SEMIPRO CYCLING
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CYCLING SCIENCE
DIGEST

A BIMONTHLY SUMMARY OF THE LATEST ENDURANCE & CYCLING PERFORMANCE RESEARCH


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Abstract

Title

The role of resistance exercise intensity on muscle fibre adaptations

Study details

OBJECTIVE

Although many training variables contribute to the performance, cellular and molecular adaptations to resistance exercise, relative intensity (% 1 repetition maximum [%1RM]) appears to be an important factor.

This review aimed to provide an examination of the role of resistance training load on adaption of human skeletal muscle.

As Fry says "Only when knowledge of muscle physiology and the appropriate application of training stimuli are combined can we hope to optimise the adaption process".

WHAT THEY DID

This review examines the scientific literature concerning the role of resistance exercise intensity on cellular and molecular adaptions of human skeletal muscle.

The author summarises and analyses data from numerous resistance exercise training studies that have monitored percentage fibre type, fibre type cross-sectional areas, percentage cross-sectional areas, and myosin heavy chain (MHC) isoform expression.

The review was limited to studies analysing the vastus laterlais muscle using muscle biopsies.

WHAT THEY FOUND

- Muscular hypertrophy responses to different relative training intensities follows a dose-response curve.
- There may be a threshold for optimal growth responses once intensity reaches 80% of 1RM. And maximal growth occurs with loads between 80% and 95% of 1RM.
- The optimal relative intensity range for muscular hypertrophy is 40% to 80% of 1RM.
- For endurance cyclists not wanting large levels of muscular hypertrophy, it is important to also include work at ≥80% 1RM because there are other physiological and performance reasons to train e.g. muscular strength or power.

Practical takeaways from study

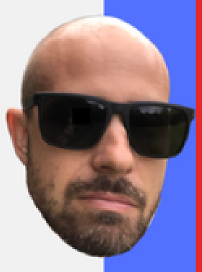
Practical Takeaways

Fry found that Fast Twitch recruitment begins at approximately 40% of maximum voluntary contraction (MVC) and peaks at ~ 80-85% MVC. Reminder: MVC is a measure of strength.

- These numbers were intended to be transferred across percentages of maximum repetitions when doing strength work. But it's also possible to use them for on the bike strength workouts using power prescriptions.

To understand how this works, we need to find an athlete's peak torque. We can calculate this using peak power and cadence. For example for an athlete that has a peak power output of 1300W (snd peak cadence of 130rpm) has a peak torque of 95 Newton meters. To prescribe strength intervals use the power that corresponds to 40-80% of peak torque. In this case 38-76 Newton meters. At 50rpm that's a power range of 200-400w.

- Once you have that information you can create interval durations that fit the athlete's ability and specificity requirements. For example, long strength endurance intervals at 40-50% of max torque might be 30-minute blocks (max 3 x 30 minutes total) at 200-250w @ 50rpm. Or shorter intervals hill reps at 80-85% of max torque might be 6 x 4-minute blocks at 400-425w @ 50rpm.



Reviewers comments on the study

Damian's Comments

"I have used this study for many years to quantify my power prescriptions for on bike strength and strength endurance work. A quick calculation can keep an athlete in their personal hypertrophy range - and not waste their training time on guesses.

Also, having a personal range helps to measure progress (see below) and helps with motivation. Give this a try the next time you are prescribing strength endurance intervals."

Session 1

Torque Nm/kg	Torque	% of Peak Torque
Nm/kg	Nm	%
0.81	60	48
0.83	62	50
0.84	63	50
0.85	63	51
0.85	63	50
0.85	63	50
0.85	63	51
0.85	63	51

Session 2

Torque Nm/kg	Torque	% of Peak Torque
Nm/kg	Nm	%
1.01	75	60
1.11	82	65
1.11	82	65
1.10	81	65
1.10	81	65
1.10	81	65
1.08	80	64
1.10	81	65

Related links to learn more about the topic

Want to learn more?
Check these out...

SEMIPRO Cycling

Welcome

If you're reading this right now, then I am seriously honoured you decided to invest in yourself and join Cycling Science Digest. I am extremely thankful for every single member who chooses to join us on our relentless quest to get cyclists the right advice at the right time. Without you, this would simply not be possible; so thank you.

So, what's special in this issue?

1. There are a total of 112 papers related to cycling science listed in this issue. In the list of articles that were not reviewed, I have made it easier to search by dividing the list into more categories.

Thanks for reading, and for being a member :)

Damian

Damian Ruse

Founder and Head Coach of SEMIPRO Cycling

Damian is an elite cycling coach and cycling science educator and has worked in the field of sports performance for over 8 years, helping athletes get the best out of themselves. Damian coaches professional, elite, and amateur athletes and has been the Performance Director of a top Australian road cycling team. Damian is also a lifelong cyclist, riding and racing bikes for over 28 years.

Performance

This month’s top research on cycling performance

The efficacy of weekly and bi-weekly heat training to maintain the physiological benefits of heat acclimation

Courteney, B, L., et al. Journal of Science and Medicine in Sport. 10 (006), 2021.

Variability in submaximal self-paced exercise bouts of different intensity and duration

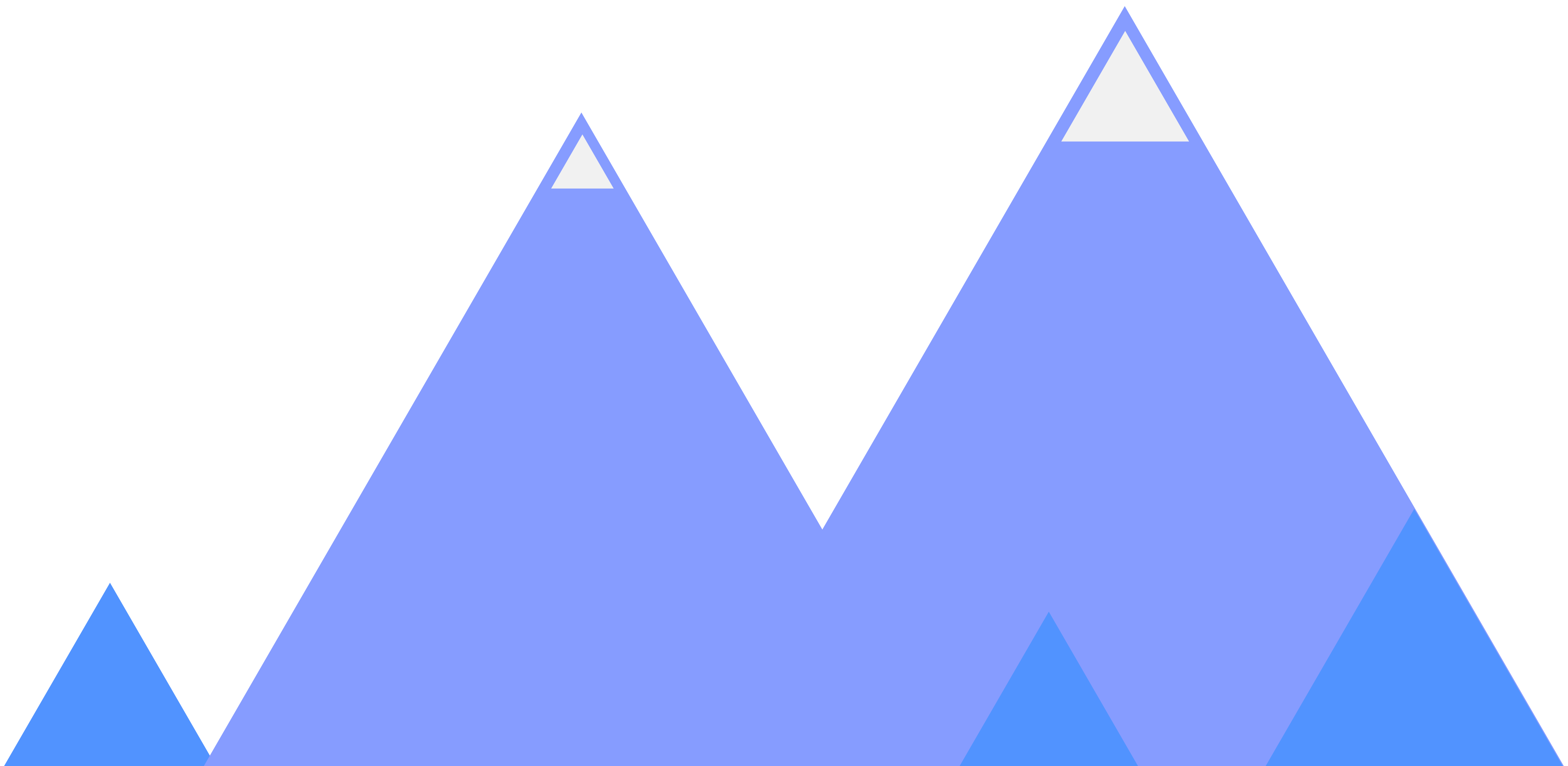
O'Grady, C., et at. International Journal of Sports Physiology and Performance. Ahead of Print (2021)

Nose-down saddle tilt improves gross efficiency during seated-uphill cycling

Wilkinson, R, D., et al. European Journal of Applied Physiology. Ahead of Print (2021).

Increasing Oxygen Uptake in Cross-Country Skiers by Speed Variation in Work Intervals

Rønnestad, B, R., et al. International Journal of Sports Physiology and Performance. Ahead of Print (2021).



Abstract

The efficacy of weekly and bi-weekly heat training to maintain the physiological benefits of heat acclimation

OBJECTIVE

Heat acclimation is an impactful strategy to optimize performance and safety when competing in the heat, strategies to sustain heat acclimation benefits throughout a competitive season are not well understood.

Limited research has investigated the effectiveness of intermittent exercise-heat exposures, or heat training, to sustain the adaptions over an extended period of time. Therefore, the optimal frequency of heat training following heat acclimation is currently unknown.

The purpose of this study was to examine the efficacy of weekly and bi-weekly heat training for four and eight weeks following heat acclimation.

They hypothesized that bi-weekly heat training will result in less decay than weekly heat training and that both heat training protocols will result in less decay than no heat training.

WHAT THEY DID

In a randomized, between-group design, twenty-four males completed five trials:

1. Baseline
2. Following heat acclimatization
3. Following heat acclimation
4. Four weeks into heat training [HTWK4]
5. Eight weeks into heat training [HTWK8]

The intervention involved 60 min of steady-state exercise in an environmental laboratory (temperature, 29.6 ± 1.4 °C) on a motorized treadmill.

Following heat acclimatization + heat acclimation, participants were assigned to three groups: control group (HT0), once per week heat training (HT1), and twice per week heat training (HT2).

Heat Training involved heated exercise (33.3 ± 1.3 °C) to achieve hyperthermia (38.5–39.75 °C) for 60 min.

WHAT THEY FOUND

- Heat acclimatization + heat acclimation resulted in significant improvements in HR ($p < 0.001$) and Trec ($p < 0.001$).

  At HTWK8, HR was significantly higher in HT0 (174 ± 22 beats·min-1) compared to HT2 (151 ± 17 beats·min-1, $p < 0.023$), but was not different than HT1 (159 ± 17 beats·min-1, $p = 0.112$).

  There was no difference in % change of Trec from post-HAz + HA to HTWK4 (0.6 ± 1.3%; $p = 0.218$), however, HTWK8 (1.8 ± 1.4%) was significantly greater than post-HAz + HA in HT0 ($p = 0.009$).

- Bi-weekly heat training provided clear evidence for the ability to maintain physiological adaptions for 8 weeks following heat acclimation.

Practical Takeaways

- Bi-weekly heat training maintained cardiovascular, rectal temperature, skin temperature, and sweat adaptations in aerobically training individuals for 8 weeks following heat acclimation.

  Note: The sixty-minute clock for the heat training did not start until the participant reached 38.50 °C so the average total session time was also recorded (83 ± 5 min).

- Weekly heat training may be enough to maintain adaptations for 8 weeks following heat acclimation in some aerobically training individuals.

  Aerobically training athletes interested in using heat acclimation primarily to lower Trec may be able to complete heat acclimation up to four weeks prior to a competition in the heat, as this variable did not show signs of decay in this population.

  Also, note the heat acclimation strategy was five heat acclimation sessions completed within eight days of a summer of training and informally heat acclimatizing.

Want to learn more?
Check this out...

Damian's Comments

"Offsetting the decay of heat acclimation benefits is a big piece of the performance puzzle. This is becasue the benefits of altitude training and heat aclimation have not shown positive results when combined.

As mentioned in the article, limited research has investigated the effectiveness of intermittent exercise-heat exposures, or heat training, to sustain the adaptions over an extended period of time.

With only one study that has investigated the implementation of an exercising heat exposure once every five days for four weeks following heat acclimation.

There was some decay even with that intervention, so more more needs to be done here and this study is a step in the right direction."

Abstract

Variability in submaximal self-paced exercise bouts of different intensity and duration

OBJECTIVE

Rating of perceived exertion (RPE) as a training-intensity prescription has been extensively used by athletes and coaches. However, individual variability in the physiological response to exercise prescribed using RPE has not been investigated.

The use of RPE in production mode may provide exercise practitioners with a useful tool to consistently prescribe exercise intensity. However, with limited research exploring the impact of duration on the reliability of perceptually regulated exercise, and no knowledge of the impact of changes in both duration and intensity on reliability, 1the interaction is unknown.

This study aimed to assess the reliability and reproducibility of self paced submaximal exercise of different intensities in trained competitive cyclists using long, medium, and short workload periods.

WHAT THEY DID

Twenty well-trained competitive cyclists (male = 18, female = 2, maximum oxygen consumption =55.07 [11.06] mL·kg-1·min-1) completed 3 exercise trials each consisting of 9 randomized self-paced exercise bouts of either 1, 4, or 8 minutes at RPEs of 9, 13, and 17.

Within-athlete variability (WAV) and between-athletes variability (BAV) in power and physiological responses were calculated using the coefficient of variation.

Total variability was calculated as the ratio of WAV to BAV.

WHAT THEY FOUND

- Increased RPEs were associated with higher power, heart rate, work, volume of expired oxygen (VO2), volume of expired carbon dioxide (VCO2), minute ventilation (VE), deoxyhemoglobin (ΔHHb) ($P < .001$), and lower tissue saturation index (ΔTSI%) and ΔO2Hb (oxyhaemoglobin; $P < .001$).

At an RPE of 9, shorter durations resulted in lower VO2 ($P < .05$) and decreased ΔTSI%, and the ΔHHb increased as the duration increased ($P < .05$).

At an RPE of 13, shorter durations resulted in lower VO2, VE, and percentage of maximum oxygen consumption ($P < .001$), as well as higher power, heart rate, ΔHHb ($P < .001$), and ΔTSI% ($P < .05$).

At an RPE of 17, power ($P < .001$) and ΔTSI% ($P < .05$) increased as duration decreased. As intensity and duration increased, WAV and BAV in power, work, heart rate, VO2, VCO2, and VE decreased, and WAV and BAV in near-infrared spectroscopy increased.

Practical Takeaways

The main findings of this study were that there were interactions between intensity and duration across all measured variables with the exception of muscle oxygenation measures.

Specifically, increases in intensity and duration resulted in greater consistency within measured parameters.

- These findings could be utilised by athletes and coaches to potentially reduce individual variability in exercise training response by including effort-based training of high intensity and longer durations.

- Coaches may also be able to detect changes in the performance of an athlete when using regular maximal effort-based exercise bouts and detecting when power output exceeds the expected WAV.

It is likely that as the intensity of exercise increases, the cyclist will likely commit more conscious attention towards the required work rate and physiological responses, such as regionalised pain.

Competitive athletes are more able to accurately and reliably utilise RPE to regulate exercise intensity. It has been previously suggested that perceptual responses are more accurate when the athlete has more experience.

Damian's Comments

"RPE is never going to die - and for good reason. It's a relable measure that avoids most of the limitations of other training-intensity measures.

I will use it when an athlete advances in their cycling career and pacing and energy management become a skill that is vital to being sucessful in races.

So it was good to see a study that addresed some of the unknown areasof using RPE as a training-intensity prescription measure.

The best conclusion from this study is the that self-paced intensity prescriptions of high effort and long duration result in the greatest consistency on both a within- and between-athletes basis.

This type of evidence confirms that prescribing training using RPE is valid and that I have been right to wait until the athlete has more experience as this will reult in a more accurate interpretation of the RPE prescribed."

Abstract

Nose-down saddle tilt improves gross efficiency during seated-uphill cycling

OBJECTIVE

Riding uphill presents a challenge to competitive and recreational cyclists. Based on only limited evidence, some scientists have reported that tilting the saddle nose down improves uphill-cycling efficiency by as much as 6%.

Therefore, they investigated if simply tilting the saddle nose down increases efficiency during uphill cycling, which would presumably improve performance.

WHAT THEY DID

Nineteen healthy, recreational cyclists performed multiple 5 min trials of seated cycling at ~ 3 W kg-1 on a large, custom-built treadmill inclined to 8° under two saddle-tilt angle conditions: parallel to the riding surface and 8° nose down. They measured subjects' rates of oxygen consumption and carbon dioxide production using an expired-gas analysis system and then calculated their average metabolic power during the last two min of each 5 min trial.

WHAT THEY FOUND

- They found that, compared to the parallel-saddle condition, tilting the saddle nose down by 8° improved gross efficiency from 0.205 to 0.208-an average increase of 1.4% ± 0.2%, $t = 5.9$, $p < 0.001$, CI95% [0.9 to 1.9], dz = 1.3.

Practical Takeaways

- These findings are relevant to competitive and recreational cyclists and present an opportunity for innovating new devices and saddle designs that enhance uphill-cycling efficiency. The effect of saddle tilt on other slopes and the mechanism behind the efficiency improvement remain to be investigated.

- There are two parts of this finding that raise questions - first, with current saddle shapes a tilted saddle will mean that the eventual riding on downhills and flat roads will not see the same benefit. And secondly, the results cannot yet be generalized to all slopes and all power outputs, since they only matched the nose-down tilt angle to a single slope of 8 ∘ and at a single power output of ∼3 W kg-1 .

  They postulate that tilting the saddle nose down would have a smaller effect on shallower slopes and a larger effect on steeper slopes due to the increase in gravitational force acting to pull the rider off the saddle. It is difficult to speculate on whether the effect of nose-down saddle tilt would be dependent on power output.

Damian's Comments

"One interesting part of this study was the aothors calculation of how much might a 1.4% improvement in efficiency affect cycling performance? Below are there workings.

'It is important to first note that due to aerodynamic resistance, a 1.4% increase in efficiency does not translate to a 1.4% increase in cycling velocity. During level-ground cycling, the mechanical power required to overcome aerodynamic drag increases with the third power of velocity. Thus, at 50 km h-1 (∼13.9 m s-1), a 1.4% increase in efficiency might increase velocity by only 0.5%. During steep uphill cycling, overcoming gravity dominates the total mechanical power required but aerodynamic resistance is not insignificant for elite cyclists. For example, the most cited record time for ascending Alpe d'Huez, a famous 13.8-km climb with an average slope of 8.1% (4.6 ∘), is 37 min 35 s — an average velocity of 22 km h-1 (6.12 m s-1). For a 57-kg rider, with a 7-kg bicycle, on a slope of 8.1%, overcoming gravity and rolling resistance would require 332 W of mechanical power while overcoming aerodynamic resistance would require an additional 32 W. With metabolic power consumption held constant, if a rider could produce 1.4% more mechanical power, due to an improvement in efficiency, their velocity would increase to 22.3 km h-1 (6.19 m s-1) — a 1.2% increase. We calculate that an elite cyclist riding in a seated posture, could save ∼26 s on the Alpe d'Huez climb by tilting their saddle nose down.'"

Abstract

Increasing Oxygen Uptake in Cross-Country Skiers by Speed Variation in Work Intervals

OBJECTIVE

Accumulated time at a high percentage of peak oxygen consumption (VO2peak) is important for improving performance in endurance athletes.

The present study compared the acute physiological and perceived effects of performing high-intensity intervals with roller ski double poling containing work intervals with:

(1) fast start followed by decreasing speed (DEC),
(2) systematic variation in exercise intensity (VAR), and
(3) constant speed (CON).

WHAT THEY DID

Ten well-trained cross-country skiers (double-poling VO2peak 69.6 [3.5] mL·min-1·kg-1) performed speed- and duration-matched DEC, VAR, and CON on 3 separate days in a randomized order (5 × 5-min work intervals and 3-min recovery).

WHAT THEY FOUND

- DEC and VAR led to longer time ≥90% VO2peak (P = .016 and P = .033, respectively) and higher mean %VO2peak (P = .036, and P = .009) compared with CON, with no differences between DEC and VAR (P = .930 and P = .759, respectively). VAR, DEC, and CON led to similar time ≥90% of peak heart rate (HRpeak), mean HR, mean breathing frequency, mean ventilation, and mean blood lactate concentration ([La-]).

  Furthermore, no differences between sessions were observed for perceptual responses, such as mean rate of perceived exertion, session rate of perceived exertion or pain score (all Ps > .147).

Practical Takeaways

- In well-trained XC skiers, decreasing speed and systematic variation led to longer time ≥90% of VO2peak compared with constant speed, without excessive perceptual effort.

  This indicates that these intervals can be a good alternative for accumulating more time at a high percentage of VO2peak and at the same time mimicking the pronounced variation in exercise intensities experienced during XC-skiing competitions

- Another way to frame decreasing speed pacing is fast start intervals. And this study builds on a previous Rønnestad paper that looked at exactly this. Comparing the acute effect of a roller-ski skating session containing work intervals with a fast start with a traditional session where the work intervals had a constant speed. This intervention showed the same, that fast start intervals are an effective pacing strategy if the aim of training is time at or near 90% of V02max.

Want to learn more?
Check this out...

Damian's Comments

"Ok, I did sneak in a non-cycling related article - but in my defence this is endurance and it's 5 x 5s! A common set of intervals in any cycling program - so I believe the information transfers very well to cycling training.

The only thing we are missing is an intervention where this study is replicated on a bike. Let's hope Rønnestad has it on his todo list."

Technology & Profiling

This month’s top research on technology and profiling

Struggles and strategies in anaerobic and aerobic cycling tests: A mixed-method approach with a focus on tailored selfregulation strategies

Hirsch, A., et al. PLoS ONE 16(10), 2021.

Monitoring and adapting endurance training on the basis of heart rate variability monitored by wearable technologies: A systematic review with meta-analysis

Düking, P., et al. Journal of Science and Medicine in Sport. Online, 2021.

Relationships between Heart Rate Variability, Sleep Duration, Cortisol and Physical Training in Young Athletes

Mishica, C., et al. Journal of Sports Science & Medicine. 20 (778-788), 2021.

Abstract

Struggles and strategies in anaerobic and aerobic cycling tests: A mixed-method approach with a focus on tailored selfregulation strategies

OBJECTIVE

Endurance sports pose a plethora of mental demands that exercisers have to deal with. Unfortunately, investigations of exercise-specific demands and strategies to deal with them are insufficiently researched, leading to a gap in knowledge about athletic requirements and strategies used to deal with them.

Here, they investigated which obstacles exercisers experience during an anaerobic (Wingate test) and an aerobic cycling test (incremental exercise test), as well as the strategies they considered helpful for dealing with these obstacles (qualitative analysis).

In addition, they examined whether thinking of these obstacles and strategies in terms of if-then plans (or implementation intentions; i.e., "If I encounter obstacle O, then I will apply strategy S!") improves performance over merely setting performance goals (i.e., goal intentions; quantitative analysis).

WHAT THEY DID

59 participants (age: M = 23.9 ± 6.5 years) performed both tests twice in a 2-within (Experimental session: 1 vs. 2) × 2-between (Condition: goal vs. implementation intention) design.

They reported to exercise M = 5.4 ± 2.9 hours per week (endurance training: M = 2.2 ± 2.2; strength training: M = 2.4 ± 2.2).

Participants performed a Wingate test and an incremental exercise test.

Exercisers' obstacles and strategies were assessed using structured interviews in Session 1 and subjected to thematic analysis. In both tests, feelings of exertion were the most frequently stated obstacle.

Motivation to do well, self-encouragement, and focus on the body and on cycling were frequently stated strategies in both tests. There were also test-specific obstacles, such as boredom reported in the aerobic test. For session 2, the obstacles and strategies elicited in Session 1 were used to specify if-then plans

WHAT THEY FOUND

Participants encountered obstacles such as missing focus, missing drive, negative sensations, cycling strategy, discomfort, and goals.

The strategies used by participants to alleviate these obstacles included distancing, attentional focus, drive, comfort, planning, and goals.

Combining obstacles and strategies into if-then plans, the if-components chosen by participants was roughly split in three, goal-orientated from exertion, the second was around the start/finish of each test. The then-component strategies comprising of self-encouragement and ambition were the most frequently chosen.

BUT the quantitative analyses suggest that an if-then planning intervention did not improve anaerobic performance or time-to-exhaustion.

Practical Takeaways

- These findings indicate that participants were able to identify exercise-related obstacles and useful strategies. But if-then plans did not help exercisers to improve their performance.

- Athletes are better to conduct some form of mental skills training rather than leaving any mental plans to chance so they can maximise performance.

Damian's Comments

" Even though the subjects in theis study are not elite athletes and no participant reported cycling as their primary sport, there is a lot we can take from this study.

Specifically, the idea that even people exercising will fall back on some mental approach to the challenges they face, and are able to create their own intervention to address these obsticles.

At an elite level, if you have not already done any mental skills training, it is worth investigating how you or your athletes are addressing their obsticles. This is an area that can benefit from some fromal guidence, as this might be the missing part of this study. That if the subjects were guided through the intervention creation process, the result might of been different."

Abstract

Monitoring and adapting endurance training on the basis of heart rate variability monitored by wearable technologies: A systematic review with meta-analysis

OBJECTIVE

Monitoring heart rate variability (HRV) as an indicator of daily variations in the functioning of the autonomic nervous system (ANS) may assist in individualizing endurance training to produce more pronounced physiological adaptations in performance.

This study aimed to systematically perform a meta-analysis of the scientific literature to determine whether the outcomes of endurance training based on HRV are more favourable than those of predefined training.

WHAT THEY DID

PubMed, and Web of Science were searched systematically using keywords related to endurance, the ANS, and training. To compare the outcomes of HRV-guided and predefined training.

All investigations involving healthy endurance athletes.

To be eligible for consideration, the interventions were required to have the following characteristics, with appropriate reporting:

- Predominant involvement of endurance training
- Continuous adjustment of training by the intervention group on the basis of alterations in HRV
- Inclusion of a control group that performed a predefined program of training
- Utilization of wearable sensors
- Either null hypothesis significance testing (NHST) and/or magnitude-based inference (MBI) statistical analysis

WHAT THEY FOUND

A total of 8 studies (198 participants) were identified encompassing 9 interventions involving a variety of approaches.

Compared to predefined training, most HRV-guided interventions included fewer moderate- and/or high-intensity training sessions.

Fixed effects meta-analysis revealed a significant medium-sized positive effect of HRV-guided training on submaximal physiological parameters (g=0.296, 95% CI 0.031 to 0.562, p=0.028), but its effects on performance (g =0.079, 95% CI -0.050 to 0.393 p= 0.597) and $\dot{V}O$ (g =0.171, 95% CI -0.213 to 0.371, p= 0.130) are small and not statistically significant.

Moreover, with regard to performance, HRV-guided training is associated with fewer non-responders and more positive responders.

Practical Takeaways

The effects of endurance training guided by heart rate variability (HRV) as an indicator of the functioning of the autonomic nervous system on parameters of performance are somewhat, although not statistically significantly better than those of predefined training. If you want to prescribe training based on HRV, here are some practical recommendations.

It is pointless to measure HRV once or twice and think you got a baseline or you know what's a person's HRV. Many studies especially before today's technology was available would measure HRV once then perform a several months study and measure HRV once again, to look at differences. This is not the best way to HRV given the day to day variability in these metrics as well as the fact that HRV should be used as a continuous feedback loop, not as some marker to optimise in the long term.

Using up to 4 weeks of measurements to determine a person's HRV. This way, you always know what's a person normal range at a given time, and based on the current baseline, can easily implement changes.

Looking at medium and long term trends, and in particular at where your daily data (either daily score or daily baseline) stands with respect to your historical data seems to be the way to go. This makes a lot of sense as comparing your daily scores with respect to your historical data is a simple statistical way to determine when a daily score or baseline is significantly different from what is normal for you, and therefore this seems an optimal moment to adjust training so that we can truly individualise it.

We have seen studies that say you should hold back when your HRV is significantly lower than your normal. Using your baseline instead of your daily score to make the decision, seems a better way as you probably are capturing stronger forms of stress (as they affect an entire week of data, not just a day).

Want to learn more?
Check this out...

Damian's Comments

"As more studies investigate different protocols to prescribe training based on individual physiological responses, a clearer picture is emerging.

One of my main issues with HRV has always been the lack of clear guidelines on its use. I am using it more and more with all levels of athletes and use these new studies and meta-analyses to refine my use of the metric even though I have not committed my entire coaching practice to using only HRV as the sole driver of daily training decisions.

This is a long and ongoing process but we are slowly uncovering the benefits of getting those daily HRV numbers."

Abstract

Relationships between Heart Rate Variability, Sleep Duration, Cortisol and Physical Training in Young Athletes

OBJECTIVE

This study was designed to characterize the relationships between HRV, salivary levels of cortisol, sleep duration, and blood lactate during submaximal running tests (SRT) in young athletes during their training and competition seasons.

The main hypothesis was that nocturnal HRV exhibits a negative relationship to salivary cortisol levels in the morning. They also hypothesized that a decrease in sleep duration alone or in combination with more intense and prolonged training reduces nocturnal HRV and elevates morning cortisol levels.

WHAT THEY DID

Eight well-trained young endurance athletes participated in this study over 7 weeks that involved both a training (T1) and early competition (T2) training phase.

They collected data using a sleep-tracking device (Emfit) and additional assessments including saliva samples.

WHAT THEY FOUND

- During all weeks of testing, HRV and salivary levels of cortisol were inversely related. Although the inter-individual differences were pronounced), the highest HRV and lowest level of cortisol were observed during week 5.

  The most pronounced correlation between HRV and morning cortisol levels was observed during week 1 and week 7 ($r = -0.833$, $p < 0.05$). The HRV values were significantly different between week 1 and week 3 ($p < 0.05$) and between week 5 and week 7 ($p < 0.05$). In addition, sleep and nocturnal sleep HR were both significantly different between week 1 and week 7 ($p < 0.05$). Differences between test weeks for cortisol and training values were not significant.

  Throughout the training period (T1, weeks 1-3), a negative correlation was observed for relative changes in cortisol levels and sleep ($r = -0.762$, $p < 0.05$). During the shift from the training to the early competition season (week 3-5), cortisol displayed a positive relationship with K2 ($r = 0.810$, $p < 0.05$).

Practical Takeaways

- Young athletes are in a developmental period and therefore, may display a greater sensitivity to stress. Application of HRV values to monitor training could identify better-individualized training profiles. This would be valuable information for coaches and athletes and when no access to laboratory settings is required, it can be used daily as well as at training camps where training load increases. Thus, these findings suggest three-day average HRV values may provide an accurate representation of young athletes' current recovery status of the autonomic nervous system and would be a beneficial value to follow during the high stress training and competition periods.

  In addition, it appears sleep is another tool that could be utilized to further facilitate success in young athletes. Although they did not examine sleep quality or the circadian rhythm of sleep in detail, the findings on sleep duration provide insights of potential value to many athletes.

- These findings provide support for previous suggestions that improved awareness of the negative consequences of sub-optimal sleep, in particular between races during the season of competition, can help athletes optimize their training. During the period of competition, the weekly training load becomes slightly more constant in order to maximize preparation for important competitions. As a result, daily stress often increases and, therefore, young endurance athletes may benefit from additional sleep during this period.

Want to learn more?
Check this out...

Damian's Comments

"I keep adding HRV studies to the digest as this data point has not progressed as fast as I thought it would. Therefore I am trying to catalogue as many new studies as I can and spend time reading and understanding the results to transfer any findings into my own understanding and coaching practice.

Of course I don't subscribe to HRV in isolation but I have slowly started to add it as a reliable data point to help make decisions on training - especially when an athlete is remote and we are training close to the edge of their capacity.

This is a good study to show not only some solid findings but how versatile HRV is and we can apply it to athletes of all levels and in any development phase."

Nutrition

This month's top research on nutrition & supplements

Nutritional approaches to counter performance constraints in high-level sports competition

Burke, L, M., et al. Experimental Physiology. 2021.

Impact of Magnesium Supplementation in Muscle Damage of Professional Cyclists Competing in a Stage Race*

Córdova, A., et al. Nutrients 11(8) 2019.

Coffee Increases Post-Exercise Muscle Glycogen Recovery in Endurance Athletes: A Randomized Clinical Trial

Loureiro, L, M, R., et al. Nutrients. 13(10), 2021.

*Classic study

Abstract

Nutritional approaches to counter performance constraints in high-level sports competition

OBJECTIVE

This report summarises current contemporary nutrition practices undertaken before, during or between events. These include strategies to ensure the availability of limited muscle fuel stores. This includes creatine supplementation to increase muscle phosphocreatine content and consideration of the type, amount and timing of dietary carbohydrate intake to optimize muscle and liver glycogen stores or to provide additional exogenous substrate. Although there is interest in ketogenic low-carbohydrate high-fat diets and exogenous ketone supplements to provide alternative fuels to spare muscle carbohydrate use, present evidence suggests a limited utility of these strategies.

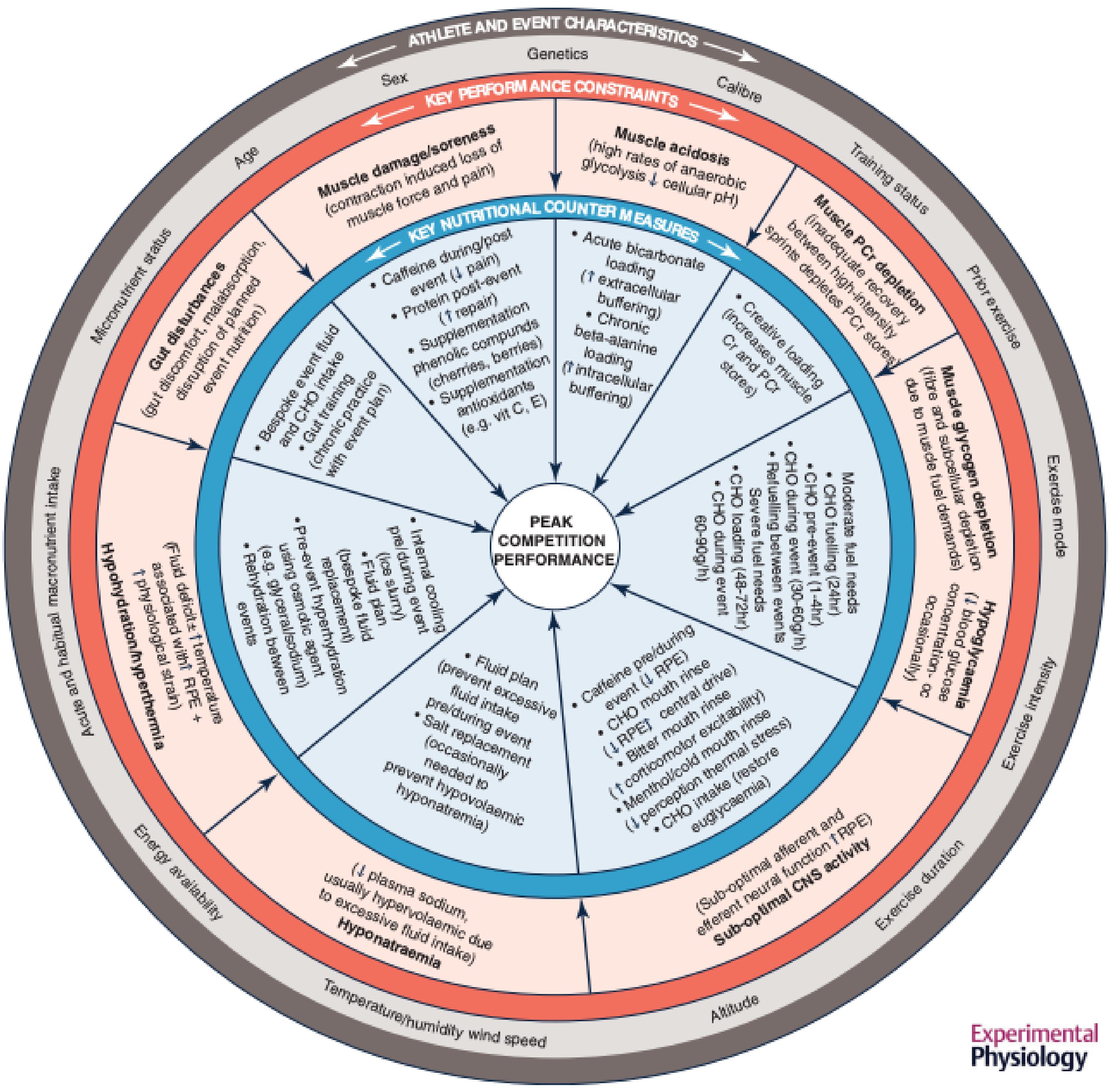
Mouth sensing of a range of food tastants (e.g., carbohydrate, quinine, menthol, caffeine, fluid, acetic acid) may provide a central nervous system derived boost to sports performance. Finally, despite decades of research on hypohydration and exercise capacity, there is still contention around their effect on sports performance and the best guidance around hydration for sporting events. A unifying model proposes that some scenarios require personalized fluid plans while others might be managed by an ad hoc approach (ad libitum or thirst-driven drinking) to fluid intake.

Practical Takeaways

A range of nutritional strategies can be used by competitive athletes, alone or in combination, to address various event-specific factors that constrain event performance. Evidence for such practices is constantly evolving but must be combined with understanding of the complexities of real-life sport for optimal implementation.

Damian's Comments

"Even though this is a broad ranging report I had to drop this one into this month's digest. Mainly because it comes from Louise Burke but also becasue of the ground it covers. I also have not attempted to dive into the details - please check out the article if you are interested in any of the practices you see in the chart on the left of this page."



Abstract

Impact of Magnesium Supplementation in Muscle Damage of Professional Cyclists Competing in a Stage Race*

OBJECTIVE

Magnesium is a cofactor of different enzymatic reactions involved in anabolic and catabolic processes that affect muscular performance during exercise. In addition, it has been suggested that magnesium could participate in maintaining muscle integrity during demanding effort.

The main purpose of this study was to analyze the effects of magnesium supplementation in preventing muscle damage in professional cyclists taking part in a 21-day cycling stage race.

WHAT THEY DID

Eighteen male professional cyclists (n = 18) from two teams were recruited to participate in the research. They were divided into 2 groups: the control group (n = 9) and the magnesium-supplemented group (n = 9).

The supplementation consisted of an intake of 400 mg/day of magnesium during the 3 weeks of competition.

Blood samples were collected according to World Anti-Doping Agency rules at three specific moments during competition: immediately before the race; mid competition; and before the last stage. Levels of serum and erythrocyte magnesium, lactate dehydrogenase, creatinine kinase, aspartate transaminase, alanine transaminase, myoglobin, aldolase, total proteins, cortisol and creatinine were determined.

WHAT THEY FOUND

Serum and erythrocyte magnesium levels decreased during the race. Circulating tissue markers increased at the end of the race in both groups. However, myoglobin increase was mitigated in the supplemented group compared with the controls. We conclude that magnesium supplementation seems to exert a protective effect on muscle damage.

In conclusion, our results indicated that Mg supplementation exceeding RDA has a modest effect in maintaining muscle integrity. In any case, adequate levels of Mg intake from diet or combined with supplements can maintain serum Mg and e-Mg levels in physiological ranges, permitting muscle recovery from intense and strenuous exercise, as is found in a cycling competition.

Practical Takeaways

A more practical recommendation for athletes outside of grand tours is from a related double-blind, between-group study that examined the effects of magnesium supplementation (350 mg·d, 10 days) on muscle soreness and performance.

This is less time and magnesium but results show significantly reduced muscle soreness, session rating of perceived exertion, acute rating of perceived exertion, and improved perceived recovery after Mg (vs. Pla) supplementation and some evidence for positive performance impact.

Of course, I am not a nutritionist, so please take this information to a nutritionist before trialling any supplementation regime.

Damian's Comments

"This mineral is a powerhouse for all levels of cyclists, from weekend warriors to pro endurance athletes alike. Magnesium is a component of more than 300 enzymes involved in energy metabolism, plus it plays a role in bone formation. You lose magnesium through sweat, so munch on some good sources of it before and after a hard workout. The recommended intake for endurance athletes is 500 to 800 mg daily. But it also naturally found in dark leafy greens, almonds, and quinoa."

Abstract

Coffee Increases Post-Exercise Muscle Glycogen Recovery in Endurance Athletes: A Randomized Clinical Trial

OBJECTIVE

Coffee is one of the most widely consumed beverages worldwide and caffeine is known to improve performance in physical exercise. Some substances in coffee have a positive effect on glucose metabolism and are promising for post-exercise muscle glycogen recovery.

They investigated the effect of a coffee beverage after exhaustive exercise on muscle glycogen resynthesis, glycogen synthase activity and glycemic and insulinemic response in a double-blind, crossover, randomized clinical trial.

WHAT THEY DID

Fourteen endurance-trained men performed an exhaustive cycle ergometer exercise (~30 min) to deplete muscle glycogen. The following morning, participants completed a second cycling protocol followed by a 4-h recovery, during which they received either test beverage (coffee + milk) or control (milk) and a breakfast meal, with a simple randomization.

Blood samples and muscle biopsies were collected at the beginning and by the end of recovery

WHAT THEY FOUND

- The consumption of coffee + milk resulted in greater muscle glycogen recovery (102.56 ± 18.75 vs. 40.54 ± 18.74 mmol·kg dw-1 ; $p = 0.01$; $d = 0.94$) and greater glucose ($p = 0.02$; $d = 0.83$) and insulin ($p = 0.03$; $d = 0.76$) total area under the curve compared with control.

The addition of coffee to a beverage with adequate amounts of carbohydrates increased muscle glycogen resynthesis and the glycemic and insulinemic response during the 4-h recovery after exhaustive cycling exercise.

Practical Takeaways

- This muscle glycogen depletion exercise may have been effective for the purposes of this study but it does not replicate any real training. Therefore it's hard to recommend but here are the nutritional facts if you want to replicate the nutritional intervention.

Each beverage and the meal were planned to provide 1.2 g of carbohydrates·kg-1 and 0.3 g of proteins·kg-1, corresponding to the 4:1 ratio of carbohydrates: proteins. The total caffeine provided with the three doses of coffee + milk treatment was 8 mg.kg-1.

Damian's Comments

"It has been shown that coffee's bioactive compounds such as caffeine, caffeic acid, and cafestol can improve glucose metabolism and promote post-exercise glycogen resynthesis when consumed during recovery. So it was interesting that this study was done because no study has been conducted to address whether coffee consumption with carbohydrates impacts post-exercise muscle glycogen recovery.

This is presumptious but it seems like the whole study was done to include latte's into the list of benefitial recovery drinks."

Psychology

The latest in psychology research

The effectiveness of pre-performance routines in sports: a meta-analysis

Anton, G, O., et al. International Review of Sport and Exercise Psychology. Online (October), 2021

How to Help Athletes Get the Mental Rest Needed to Perform Well and Stay Healthy

Ecceles, D, W.,et al. Journal of Sport Psychology in Action. Online (October), 2021

Abstract

The effectiveness of pre-performance routines in sports: a meta-analysis

OBJECTIVE

A pre-performance routine (PPR) refers to a set of task-relevant thoughts and actions an athlete systematically engages in prior to performance execution.

The aim of this meta-analysis was to determine the effectiveness of the PPR intervention to facilitate sport performance.

WHAT THEY DID

The meta-analysis included 112 effect sizes from pre–post and experimental designs in low-pressure and pressurised conditions. Extensive PPRs with several preparatory elements as well as specific stand-alone PPRs, such as left-hand dynamic handgrip and quiet eye, were analysed.

Three-level random-effects models were used for analysis, utilising Knapp-Hartung adjustments and restricted maximum likelihood estimation.

WHAT THEY FOUND

- Results showed a significant but small effect of PPRs on sport performance in pre–post designs (SMC = 0.31, 95% CI [0.18, 0.44]) and moderate-to-large effects in experimental designs, both under low-pressure (Hedges' g = 0.64, 95% CI [0.45, 0.83]) and pressurised conditions (Hedges' g = 0.70, 95% CI [0.24, 1.16]).

Practical Takeaways

These effects were not moderated by the type of PPR, age, gender, skill level, or intervention characteristics.

Overall, the meta-analytic results support the benefits of the PPR intervention in practice regardless of the type of routine. Both extensive and stand-alone PPRs are effective in optimising sport performance.

- Things you need to consider when creating a routine:
  - Desired mental state you're aiming to create
  - Timing (when to start, when to do what)
  - Your routine as part of the 'team' process
  - Practical issues (e.g., location, equipment)
  - Working with your coach to develop the routine

Damian's Comments

"This may feel like a worthless pursuit for an endurance athlete as they get to correct their performance many times during an event and PPR may relate to a short window of performance, but I would argue that a pre-performance routine can be done on the bike before key moments of a race when the athlete needs to perform.

As noted routines can include physical routines, imagery, self-talk, relaxation, and external focus of attention. There is lots of scope here to conduct an number of these on the bike in the middle of a race to set up the performance with clarity and consistency."

Abstract

How to Help Athletes Get the Mental Rest Needed to Perform Well and Stay Healthy

OBJECTIVE

Mental rest appears critical to sustained high performance in sports and other human performance contexts. They draw on the developing science of mental rest to provide a useful guide for practitioners about how athletes and other performers can obtain the mental rest they need. They describe why mental rest is important for recovery and skill learning in athletes and how athletes obtain mental rest by engaging in sleep and resting while awake, known as wakeful resting. They also provide strategies that enable athletes to obtain more sleep and wakeful resting, and present tools for monitoring athletes' mental rest.

Practical Takeaways

Mental rest is key to acquiring new technical and tactical skills. Research indicates that providing much rest between practice sessions results in better skill learning than providing little rest between practice sessions.

Research indicates that wakeful resting comprises six psychological experiences, called resting experiences

Resting experience 1: Getting a break from always thinking about one's sport

Resting experience 2: Getting a break from any kind of effortful thinking

Resting experience 3: Getting a break from feeling life is controlled by sport

Resting experience 4: Getting a break from the monotony of the daily routine

Resting experience 5: Being able to catch up on important work tasks

Resting experience 6: Being able to have a personal life outside of my sport

Damian's Comments

"This is a stright forward guide for coaches and athletes about how they might work to achieve the mental rest they need.

To this end, they describe what mental rest is, why mental rest is important for recovery and skill learning in athletes, and how athletes get mental rest via sleep and wakeful resting.

The provided strategies that enable athletes to obtain more sleep and wakeful resting are simple but useful.

And they end the guide by presenting an approach for monitoring and enhancing athletes' mental rest."

The Rest List

These are the papers that did not make it into the Digest.

Performance
Muscle Fiber Type Transitions with Exercise Training: Shifting Perspectives

Durability and repeatability of professional cyclists during a Grand Tour

Unique Concerns of the Woman Cyclist

Psychophysiological effects of slow-paced breathing at six cycles per minute with or without heart rate variability biofeedback

Larger improvements in fatigue resistance and mitochondrial function with high- than with low-intensity contractions during interval training of mouse skeletal muscle

Human skeletal muscle fiber type-specific responses to sprint interval and moderate-intensity continuous exercise: acute and training-induced changes*

Muscle recruitment patterns and saddle pressures indexes with alterations in effective seat tube angle

Central and Peripheral Oxygen Distribution in Two Different Modes of Interval Training

Effects of Increased Load of Low- Versus High-Intensity Endurance Training on Performance and Physiological Adaptations in Endurance Athletes

Effects of 16 weeks of pyramidal and polarized training intensity distributions in well-trained endurance runners

Self-selected motivational music enhances physical performance in normoxia and hypoxia in young healthy males

Four-Second Power Cycling Training Increases Maximal Anaerobic Power, Peak Oxygen Consumption, and Total Blood Volume

Higher evening metabolic responses contribute to diurnal variation of self-paced cycling performance

Key role of left ventricular untwisting in endurance cyclists at onset of exercise

Freely chosen cadence during ergometer cycling is dependent on pedalling history

Variability in Submaximal Self-Paced Exercise Bouts of Different Intensity and Duration

Nose-down saddle tilt improves gross efficiency during seated-uphill cycling

Prevalence, Characteristics, Association Factors of and Management Strategies for Low Back Pain Among Italian Amateur Cyclists: an Observational Cross-Sectional Study

Effect of crank length on biomechanical parameters and muscle activity during standing cycling

Incidence of Injuries, Illness and Related Risk Factors in Cross-Country Marathon Mountain Biking Events: A Systematic Search and Review

Methods to determine saddle height in cycling and implications of changes in saddle height in performance and injury risk: A systematic review

Various Workload Models and the Preseason Are Associated With Injuries in Professional Female Cyclists

Peak fat oxidation is positively associated with vastus lateralis CD36 content, fed-state exercise fat oxidation, and endurance performance in trained males

Maximal muscular power: lessons from sprint cycling

Methods to determine saddle height in cycling and implications of changes in saddle height in performance and injury risk: A systematic review

Energy Metabolism in Continuous, High-Intensity, and Sprint Interval Training Protocols With Matched Mean Intensity

The Rest List

These are the papers that did not make it into the Digest.

Environment

Exercise Heat Acclimation With Dehydration Does Not Affect Vascular and Cardiac Volumes or Systemic Hemodynamics During Endurance Exercise

Heat Added to Repeated-Sprint Training in Hypoxia Does Not Affect Cycling Performance

Effects of Heat Acclimation and Acclimatisation on Maximal Aerobic Capacity Compared to Exercise Alone in Both Thermoneutral and Hot Environments: A Meta-Analysis and Meta-Regression

Increased air temperature during repeated-sprint training in hypoxia amplifies changes in muscle oxygenation without decreasing cycling performance

The efficacy of weekly and bi-weekly heat training to maintain the physiological benefits of heat acclimation

Quantifying the impact of heat on human physical work capacity; part II: the observed interaction of air velocity with temperature, humidity, sweat rate, and clothing is not captured by most heat stress indices

A Combination of Ice Ingestion and Head Cooling Enhances Cognitive Performance during Endurance Exercise in the Heat

Passive heat acclimation does not modulate processing speed and executive functions during cognitive tasks performed at fixed levels of thermal strain

Effects of Active Preconditioning With Local and Systemic Hypoxia on Submaximal Cycling

The Rest List

These are the papers that did not make it into the Digest.

Technology, Profiling & Monitoring

Validating an Adjustment to the Intermittent Critical Power Model for Elite Cyclists—Modeling W′ Balance During World Cup Team Pursuit Performances

Analysis of Fractal Correlation Properties of Heart Rate Variability during an Initial Session of Eccentric Cycling

Methodological Reconciliation of CP and MLSS and Their Agreement with the Maximal Metabolic Steady State

Relationships between Heart Rate Variability, Sleep Duration, Cortisol and Physical Training in Young Athletes

The ratio of heart rate to heart rate variability reflects sympathetic activity during incremental cycling exercise

Testing, Training, and Optimising Performance of Track Cyclists: A Systematic Mapping Review

Multi-Night Validation of a Sleep Tracking Ring in Adolescents Compared with a Research Actigraph and Polysomnography

Case Study: Energy Availability and Endocrine Markers in Elite Male Track Cyclists

Struggles and strategies in anaerobic and aerobic cycling tests: A mixed-method approach with a focus on tailored self-regulation strategies

Power Profile of Top 5 Results in World Tour Cycling Races

The W′ Balance Model: Mathematical and Methodological Considerations

Over 55 years of critical power: Fact or artifact?

Functional Threshold Power Is Not Equivalent to Lactate Parameters in Trained Cyclists

Power profiling and the power-duration relationship in cycling: a narrative review

Monitoring and adapting endurance training on the basis of heart rate variability monitored by wearable technologies: A systematic review with meta-analysis

Blood Biomarker Profiling and Monitoring for High-Performance Physiology and Nutrition: Current Perspectives, Limitations and Recommendations

Identification of Non-Invasive Exercise Thresholds: Methods, Strategies, and an Online App

Prediction of viral symptoms using wearable technology and artificial intelligence: A pilot study in healthcare workers

Adaptive Athlete Training Plan Generation: An intelligent control systems approach

Model of 30-s sprint cycling performance: Don't forget the aerobic contribution!

What Is behind Changes in Resting Heart Rate and Heart Rate Variability? A Large-Scale Analysis of Longitudinal Measurements Acquired in Free-Living

Aerodynamic Study of the Pedalling of a Cyclist with a Transitional Hybrid RANS–LES Turbulence model

On-site drag analysis of drafting cyclists

Countermovement jump variables not tensiomyography can distinguish between sprint and endurance focused track cyclists

Can Wearable Sweat Lactate Sensors Contribute to Sports Physiology?

Heart Rate Variability-Guided Training for Enhancing Cardiac-Vagal Modulation, Aerobic Fitness, and Endurance Performance: A Methodological Systematic Review with Meta-Analysis

The Rest List

These are the papers that did not make it into the Digest.

Technology, Profiling & Monitoring

A Learn-to-Rank Approach for Predicting Road Cycling Race Outcomes

Heart rate variability-guided training in professional runners: Effects on performance and vagal modulation

Training-induced muscle adaptations during competitive preparation in elite female rowers

Validity of a novel device for indoor analysis of cyclists' drag area

The Rest List

These are the papers that did not make it into the Digest.

Nutrition

Nitrate-rich beetroot juice ingestion reduces skeletal muscle O2 uptake and blood flow during exercise in sedentary men

Commercially available carbohydrate drink with menthol fails to improve thermal perception or cycling exercise capacity in males

Carbohydrate and Protein Co-Ingestion Postexercise Does Not Improve Next-Day Performance in Trained Cyclists

Ketogenic and High-Carbohydrate Diets in Cyclists and Triathletes

The Hydrating Effects of Hypertonic, Isotonic and Hypotonic Sports Drinks and Waters on Central Hydration During Continuous Exercise: A Systematic Meta-Analysis and Perspective

Impact of Dietary Carbohydrate Restriction versus Energy Restriction on Exogenous Carbohydrate Oxidation during Aerobic Exercise

Effects of Energy Gel Ingestion on Blood Glucose, Lactate, and Performance Measures During Prolonged Cycling

Nutritional approaches to counter performance constraints in high-level sports competition

Carbohydrate Mouth Rinsing Does Not Alter Central or Peripheral Fatigue After High-Intensity and Low-Intensity Exercise in Men

Overtraining Syndrome (OTS) and Relative Energy Deficiency in Sport (RED-S): Shared Pathways, Symptoms and Complexities

Supplements

Effects of Paracetamol (Acetaminophen) Ingestion on Endurance Performance: A Systematic Review and Meta-Analysis

Effects of sodium bicarbonate supplementation on exercise performance: an umbrella review

The effects of sodium bicarbonate supplementation at individual time-to-peak blood bicarbonate on 4-km cycling time trial performance in the heat

Effect of Warm-Up and Sodium Bicarbonate Ingestion on 4-km Cycling Time-Trial Performance

Twenty-one days of spirulina supplementation lowers heart rate during submaximal cycling and augments power output during repeated sprints in trained cyclists

Extracellular Buffering Supplements to Improve Exercise Capacity and Performance: A Comprehensive Systematic Review and Meta-analysis

Coffee Increases Post-Exercise Muscle Glycogen Recovery in Endurance Athletes: A Randomized Clinical Trial

Caffeine Increases Exercise Performance, Maximal Oxygen Uptake, and Oxygen Deficit in Elite Male Endurance Athletes

Exogenous ketosis increases blood and muscle oxygenation but not performance during exercise in hypoxia

Impact of Magnesium Supplementation in Muscle Damage of Professional Cyclists Competing in a Stage Race*

Sodium bicarbonate ingestion mitigates the heat-induced hyperventilation and reduction in cerebral blood velocity during exercise in the heat

The Effect of Beetroot Ingestion on High-Intensity Interval Training: A Systematic Review and Meta-Analysis

The Rest List

These are the papers that did not make it into the Digest.

Strength

Effects of Music on Resistance Exercise Performance

Making Sense of Muscle Protein Synthesis: A Focus on Muscle Growth During Resistance Training

Compatibility of Concurrent Aerobic and Strength Training for Skeletal Muscle Size and Function: An Updated Systematic Review and Meta-Analysis

The role of supervision in resistance training: An exploratory systematic review and meta-analysis

Energy deficiency impairs resistance training gains in lean mass but not strength: A meta-analysis and meta-regression

Minimal-Dose Resistance Training for Improving Muscle Mass, Strength, and Function: A Narrative Review of Current Evidence and Practical Considerations

Cycle ergometer training and resistance training similarly increase muscle strength in trained men

Lack of increased rate of force development after strength training is explained by specific neural, not muscular, motor unit adaptations

High Dose of Caffeine Mouth Rinse Increases Resistance Training Performance in Men

Psychology

How Does Interval-Training Prescription Affect Physiological and Perceptual Responses?

“Short and Sweet”: A Randomized Controlled Initial Investigation of Brief Online Psychological Interventions With Endurance Athletes

The effectiveness of pre-performance routines in sports: a meta-analysis

Too tired to switch off? How post-training physical fatigue impairs mental recovery through increased worry

How to Help Athletes Get the Mental Rest Needed to Perform Well and Stay Health

‘Psyching-Up’ and Muscular Force Production*

Chronic psychological stress impairs recovery of muscular function and somatic sensations over a 96-hour period*

The Rest List

These are the papers that did not make it into the Digest.

Recovery

Sleep interventions for performance, mood and sleep outcomes in athletes: A systematic review and meta-analysis

Athlete, coach and practitioner knowledge and perceptions of post-exercise cold-water immersion for recovery: a qualitative and quantitative exploration

Sleep Duration Correlates With Performance in Ultra-Endurance Triathlon

Effects of High-Intensity Interval Training on Sleep: A Systematic Review and Meta-Analysis

Monitoring Effects of Sleep Extension and Restriction on Endurance Performance Using Heart Rate Indices

An Individualized Intervention Increases Sleep Duration in Professional Athletes

Post-exercise Cold Water Immersion Does Not Improve Subsequent 4-km Cycling Time-Trial Compared With Passive and Active Recovery in Normothermia

Complete sleep evaluation of top professional cross-country mountain bikers athletes

Cold Water Immersion Offers No Functional or Perceptual Benefit Compared to a Sham Intervention During a Resistance Training Program

Monitoring Effects of Sleep Extension and Restriction on Endurance Performance Using Heart Rate Indices

Coaching & Sports Science

Innovating Together: Collaborating to Impact Performance

Performance Profiling: Theoretical Foundations, Applied Implementations and Practitioner Reflections

Managing the Training Process in Elite Sports: From Descriptive to Prescriptive Data Analytics

Methodology over metrics: current scientific standards are a disservice to patients and society

Why—How—What—So What

Thanks for reading

Next issue will be published on the first of every other month.

If you liked all the great content, then make sure to share it and spread the knowledge to your friends and colleagues who you know will also find it useful!

Cheers!
Damian

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