several other studies found a negative association between demands such as negative work events and high self-control demands and employees' detachment from work (Bono, Glomb, Shen, Kim, & Koch, 2013; Germeys & De Gieter, 2018). Yet, the existence of the recovery paradox in sport has not been formally tested. Additionally, insight into causal mechanisms linking high demands and low detachment is still lacking (Wendsche & Lohmann-Haislah, 2017).

Potential Mechanisms Underlying the Recovery Paradox

A first potential mechanism linking high demands and low detachment is *a lack of energetic resources* (Sonnentag, 2018). This is rooted in the idea that adequate recovery depends on sufficient self-regulation resources (Balk & Englert, 2020). For instance, distancing oneself from sport-related tasks, thoughts, and feelings requires energy, initiative, and willpower (Beckmann & Kellmann, 2004). However, according to the strength model of self-regulation, self-regulation operates by consuming limited energy resources, which can become depleted as a result of previous demands (Baumeister & Vohs, 2016). Consequently, whether one succeeds in regulating postperformance cognitions and emotions may be in part determined by available energetic resources. Research shows indeed that self-regulation is impaired when fatigue is high and when vigor is low (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Ryan & Deci, 2008). So, when energetic resources are depleted, it will likely be more difficult to control one's thought processes and emotional reactions to events that took place earlier (Sonnentag, 2018). This effect can also be explained by the scarcity hypothesis (Shah, Mullainathan, & Shafir, 2012), which stems from classical economic theory. According to this hypothesis, a shortage of (personal) resources leads to a shift in attentional focus, such that they capture individuals' attention. For instance, people who are hungry and thirsty focus more on cues related to food and drinks (Aarts, Dijksterhuis, & De Vries, 2001; Radel & Clément-Guillotin, 2012). So, the depletion of physical and cognitive energetic resources, which is particularly applicable in sport, can potentially interfere with athletes' detachment from sport by capturing their attention. This occurs, for instance, when aching muscles and heavy limbs remind athletes how hard their training has been.

Another potential mechanism linking high demands and low detachment is *affect* (Sonnentag, 2018). When negative activation is high, it is difficult to gain mental distance from negative events experienced before (Judge & Ilies, 2004). Research has also demonstrated that daily events that evoke a higher degree of negative affect induce a higher level of perseverative cognition (Brans, Koval, Verduyn, Lim, & Kuppens, 2013). Perseverative cognition refers to relatively uncontrollable and unpleasant repetitive thoughts such as rumination and worrying (Geurts & Sonnentag, 2006). As a result, athletes may find it more difficult to detach from sport as they may be occupied with—usually negative—sport-related thoughts and feelings when negative activation is high. In contrast, a positive affective state can promote detachment during the recovery phase (cf. Ryan & Deci, 2008). In support of this, a study by Tice, Baumeister, Shmueli, and Muraven (2007) provided empirical evidence for the link between positive mood and better self-regulation. Positive emotions can also have an energizing and attention-directing effect (Carver, 2003), thereby limiting the chance of ruminating about previous sport-related demands during recovery time (Grebner, Elfering, & Semmer, 2010).

The Present Study

In elite sport there is the risk of an *underrecovery trap*, in which the high sport-related demands interfere with adequate recovery from sport. Therefore, the present study investigates the role of both physical and cognitive energetic resources (i.e., perceived physical fatigue and cognitive liveliness) and (low) positive affect as the underlying mechanisms linking high sport-related demands and low detachment after training/competition. Such knowledge could allow for better targeted means to attenuate the negative effects of high demands on subsequent recovery experiences. Furthermore, empirical evidence has shown that it is worthwhile to take physical, cognitive, and emotional dimensions of demands and recovery into account (Balk et al., 2017; de Jonge, 2020; de Jonge, Spoor, Sonnentag, Dormann, & Van den Tooren, 2012). In doing so, this study also sheds more light on processes linked to mental recovery, an aspect of recovery that has largely been ignored in elite sport thus far (Eccles & Kazmier, 2019; Rattray, Argus, Martin, Northey, & Driller, 2015). Hence, the present study investigates elite athletes' within-person associations between daily *physical*, *cognitive*, and *emotional* sport demands and daily *physical*, *cognitive*, and *emotional* detachment over the course of 2 weeks. In addition, we examine whether physical fatigue, cognitive liveliness, and positive affect mediate the association between daily sport demands and daily detachment. In general, we hypothesized that daily sport demands would be positively related to perceived physical fatigue (Hypothesis 1), and negatively related to cognitive liveliness (Hypothesis2) and positive affect (Hypothesis 3) immediately after training or competition. We also hypothesized in general that, in turn, physical fatigue would be negatively related to detachment during time in recovery (Hypothesis 4), and that cognitive liveliness and positive affect will be positively related to detachment during time in recovery (Hypothesis 5). Figure 1 depicts the hypothesized model accordingly.

Method

Design

We used a daily diary design in which elite athletes completed a daily survey at two time points, namely, after waking up (T1) and after training/competition (T2), during a maximum period of 2 weeks. For an overview of the measurements at both time points, see Table S1 in the online supplemental materials.

Participants

We chose to only include participants in our final sample who had filled out the daily diary on at least 5 days, either consecutively or not, as this is the recommended minimum number of observations at the lowest level (Maas & Hox, 2005). This led to the exclusion of one athlete who filled out the daily survey on just 1 day. Hence, a convenience sample of 85 elite athletes participated in the study. Athletes were on average 21.3 years old (SD = 3.8; range = 15–33 years). Fifty-six athletes were male (66%) and 29 were female (34%). All athletes were taking part in an elite (youth) sport program and competed at either the national or international level in soccer (n = 32), swimming (n = 24), Australian football (n = 9), water polo (n = 8), beach volleyball (n = 5), short track speed skating (n = 4), and archery (n = 3).

Measures

Physical, *cognitive*, *and emotional sport demands* were measured at T2 with one item per dimension. Athletes indicated how physically, cognitively, and emotionally demanding they considered training or competition that day using a visual analog scale (VAS) for every dimension, ranging from 1 (*not demanding at all*) to 10 (*very demanding*). Several studies have provided support for the validity of single item measures, particularly in daily diary studies (Elo, Leppänen, & Jahkola, 2003).

Physical fatigue was measured at both T1 and T2 with six items of the corresponding subscale of the Multidimensional Fatigue Symptom Inventory–Short Form (Stein, Jacobsen, Blanchard, & Thors, 2004). An example item is "At

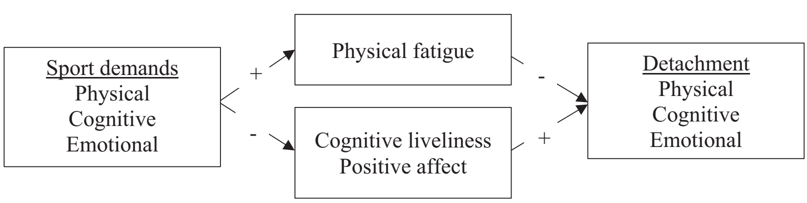

Figure 1. Model of assumed relations between daily sport demands, physical fatigue, cognitive liveliness, positive affect, and detachment. Pluses and minuses represent the direction of assumed relations.

this moment, my legs feel weak" (average Cronbach's α across T1–T2 = .90). Items were scored on a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Cognitive liveliness was measured at T1 and T2 with the corresponding subscale of the Shirom–Melamed Vigor Measure (Shirom, 2003) that was adapted to the sport setting (Balk et al., 2020). The measure consists of five items (e.g., "At this moment, I feel I can think rapidly"; Cronbach's α across T1–T2 = .89). Athletes indicated to what extent they agreed with each statement using a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Positive affect was measured at T1 and T2 using the five items of the positive affect subscale of the International Positive and Negative Affect Schedule–Short Form (Thompson, 2007). Athletes indicated to what extent they experienced positive affect (e.g., "At this moment, I feel inspired"; average Cronbach's α across T1–T2 = .88) on a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Physical, *cognitive*, *and emotional detachment* from sport during the previous evening was measured after waking up (T1) with three items per dimension that were derived from well-validated scales developed by de Jonge et al. (2012). Example items of each dimension are "Yesterday, after training/competition, I shook off the physical exertion from my sport activities" (physical detachment; Cronbach's α = .88); "Yesterday, after training/competition, I put all thoughts about my sport aside" (cognitive detachment; Cronbach's α = .89); and "Yesterday, after training/competition, I emotionally distanced myself from my sport" (emotional detachment; Cronbach's α = .95). The items were scored on a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

To test the factorial validity of the three detachment factors in the present study, a confirmatory factor analysis was conducted. Fit indices revealed that the proposed three-factor model provided a good fit to the data (comparative fit index [CFI] = .96, Tucker–Lewis index [TLI] = .94, standardized root-mean-square residual [SRMR] = .06, root mean square error of approximation [RMSEA] = .12, 90% confidence interval [CI; .10, .13]). The three-factor model also showed a significantly and substantially better fit to the data compared with a one-factor solution (i.e., general detachment; $\Delta\chi^2 = 761.95$, $\Delta df = 3$, $p < .001$) and a two-factor solution (i.e., physical and mental detachment; $\Delta\chi^2 = 108.65$, $\Delta df = 2$, $p < .001$).

We included demographic characteristics such as gender (coded: 0 = male and 1 = female) and age (continuous variable in years) as control variables. We also included physical fatigue, cognitive liveliness, and positive affect in the morning (T1) as control variables when predicting physical fatigue, cognitive liveliness, and positive affect after training/competition (T2). Including these covariates ought to give a more complete picture of the relations between predictor and outcome variables (Balk et al., 2017).

Procedure

Before recruitment, the study received institutional ethical approval and was conducted in accordance with ethical guidelines of the American Psychological Association. All participating athletes attended a briefing session delineating the procedure of the study. All athletes gave their informed consent. Both parents and coaches provided approval when athletes were under the age of 18 years. Before the start of the study, athletes completed an intake questionnaire consisting of questions related to demographic characteristics. Athletes were asked to complete two daily surveys during a maximum period of 2 weeks, including days of training, competition, and days off. To enhance compliance with the study, they received a text message with a reminder on their mobile phones, which included a hyperlink to the online diary in the early morning (around 7:30 a.m.) and after training/competition (between 6:00 p.m. and 9:00 p.m.).

Analytical Strategy

Our data had a hierarchical structure with days (Level 1) nested within persons (Level 2). We used Mplus (Muthén & Muthén, 2010) to test the hypothesized model with multilevel structural equation modeling (MSEM). The following variables were allowed to covary: the three types of sport demands; physical fatigue, cognitive liveliness, and positive affect; and the three types of detachment. All study variables, except for age and gender, were modeled at the person level and the day level to account for both between-person and within-person variability. By modeling the variables on both levels, the possibility that day-level relations between the study variables are due to response tendencies stemming from individual differences can be ruled out (Ohly, Sonnentag, Niessen, & Zapf, 2010). Age (grand mean centered) and gender were only modeled at the person level. For the three types of demands, physical fatigue, cognitive liveliness, and positive affect (measured at T2), we created a lagged variable to assess relations with detachment from sport (measured at T1).

Because nonsignificant χ^2 test values are rarely obtained in this kind of analysis, we also used the following fit indices and cutoff values as recommended in the literature to evaluate model fit (Hair, Black, Babin, & Anderson, 2014): the CFI $\geq$ .92, the TLI $\geq$ .92, the SRMR $\leq$ .08, and the RMSEA $\leq$ .06.

Results

Preliminary Analysis

The number of days athletes filled out the daily questionnaires ranged from 5 to 15 days (see Table S2 in the online supplemental materials). In total, the data reflected 867 days, comprising training days (75%), match days (8.1%), and rest days (16.9%).[1] Table 1 displays day-level means, *SDs*, reliability coefficients, and Pearson's zero-order correlations between the study variables. We examined the intraclass correlations of our day-level variables to determine the degree of within-person and between-person variation. The intraclass correlations of three types of sport demands, physical fatigue, cognitive liveliness, positive affect, and the three types of detachment indicated that for these variables, a substantial proportion of the variance could be explained at the within-person level (ranging from 43% to 78%). These numbers support our choice for multilevel analysis.

Main Analysis

The fit of the hypothesized MSEM model to the data was good: $\chi^2 = 92.94$, $df = 57$, $p = .002$, RMSEA = .03, CFI = .99, TLI = .97, SRMR = .05 (within level). Figure 2 displays the final MSEM model. Daily physical sport demands were positively related to daily physical fatigue ($B = 0.157$ [$SE = 0.023$], $p < .001$), while controlling for physical fatigue in the morning. Likewise, daily emotional sport demands were positively related to daily physical fatigue ($B = 0.70$ [$SE = 0.029$], $p = .016$), while controlling for physical fatigue in the morning. Daily emotional sport demands were negatively related to daily cognitive liveliness ($B = -0.087$ [$SE = 0.030$], $p = .004$) and positive affect ($B = -0.084$ [$SE = 0.028$], $p = .003$), while controlling for cognitive liveliness and positive affect in the morning, respectively. Cognitive sport demands were not related to physical fatigue, cognitive liveliness, and positive affect. Taken together, these findings largely support Hypotheses 1–3 that daily sport demands would be positively related to physical fatigue and negatively related to cognitive liveliness and positive affect. In turn, daily physical fatigue was negatively related to daily physical detachment ($B = -0.164$ [$SE = 0.067$], $p = .014$) and daily cognitive detachment ($B = -0.130$ [$SE = 0.059$], $p = .028$) during the recovery phase. However, both daily cognitive liveliness and daily positive affect were not related to daily physical, cognitive, and emotional detachment. So, our fourth hypothesis that physical fatigue would be negatively related to detachment was supported. In contrast, we did not find support for our fifth hypothesis that cognitive liveliness and positive affect would be positively related to detachment.

Results also revealed a significant indirect effect of physical fatigue between physical sport demands and physical detachment ($B = -0.026$ [$SE = 0.011$], $p = .022$, 95% CI [-0.048, -0.004]), and between physical sport demands and cognitive detachment ($B = -0.020$ [$SE = 0.010$], $p = .039$, 95% CI [-0.040, -0.001]). Physical fatigue fully mediated these relations, as we found no statistically significant direct effect between physical sport demands and physical detachment ($B = -0.073$ [$SE = 0.038$], $p = .053$), as well as between physical sport demands and cognitive detachment ($B =$

[1] Including the type of day as a covariate did not affect the pattern of significant findings. Hence, we omitted this variable from the analyses presented here for reasons of parsimony (i.e., ratio of cases to variables).

Table 1
Means, SDs, and Correlations Between the Study Variables

Measure	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	21.32	3.56	—													
2. Gender	0.35	0.48	.10	—												
3. Physical sport demands (T2)	6.41	2.02	−.01	−.11	—	.56	.44	−.07	.37	.10	−.13	.09	−.14	−.14	−.06	−.04
4. Cognitive sport demands (T2)	6.01	2.04	−.11	−.12	.62	—	.68	−.10	.29	.07	−.17	.05	−.20	−.10	−.12	−.06
5. Emotional sport demands (T2)	5.10	2.17	−.06	−.07	.44	.73	—	−.09	.29	.06	−.20	.09	−.23	−.07	−.11	−.13
6. Physical fatigue (T1)	3.16	1.22	.09	.05	.04	.01	.01	—	.32	−.28	−.01	−.35	−.07	.02	.04	.05
7. Physical fatigue (T2)	3.39	1.31	.06	.06	.29	.21	.20	.71	—	−.08	−.34	−.12	−.40	−.17	−.12	−.10
8. Cognitive liveliness (T1)	5.03	0.93	−.11	−.13	.12	.13	.09	−.37	−.28	—	.23	.62	.18	−.07	.02	.04
9. Cognitive liveliness (T2)	4.84	1.06	−.03	−.14	−.09	−.04	−.06	−.26	−.41	.53	—	.20	.75	.07	.01	.06
10. Positive affect (T1)	5.13	0.92	−.15	−.16	.11	.08	.07	−.40	−.30	.73	.44	—	.20	−.06	−.02	.01
11. Positive affect (T2)	4.90	1.04	−.12	−.11	−.08	−.05	−.10	−.25	−.41	.48	.80	.52	—	.04	.02	.06
12. Physical detachment (T1)	5.03	1.29	.08	.07	−.25	−.27	−.26	−.06	−.14	.13	.16	.12	.18	—	.49	.45
13. Cognitive detachment (T1)	4.08	1.46	.26	.01	−.11	−.22	−.22	.13	.05	.08	.10	.06	.11	.59	—	.73
14. Emotional detachment (T1)	4.31	1.49	.26	.02	−.15	−.24	−.26	.09	.03	.10	.11	.09	.13	.59	.86	—

Note. T1 = Time 1 (after waking up); T2 = Time 2 (after training/competition). Correlations below the diagonal are person-level correlations ($N = 85$). Gender was coded as 0 = male, 1 = female. All correlations $\geq .07$ are significant at $p < .05$; all correlations $\geq .12$ are significant at $p < .01$. Correlations above the diagonal are day-level correlations ($N = 867$).

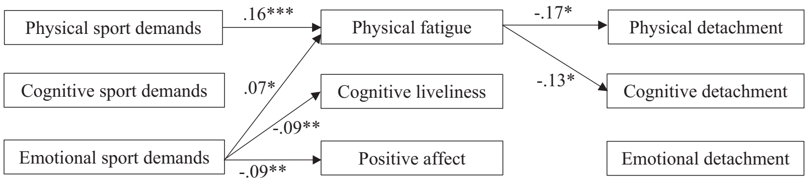

Figure 2. Multilevel structural equation model of sport demands, physical fatigue, cognitive liveliness, positive affect, and detachment. The values are unstandardized coefficients. * $p < .05$. ** $p < .01$. *** $p < .001$.

0.009 [*SE* = 0.034], $p = .791$). The indirect effect of physical fatigue between emotional sport demands and physical detachment was not significant ($B = -0.011$ [$SE = 0.007$], $p = .085$, 95% CI [−0.025, 0.001]). Likewise, the indirect effect of physical fatigue between emotional sport demands and cognitive detachment was not significant ($B = -0.009$ [$SE = 0.006$], $p = .103$, 95% CI [−0.020, 0.002]). The results did not change when excluding the control variables age and gender from the MSEM model.

Discussion

Detachment from sport, which refers to getting a physical, cognitive, and emotional break from the demands of training and competition, can attenuate the negative effects of high sport demands on fatigue and well-being (Balk et al., 2017). Paradoxically, however, these high demands may impede detachment as well (Sonnentag, 2018). The present diary study revealed that high physical and emotional sport demands were associated with increased physical fatigue after training and competition. Consecutively, high physical fatigue was associated with lower physical and cognitive detachment during the recovery phase. More importantly, physical fatigue mediated the association between physical and emotional sport demands and physical and cognitive detachment. Taken together, high physical and emotional sport demands appear to induce a high need for recovery (reflected in higher levels of physical fatigue), which is, in turn, difficult to achieve, as it interferes with detachment from sport. This underrecovery trap indicates that highly fatigued elite athletes are at risk of inadequate physical *and* mental recovery (i.e., underrecovery), which may ultimately lead to chronic physical and mental strain (i.e., allostatic load; McEwen, 1998).

Theoretical Implications

To our knowledge, this study is the first to show that higher daily sport demands are in fact associated with lower levels of daily detachment from sport. Moreover, this study sheds light on potential underlying mechanisms explaining this paradoxical relation. In line with the strength model of self-regulation (Baumeister & Vohs, 2016), it appears that a lack of energetic resources, reflected in high levels of physical fatigue, hampers athletes' physical and cognitive detachment from sport. Hence, the present study supports the idea that recovery self-regulation, in terms of ceasing thoughts about one's sport, is dependent on energetic resources and requires deliberate action or effort (Balk & Englert, 2020; Sonnentag, 2018). This also supports the scarcity hypothesis, which states that a shortage of resources actually draws attention, such that high levels of physical fatigue might increase the occurrence of (negative) sport-related thoughts (Shah et al., 2012). Although Carver (2003) argued that a positive affective state indicates that one can attend to something else, the findings of the present study do not provide support for the premise that a positive affective state promotes detachment during the recovery phase.

The recovery paradox refers to the general finding that high job demands are linked to impaired recovery processes (e.g., detachment, sleep, physical exercise) among employees (Sonnentag, 2018). The underrecovery trap is a specific manifestation of the apparently paradoxical relation between sport demands and detachment from sport. Specifically, the underrecovery trap suggests that higher sport-related demands are associated with higher physical fatigue, which can interfere with mental recovery, and as such potentially set up an athlete for underrecovery. Previous studies have shown that detachment from sport is not the only recovery experience that is impaired when sport demands are high. For instance, research by Teng, Lastella, Roach, and Sargent (2011) indicated that high demands in sport are linked with impaired sleep of athletes. Sonnentag (2018) suggested that low energetic resources might negatively affect sleep through impaired sleep hygiene. Furthermore, a study among rugby league players reported a decrease in the frequency of partaking in social activities during a period of overload training (Coutts & Reaburn, 2008). This implies that tired athletes might also withdraw from social activities, and they could actually be effective in promoting recovery. It remains to be seen whether physical fatigue can also explain the relation between sport-related demands and subsequent recovery processes in terms of presleep behavior and partaking in social activities. Likewise, an interesting avenue for future studies is to examine whether our finding that fatigue can explain the relation between high sport demands and low detachment from sport among elite athletes also applies to nonathletes. It seems plausible that in (elite) sport, physical fatigue plays a more important role compared with contemporary work, given the different nature of demands (Balk et al., 2020).

Practical Implications

The findings of this study highlight the importance of strategies intended to deal effectively with postperformance physical fatigue (cf. Barnett, 2006). That is, decreased levels of perceived physical fatigue will likely benefit both physical and mental recovery processes. Postperformance relaxation exercises could be used to deal with physical fatigue, particularly on highly demanding training or competition days. Relaxation techniques include progressive muscle relaxation, biofeedback or breathing techniques, autogenic training, hypnosis, and meditation. Ultimately, such exercises could also improve cognitive detachment as well (Kellmann, Pelka, & Beckmann, 2018). Findings by Kudlackova colleagues (Kudlackova, Eccles, & Dieffenbach, 2013) showed that elite athletes appear to appreciate the function of relaxation strategies for promoting recovery and use them more often compared with recreational and college athletes. Yet, elite athletes spend the fewest time on autogenic relaxation exercises (Kudlackova et al., 2013). Ideally, these exercises are incorporated into the training program, by either coaches or athletes themselves. However, coaches seem to be unaware of the potential of relaxation exercises for both physical and mental recovery (Nash & Sproule, 2018). Overall, engagement in activities that could guide attention away from feelings of fatigue should be encouraged.

The findings from this study may have implications for sport organizations as well. As lowering demands in elite sport may not always be feasible, practical or even desirable, optimizing recovery could be a better and more effective approach for preventing negative outcomes of sport participation (DeFreese, Raedeke, & Smith, 2015; Kellmann, 2002). Specifically, sport organizations and coaching staff members should incorporate time and possibilities for athletes to optimally recover. Ideally, mental recovery sessions will become part of a regular training program just as physical recovery sessions are incorporated by coaches and athletic trainers. One could also think of mental periodization next to physical periodization (Mujika, Halson, Burke, Balagué, & Farrow, 2018). Furthermore, research indicates that rest and recovery in sport might be undervalued at both cultural and societal levels (Eccles et al., 2020), which likely has an impact on the extent to which athletes push themselves and allow themselves to detach from sport. Likewise, being involved as an organization or staff member with an athletes' personal life (e.g., through monitoring resting behaviors and sleep, communicating during leisure time) likely interferes with recovery experiences such as detachment and mental rest. A specific recommendation to coaches and other staff members is therefore to limit communication between the last training session and the next day (e.g., no contact after 8 p.m.). This approach can help to establish sport–home boundaries for athletes. As recovery is a fundamental aspect underlying athletic health and well-being, we believe that, in addition to individual approaches to recovery, there is a responsibility for coaches, management, media, and policymakers to encourage a healthy balance between stress and rest.

Limitations and Directions for Future Research

Although this daily diary study provides insight into both barriers and means to achieve adequate physical and mental recovery, several limitations of this study need to be acknowledged. First and foremost, the study did not include measures that parallel physical fatigue (e.g., mental fatigue and negative affect). We included constructs with both negative valence (i.e., physical fatigue) and positive valence (i.e., cognitive liveliness) that are reflective of energetic resources that can become depleted. Several previous studies on recovery have used a combination of energetic resources indicators, reflecting both a positive and negative valence (Blasche, Bauböck, & Haluza, 2017; van Hooff & Geurts, 2015). Nevertheless, future studies might include other dimensions of fatigue (e.g., mental, emotional) to further disentangle how postperformance fatigue plays a role in the mental recovery process.

Second, the study relied on self-report data, which raises concerns about method variance and social desirability (Podsakoff, MacKenzie, & Podsakoff, 2012). However, we eliminated the potential influence of response tendencies stemming from individual differences by centering the day-level variables (Level 1) around the person-mean. This method reduces the regular problems associated with method variance (van de Pol & Wright, 2009). Notwithstanding the latter, future studies could benefit from adding social desirability scales (Stöber, 2001) or more objective measures to control for individuals' inclination to respond in a socially desirable manner.

Finally, it could be argued that it is preferable to measure detachment at bedtime. However, asking participants to fill out an online survey before bedtime could interfere with their detachment experience in the evening (cf. Park, Fritz, & Jex, 2015). Therefore, we believe that this approach fits with the current research question.

In addition to the aforementioned limitations, there are several areas for future research that can be identified. First, more research is needed to better understand why physical fatigue hinders cognitive detachment. Cognitive detachment enables an individual to recover as there are no intrusive thoughts related to the *past* or *future* (Beckmann, 2002). From this study it remains unclear, however, whether fatigued athletes experienced lower cognitive detachment because they were ruminating about the past (e.g., "Today was really hard, I am not in good shape") or worrying about the future (e.g., "I am so tired, tomorrow will be really hard"). Future research might explore the specific nature of low cognitive detachment on highly demanding days.

Second, identification of effective recovery strategies targeting changes in negative thoughts and mood is highly needed, as they promote complete recovery (Rattray et al., 2015). Currently, knowledge about the link between specific behaviors and detachment is limited. Moreover, it is important to note that recovery is idiosyncratic by nature, as it is not just the time spent on specific activities but rather the subjective experience of such activities (i.e., whether they are enjoyed or provide a welcome distraction) that determines how they are linked to recovery (Oerlemans, Bakker, & Demerouti, 2014). Research in organizational psychology has provided mixed evidence for the effectiveness of relaxation exercises in promoting detachment (de Bloom et al., 2017; Sianoja, Syrek, de Bloom, Korpela, & Kinnunen, 2018) although evidence for the positive effects of relaxation exercises on general strain levels is more consistent (Richardson & Rothstein, 2008). Whether or not such relaxation techniques or other types of activities (e.g., passive, active, and social activities) can improve detachment and recovery states among elite athletes is an interesting avenue for future research.

Third, using experimental designs to investigate the underrecovery trap would be of great interest. This would imply that levels of demands are manipulated to investigate how this might lead to different levels of physical and mental states, as well as to different levels of detachment from sport. However, given the challenges and potential risks associated with manipulating training load, a more suitable approach could be to conduct quasi-experimental studies during periods in which it is anticipated that training load will vary considerably and naturally.

Finally, the present study is limited to day-to-day dynamics in sport demands, physical and mental states, and detachment from sport. An advantage of this approach is that daily measurement of behavior reduces recall bias to a large extent (Ohly et al., 2010). Future studies could extend this time frame to a competitive season, perhaps using longer time intervals between measurements (e.g., weekly intervals). This would also allow for the investigation of individual differences that are of potential interest, such as differences in recovery needs and goal motivation. That is, for some athletes it is not problematic to immerse themselves fully in the demands of sport for several days or even weeks, whereas others would benefit from daily breaks and distraction from such demands. This could also shed more light on what the required or optimal duration of detachment is and whether this is dependent on one's need for recovery. Furthermore, Inzlicht and Schmeichel (2012) proposed an alternative model for explaining self-regulation processes. According to their process model, goal motivation refers to goals pursued for "want-to" reasons and controlled goals pursued for "have-to" reasons (Deci & Ryan, 2000, p. 200). Thus, athletes can pursue recovery activities because they genuinely *want-to* or feel they *have-to* (Milyavskaya & Inzlicht, 2017). If recovery is seen as a want-to goal, it is more likely to be attained because pursuing recovery is then perceived as relatively effortless (Werner & Milyavskaya, 2019), and would therefore suffer less from fatigue. However, it is unknown whether athletes' goal motivation can buffer against the negative effects of high demand on subsequent recovery processes.

Conclusion

This daily diary study has demonstrated that physical fatigue serves as an underlying mechanism linking high sport demands and low detachment from sport during subsequent time in recovery among elite athletes. These findings point toward an "underrecovery trap," in which high levels of physical fatigue can interfere with athletes' physical and mental recovery. It appears that effective management of postperformance physical strain is important for elite athletes for achieving complete recovery, which will in turn benefit subsequent performance.

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