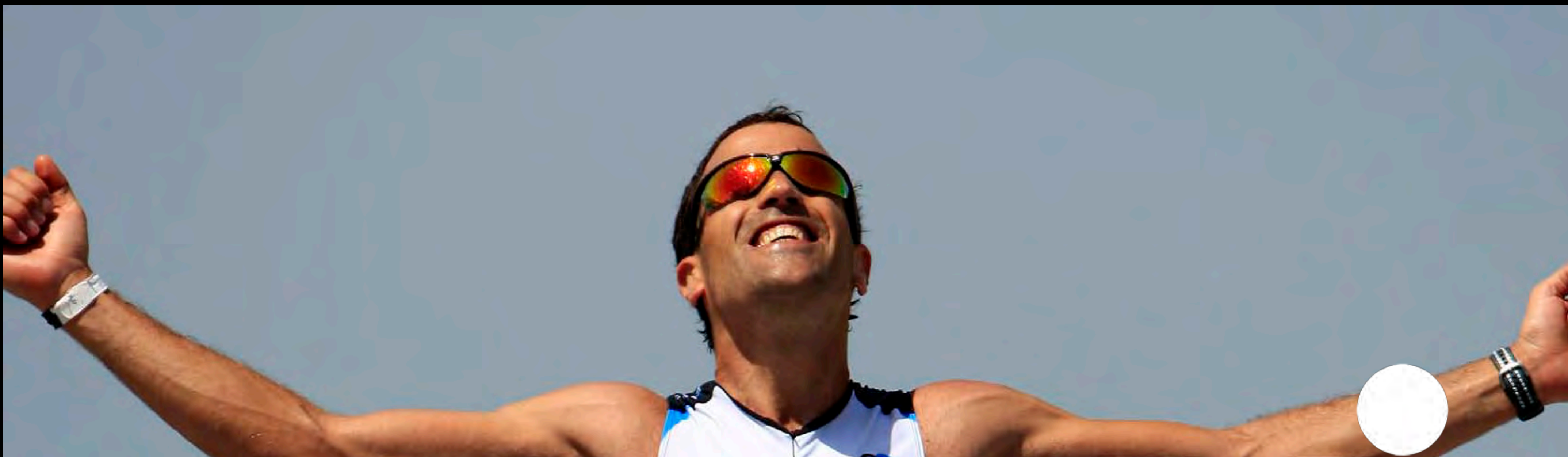
Tapering and Peaking: Facts and Fiction



Iñigo Mujika
PHYSIOLOGY & TRAINING

Contents

- The "ideal" taper
- Effects of tapering on performance: a meta-analysis
- Body composition and nutrient intake during the taper
- Enhancing recovery during the taper
- Environmental factors and the taper
- Communication
- Conclusions and practical implications
- Final comment

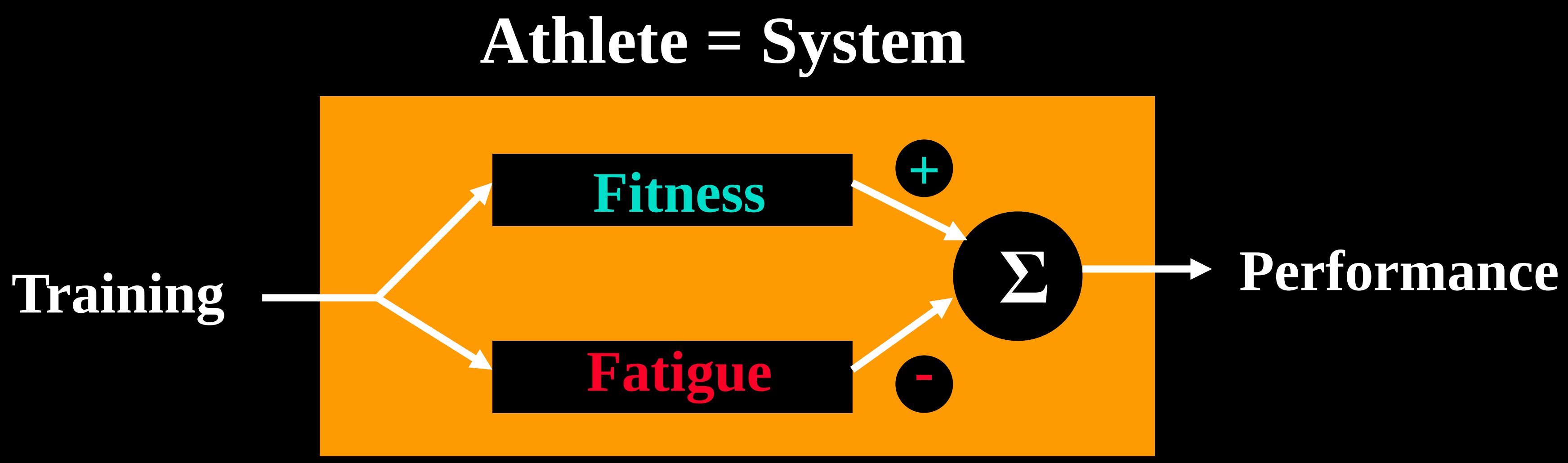
The “ideal” taper

Aim of the taper

- **"The goal during taper periods is to maintain the physiological adaptations achieved during intensive training, while the negative impact of training resolves. Under ideal circumstances, this will result in an athlete who has made maximal physiological adjustments at the exact same time the negative influences of training have diminished, resulting in an optimal performance potential."** **Mujika *Int. J. Sports Med.* 19: 439-446, 1998**

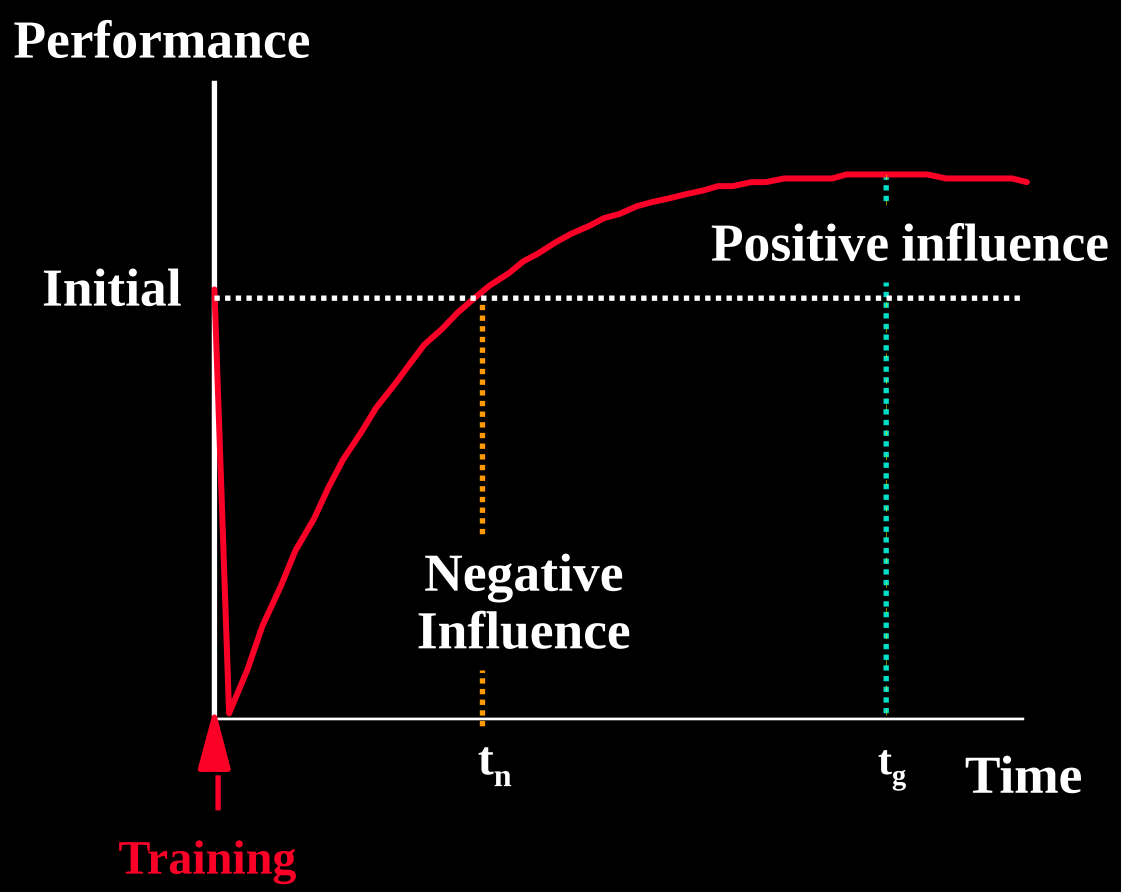
- **"The performance enhancement that usually takes place with the taper is related to recovery of physiological capacities that were impaired by past training and to restoration of the tolerance to training, resulting in further adaptations during the taper."** **Mujika *Tapering and Peaking for Optimal Performance* p. 7, 2009**

Mathematical modeling and systems theory



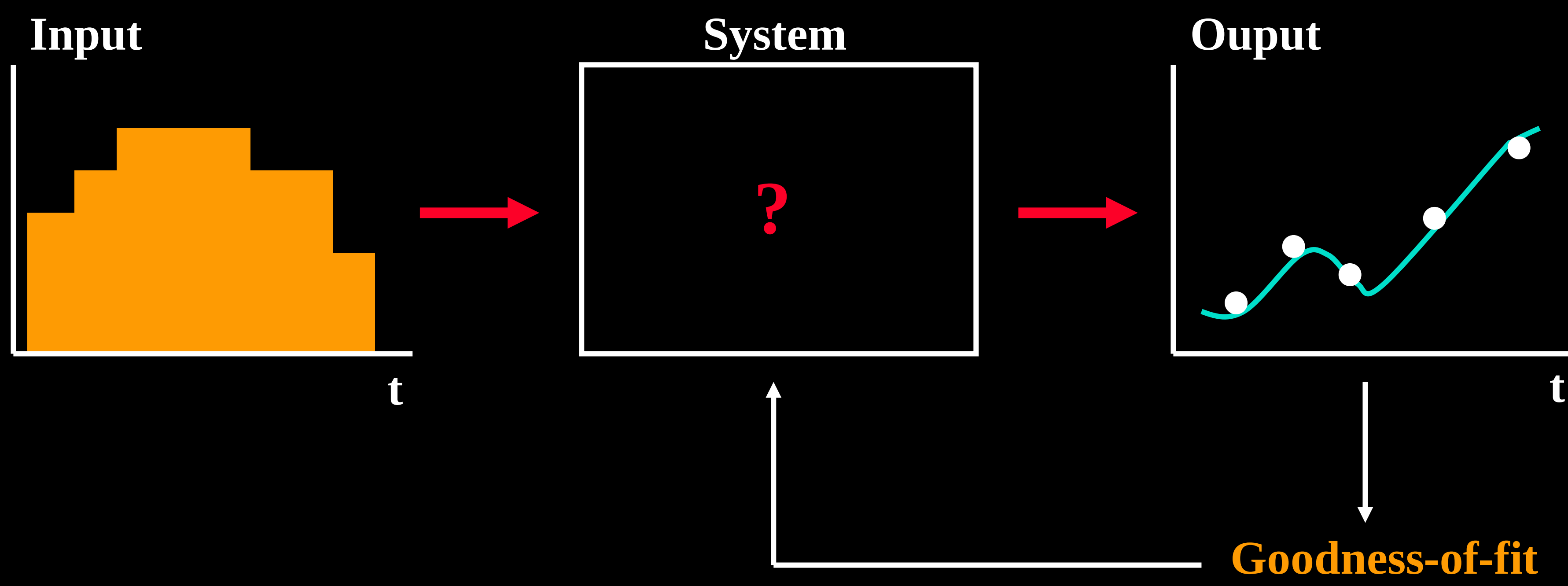
Banister & Fitz-Clarke *J. Therm. Biol.* 18: 587-597, 1993

Modeling the effects of training



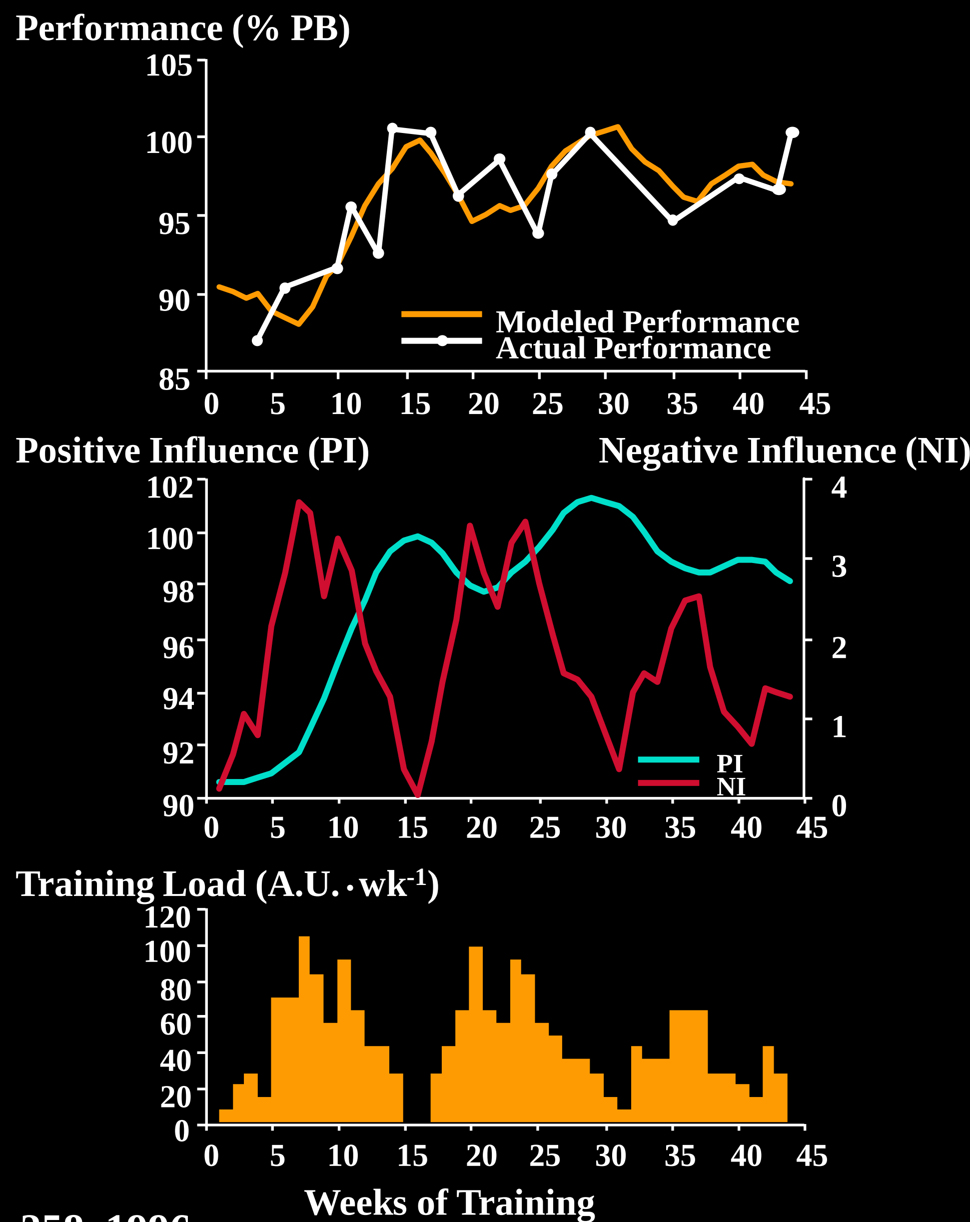
Mujika et al. *Med. Sci. Sports Exerc.* 28: 251-258, 1996

Characterisation of a dynamical process



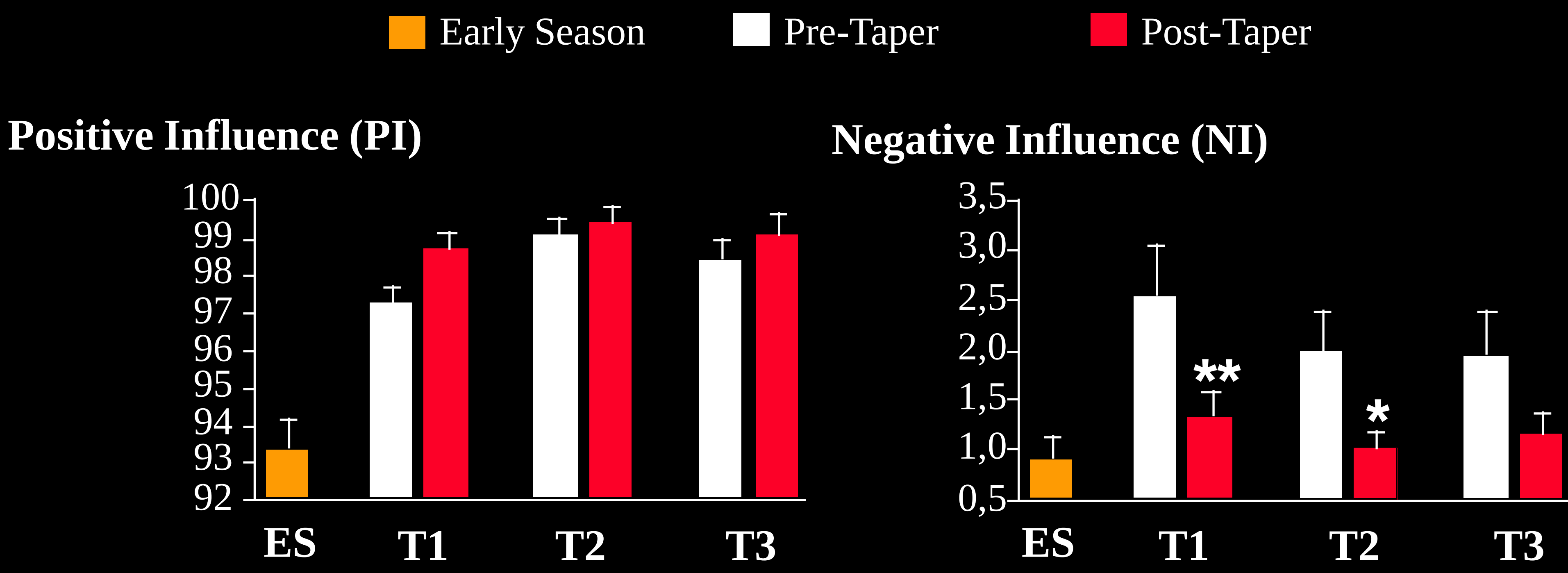
Busso & Thomas. *Int. J. Sports Physiol. Perf.* 1: 400-405, 2006

Mathematical modeling in swimming



Mujika et al.
Med. Sci. Sports Exerc. 28: 251-258, 1996

Modeling the effects of the taper



Mujika et al. *Med. Sci. Sports Exerc.* 28: 251-258, 1996

Physiological and psychological indices of the effects of the taper

- **Physiological:** increased VO_{2max}, economy, muscle oxygenation, testosterone, red cell volume, hematocrit, hemoglobin, reticulocytes, glycogen concentration, oxydative enzymes, muscle fiber contractile properties, strength and power

- **Psychological:** reduced perception of effort, global mood disturbance, perception of fatigue; increased vigor, quality of sleep

Mujika et al. *Sports Med.* 34:891-927, 2004

Effects of tapering on performance: a meta-analysis

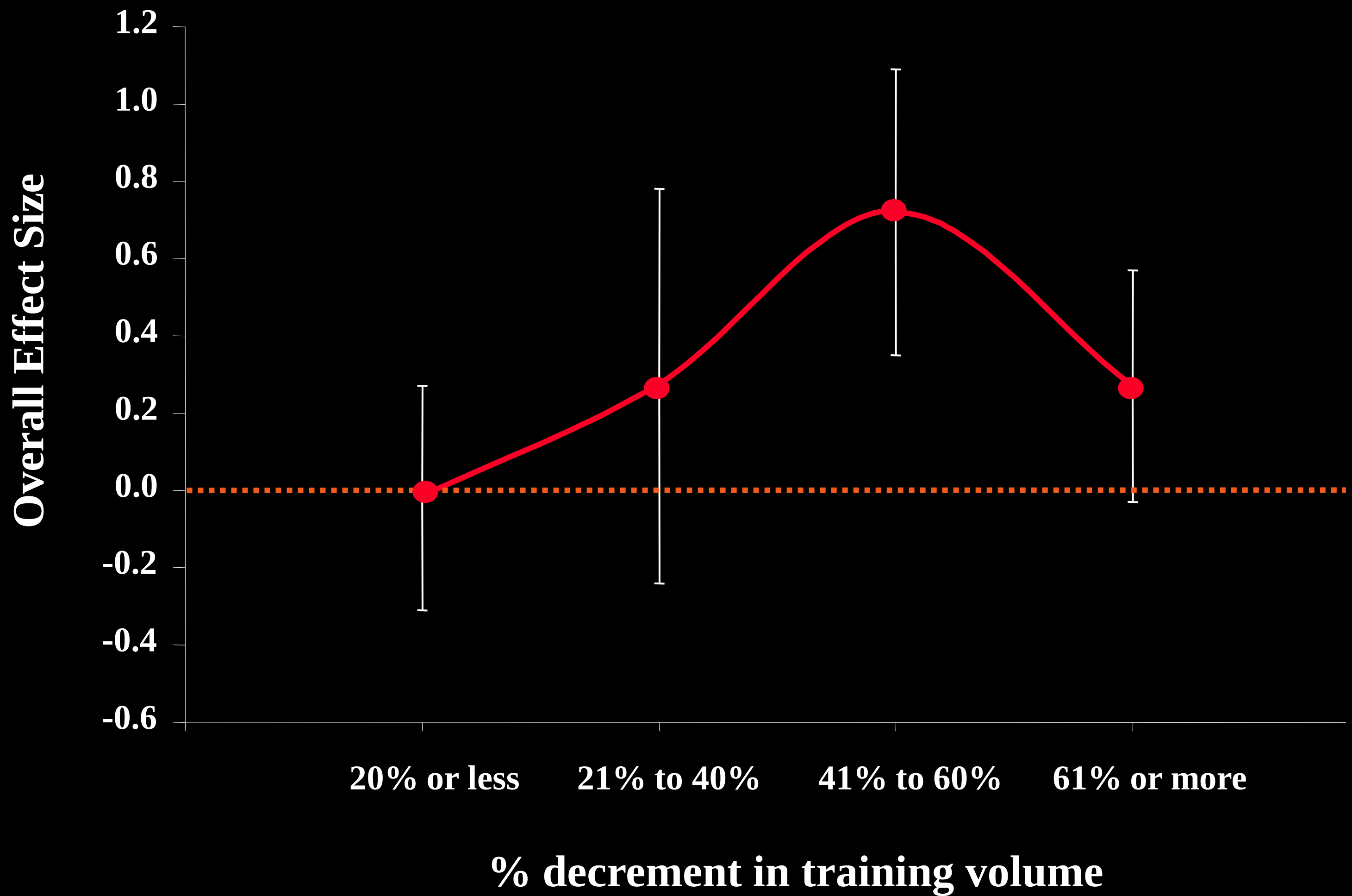
Reduction of intensity meta-analysis

Effect of REDUCED INTENSITY on overall effect size of performance changes

REDUCED INTENSITY	EFFECT SIZE Mean (95% C.I.)	N	P
YES	-0.02 (-0.37, 0.33)	63	0.91
NO	0.33 (0.19, 0.47)	415	0.0001

Bosquet et al. *Med. Sci. Sports Exerc.* 39: 1358-1365, 2007

Reduction of volume meta-analysis



Bosquet et al. *Med. Sci. Sports Exerc.* 39: 1358-1365, 2007

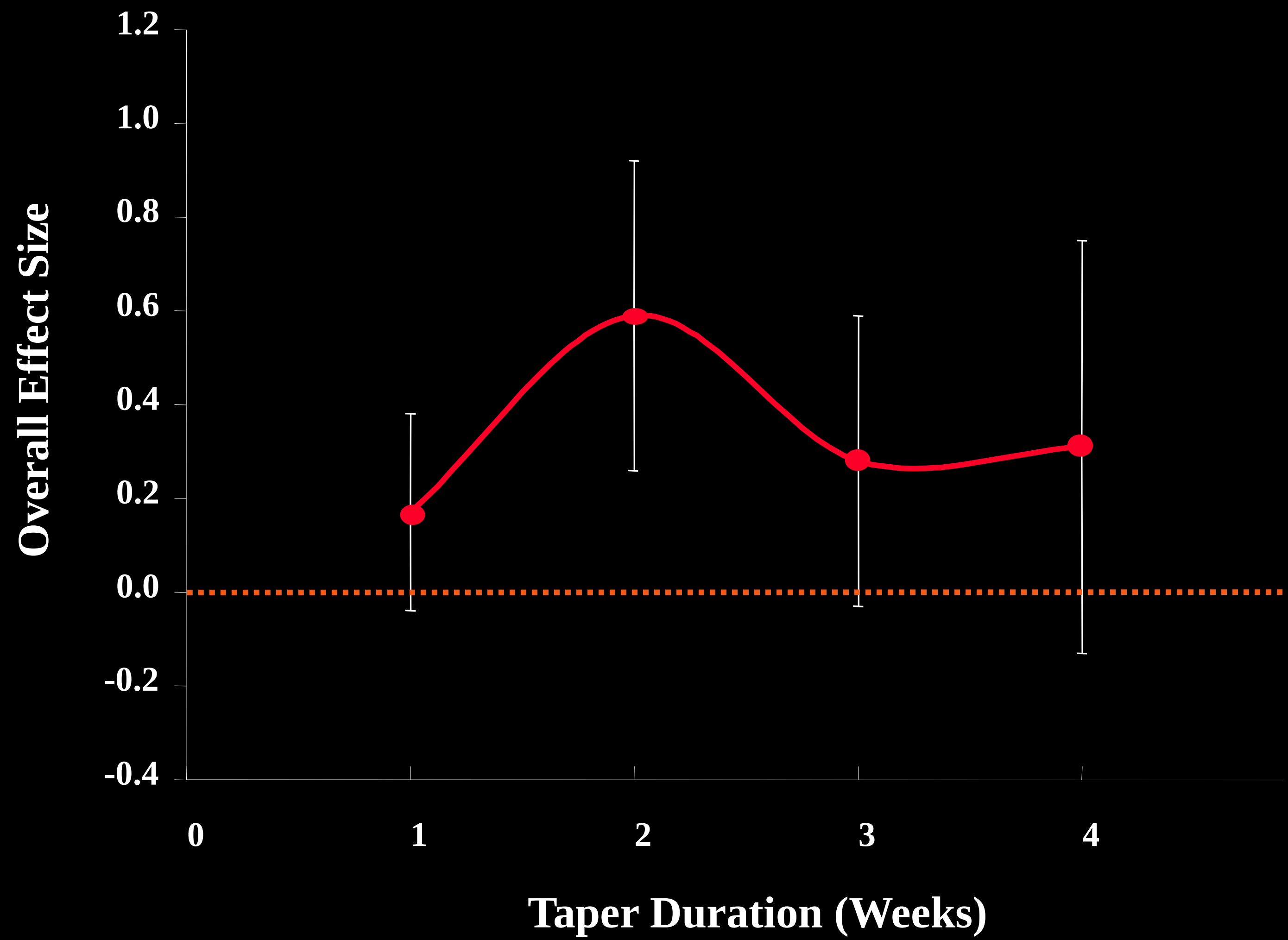
Reduction of frequency meta-analysis

Effect of REDUCED FREQUENCY on overall effect size of performance changes

REDUCED FREQUENCY	EFFECT SIZE Mean (95% C.I.)	N	P
YES	0.24 (-0.03, 0.52)	176	0.08
NO	0.35 (0.18, 0.51)	302	0.0001

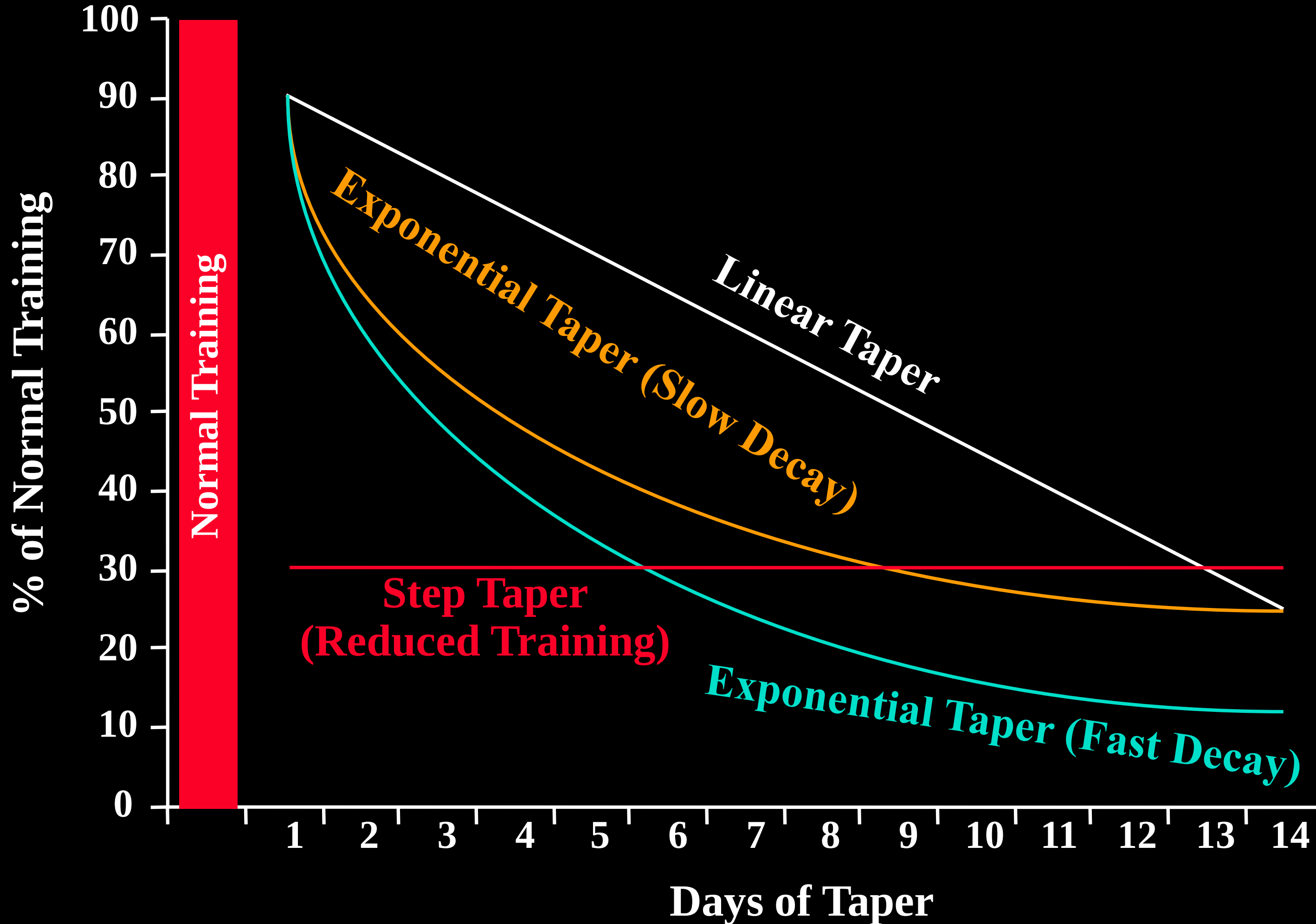
Bosquet et al. *Med. Sci. Sports Exerc.* 39: 1358-1365, 2007

Taper duration meta-analysis



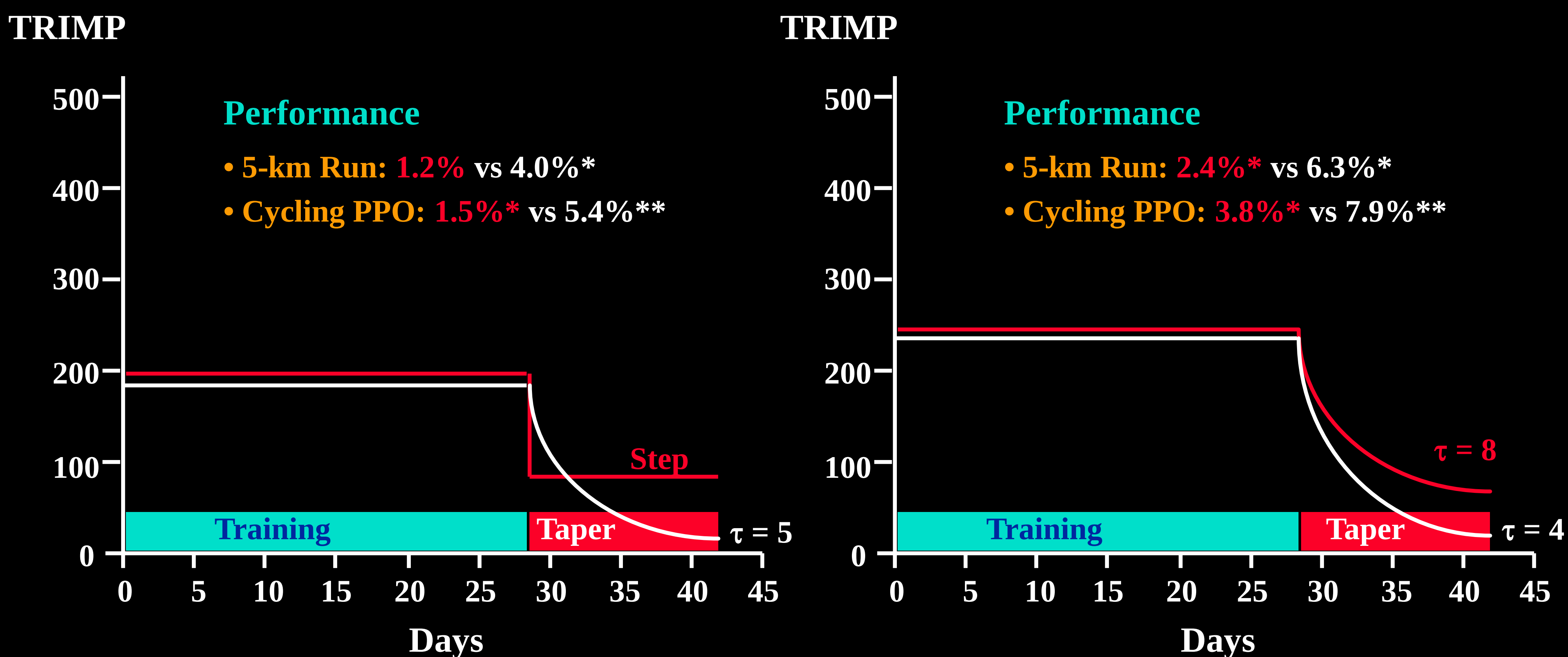
Bosquet et al. *Med. Sci. Sports Exerc.* 39: 1358-1365, 2007

Different concepts of taper



Mujika & Padilla, *Med. Sci. Sports Exerc.* 35:1182-1187, 2003

Type of taper and simulated performance



Zarcadas et al. *Adv. Exp. Med. Biol*. 393: 179-186, 1995

Banister et al. *Eur. J. Appl. Physiol*. 79: 182-191, 1999

Type of taper meta-analysis

Effect of TAPER TYPE on overall effect size of performance changes

TYPE OF TAPER	EFFECT SIZE Mean (95% C.I.)	N	P
STEP TAPER	0.42 (-0.11, 0.95)	98	0.12
PROGRESSIVE TAPER	0.30 (0.16, 0.45)	380	0.0001

Bosquet et al. *Med. Sci. Sports Exerc.* 39: 1358-1365, 2007

Various modes of locomotion

Effect of MODERATOR VARIABLES on overall effect size of performance changes

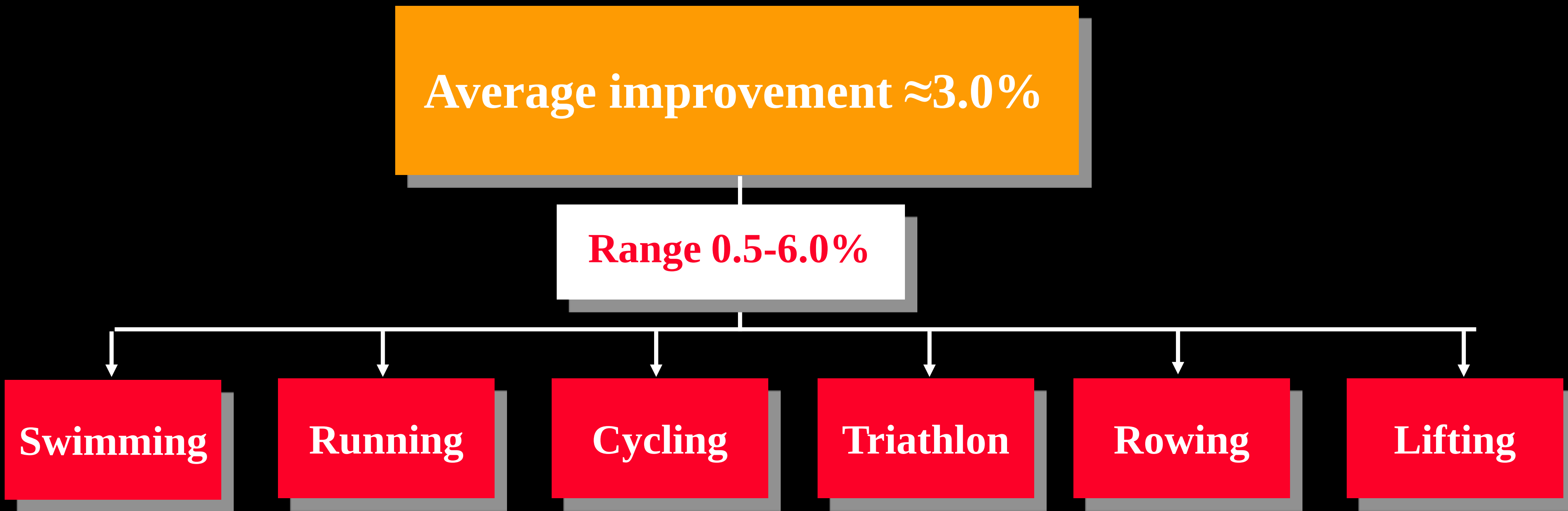
TABLE 2. Effects of moderator variables on effect size for taper-induced changes in swimming, running, and cycling performance.

Categories	Swimming		Running		Cycling	
	Mean (95% CI)	*N*	Mean (95% CI)	*N*	Mean (95% CI)	*N*
Decrease in training volume						
≤ 20%	−0.04 (−0.36, 0.29)	72	No data available		0.03 (−0.62, 0.69)	18
21–40%	0.18 (−0.11, 0.47)	91	0.47 (−0.05, 1.00)‡	30	0.84 (−0.05, 1.74)‡	11
41–60%	0.81 (0.42, 1.20)*	70	0.23 (−0.52, 0.98)	14	2.14 (−1.33, 5.62)	15
≥ 60%	0.03 (−0.66, 0.73)	16	0.21 (−0.14, 0.56)	66	0.56 (−0.24, 1.35)	36
Decrease in training intensity						
Yes	0.08 (−0.34, 0.49)	45	−0.72 (−1.63, 0.19)	10	0.25 (−0.73, 1.24)	8
No	0.28 (0.08, 0.47)*	204	0.37 (0.09, 0.66)*	100	0.68 (0.09, 1.27)†	72
Decrease in training frequency						
Yes	0.35 (−0.36, 1.05)	54	0.16 (−0.17, 0.49)	74	0.95 (−0.48, 2.38)	25
No	0.30 (0.10, 0.50)*	195	0.53 (0.05, 1.01)†	36	0.55 (−0.05, 1.15)‡	55
Duration of the taper						
≤ 7 d	−0.03 (−0.41, 0.35)	54	0.31 (−0.08, 0.70)	52	0.29 (−0.12, 0.70)	47
8–14 d	0.45 (−0.01, 0.90)‡	84	0.58 (0.12, 1.05)*	38	1.59 (−0.01, 3.19)†	33
15–21 d	0.33 (0.00, 0.65)†	75	−0.08 (−0.95, 0.80)	10	No data available	
≥ 22 d	0.39 (−0.08, 0.86)	36	−0.72 (−1.63, 0.19)	10	No data available	
Pattern of the taper						
Step taper	0.10 (−0.65, 0.85)	14	−0.09 (−0.56, 0.38)	36	2.16 (−0.15, 4.47)	25
Progressive taper	0.27 (0.08, 0.45)*	235	0.46 (0.13, 0.80)*	74	0.28 (−0.10, 0.66)‡	55

* $P \leq 0.01$; † $P \leq 0.05$; ‡ $P \leq 0.10$.

Bosquet et al. *Med. Sci. Sports Exerc.* 39: 1358-1365, 2007

Performance improvements in different sports



Mujika & Padilla, *Med. Sci. Sports Exerc.* 35: 1182-1187, 2003

Universality of performance improvements

- No evidence of a sex effect concerning physiological adaptations and taper effects on performance
- Event duration and metabolic contribution do not affect the potential gain that can be obtained during the taper
- Technical and biomechnical aspects of competition do not seem to affect the performance outcome of a taper
- Tapering-induced performance gains can be expected irrespective of the caliber of the athlete
- Tapering-induced performance gains may have a major impact on competition placing

Mujika et al. *Int. J. Sports Med.* 23: 582-587, 2002

Body composition and nutrient intake during the taper

Energy balance during the taper

- **Four weeks of overload training followed by two weeks of tapered training in LD triathletes:** energy intake did not change between both training phases (13.8-15.0 vs 13.2-15.0 MJ/day), whereas energy expenditure decreased from 16.8-17.0 to 12.1-12.7 MJ/day. Total body mass did not change during the taper, but the percentage body fat increased slightly from 11.4-11.5 to 11.8-12.1%. Margaritis et al. *J. Am. Coll. Nutr.* 22: 147-156, 2003

- **Four weeks of reduced training on male distance runners:** body fat increased from 10.4 to 11.8%. McConell et al. *Int. J. Sports Med.* 14: 33-37, 1993

- "Athletes tapering for competition should pay careful attention to matching energy intake in accordance with the reduced energy expenditure that characterises this training period." Mujika et al. *Sports Med.* 34:891-927, 2004

Substrate utilisation and iron status during the taper

- Available reports on the effects of tapering on the RER during both maximal and submaximal intensity exercise suggest that the substrate contribution to power production is not modified by a taper

- Enhanced erythropoietic activity in the bone marrow associated with the taper could jeopardise the iron status of athletes. Iron profiles indicative of a prelatent-latent iron deficiency, with normal red cell count and haemoglobin, but lowered ferritin, serum iron and transferrin saturation, and increased transferrin values have been reported in tapering athletes

Mujika et al. *Sports Med.* 34:891-927, 2004

Enhancing recovery during the taper

Sleep

Promoting sleep quality and/or quantity

Halson, *Eur. J. Sport Sci.*, 8:119-126, 2008

Table II. Potential non-pharmacological means for promoting sleep quality and/or quantity

Ensure appropriate recovery (physical, nutritional and psychological) from training and competition

Consume tryptophan containing foods such as milk, meat, fish, poultry, eggs, beans, peanuts, cheese and leafy green vegetables

Consume a high glycemic index meal 4 hours before bedtime

Consume a balanced, healthy diet

Minimise alcohol intake prior to bedtime

Minimise caffeine intake prior to bedtime (individual tolerances do exist)

Be cautious of fluid intake following completion of training/ competition and bedtime. For athletes who are repeatedly waking at night to use the bathroom, hydration testing and fluid balance assessment may be useful to prescribe type and quantity of fluid both during the day and during the recovery period

Skin warming (in cool environmental conditions)- this can be achieved through prior warm baths/ spa baths, hot footbaths, warm blankets and wearing of socks

Skin cooling (in warm environmental conditions)- this can be achieved through cool showers, the appropriate use of air-conditioning

Sleep hygiene- the following sleep hygiene strategies are commonly recommended:

- If you cannot sleep within 15 minutes, get out of bed and try another strategy
- Eliminate the bedroom clock
- Avoid coffee, alcohol and nicotine
- Regularise the bedtime
- Be conscious of food and food intake
- Nap appropriately (for no more than 45 minutes and not late in the afternoon)

Explore the use of muscle relaxation and cognitive relaxation

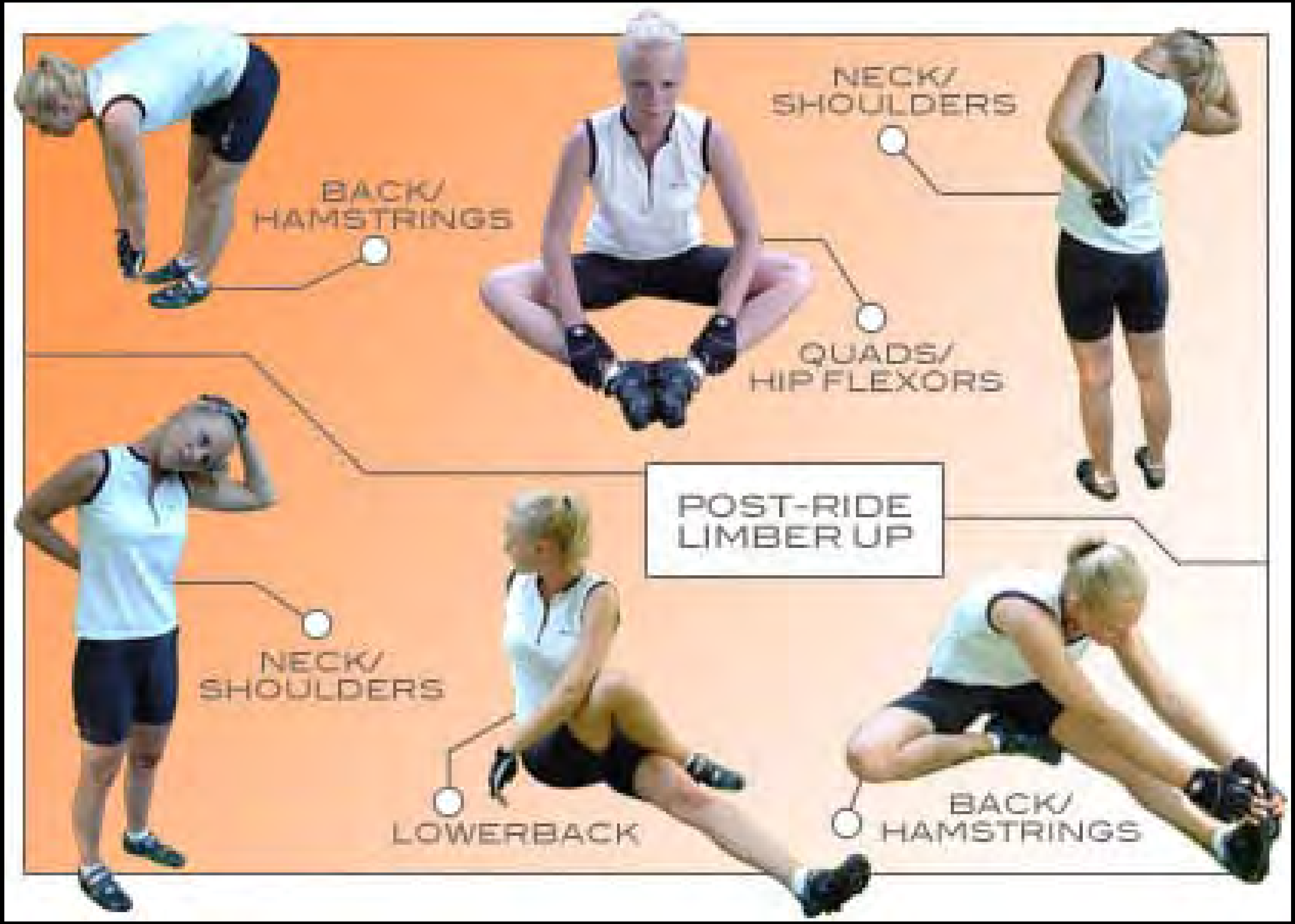
Nutrition


AIL
FENOUIL
TOMATE
OIGNON
ROYAL GALA


Citron
CLEMENTINE
RED GLOBE
ROYAL GALA
LA SOCULENTE

Active recovery

Stretching



BACK/
HAMSTRINGS
NECK/
SHOULDERS
QUADS/
HIP FLEXORS
POST-RIDE
LIMBER UP
NECK/
SHOULDERS
LOWERBACK
BACK/
HAMSTRINGS

Hydrotherapy

Cold water immersion

Cold water immersion

Hot water immersion

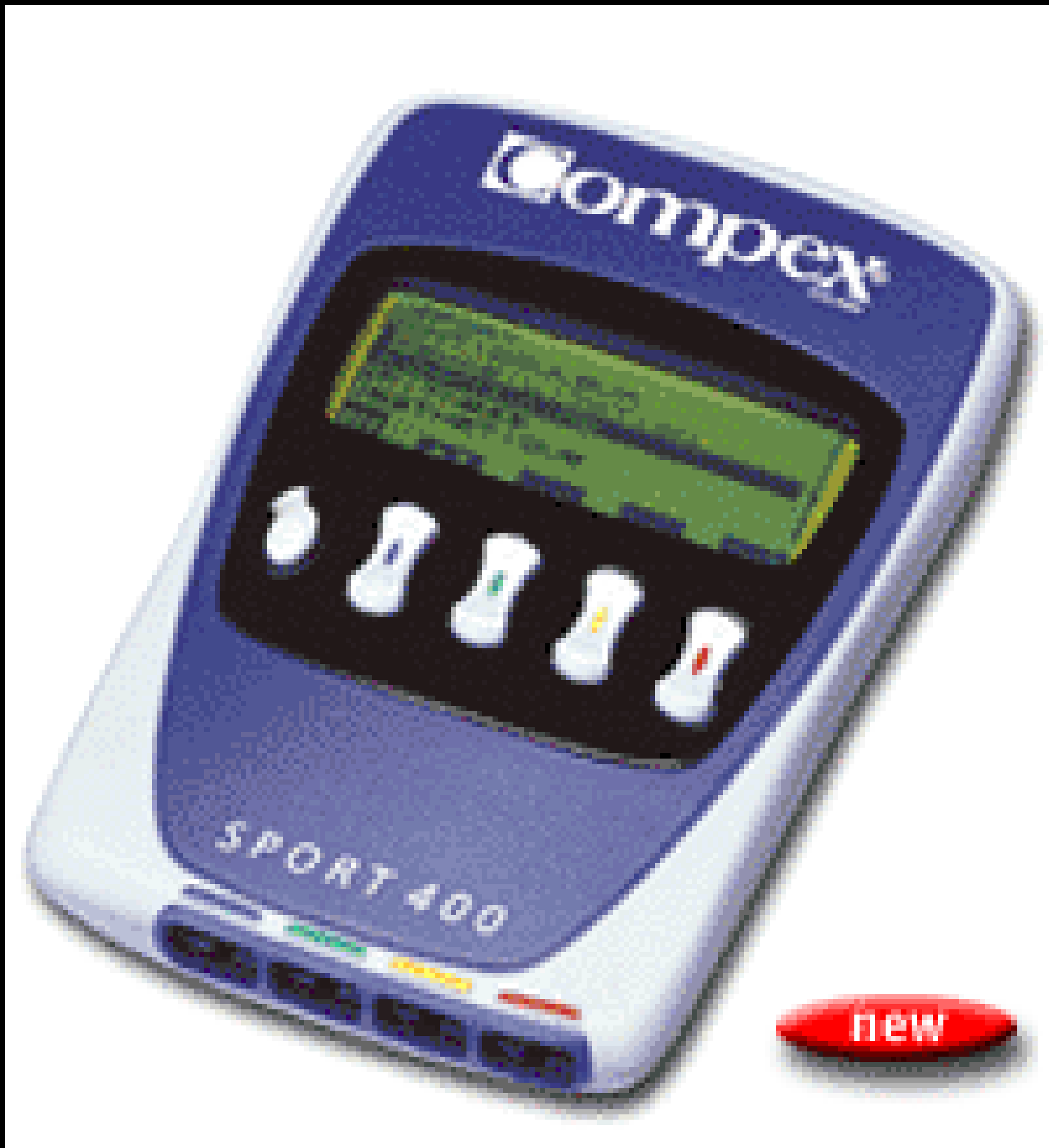
Contrast hydrotherapy

Whole body cryostimulation

Massage

Compression garments

Electrostimulation



Psychology and relaxation

REVIEW ARTICLE

Sports Med 2006; 36 (9): 781-796
0112-1642/06/0009-0781/$39.95/0

Using Recovery Modalities between Training Sessions in Elite Athletes

Does it Help?

Anthony Barnett[1,2]

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2 School of Health and Human Performance, Central Queensland University, North Rockhampton, Queensland, Australia

Contents

Abstract

Achieving an appropriate balance between training and competition stresses and recovery is important in maximising the performance of athletes. A wide range of recovery modalities are now used as integral parts of the training programmes of elite athletes to help attain this balance. This review examined the evidence available as to the efficacy of these recovery modalities in enhancing between-training session recovery in elite athletes. Recovery modalities have largely been investigated with regard to their ability to enhance the rate of blood lactate removal following high-intensity exercise or to reduce the severity and duration of exercise-induced muscle injury and delayed onset muscle soreness (DOMS). Neither of these reflects the circumstances of between-training session

"...there is no substantial scientific evidence to support the use of the recovery modalities reviewed to enhance the between-training session recovery of elite athletes"

"Because recovery modalities are gaining wide acceptance among elite athletes and sports are investing time and money in providing these modalities, further research and better consideration of the evidence of their effectiveness appear warranted"

Barnett *Sports Med.* 36: 781-796, 2006

Journal of Sports Sciences, November 2009; 27(13): 1409–1420

Routledge

Fatigue management in the preparation of Olympic athletes

PAULA J. ROBSON-ANSLEY[1], MICHAEL GLEESON[2], & LES ANSLEY[1]

Table I. Summary of methods for monitoring and managing fatigue in the preparation of Olympic athletes.

Monitoring tools	
Self-scored questionnaires	Effective in the short term. Insufficient data on long-term use
Training load assessment	Subjective assessment provides a simple but effective method
Performance tests	Need to be sport specific. Time to fatigue tests currently favoured
Blood/saliva screening	Cannot detect underperformance syndrome, but may be useful in monitoring health status
General fatigue management	
Rest	Alleviates boredom and reduces stress perception
Sleep	Nervous system restoration; improves/maintains motivation and skill
Nutrition	Adequate and timely carbohydrate intake optimizes glycogen recovery and maintains immune function. Protein/carbohydrate intake enhances muscle gain
Hydration	Particularly important in hot climates such as Bejiing. Salt replacement usually obtained through food
Short-term fatigue management	
Physical therapy	No evidence for massage or stretching. Compression garments may confer benefits
Cryotherapy	No evidence of benefit on its own
Hydrotherapy	No evidence of benefit; may be detrimental
Active recovery	No evidence of benefit; may be detrimental

manage fatigue to optimize recovery in their preparation for Olympic competition. In this paper, we explore practical methods of monitoring and managing fatigue in athletes.

under-recovery and overreaching, which may lead to the development of underperformance syndrome (UPS) (Foster, 1998). During periods of high training loads, athletes and coaches need to be

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DOI: 10.1080/02640410802702186

Robson-Ansley et al. *J. Sports Sci.* 27: 1409-1420, 2009

ASCA Current Trends and Practices – Recovery – Science vs. Practice. . J. Aust. Strength Cond. Supplement (2)August, 2010 © ASCA

RECOVERY REVIEW – SCIENCE VS. PRACTICE

Jo Vaile, PhD
Shona Halson, PhD
Stuart Graham

Australian Institute of Sport

OVERVIEW

Recovery has been identified as an important component of athletic performance. Despite the obvious popularity, there is a lack of scientific evidence for the validity of many recovery interventions. Because of this, the ability to prescribe discrete and specific recommendations for recovery interventions in elite sport is not feasible. Therefore, the aim of this review is to provide practitioners with current scientific information in the area of recovery and elite athlete performance, and where possible provide recommendations regarding usage.

It is important to consider that while scientific evidence for certain recovery interventions may be lacking this review does not dismiss the importance of anecdotal reports by elite athletes. As research in the area of recovery is in its infancy it would be inappropriate to suggest that certain recovery interventions may not be beneficial simply as a consequence of limited scientific investigation.

OBJECTIVE

To evaluate the scientific evidence and current practice of recovery interventions.

METHODOLOGY

Peer reviewed research in the area of recovery was examined to collate evidence regarding the effectiveness of popular recovery interventions. Following this, a number of recovery interventions were given a rating (LOW, MEDIUM, HIGH) based on the ***current scientific knowledge*** and the ***current** practice* in elite athlete populations. It was necessary to consider both parameters in this process, as a recovery intervention could be deemed an appropriate recovery practice if a) there is scientific evidence to support its usage or b) large numbers of athletes currently use the modality and there is no scientific evidence suggesting it is detrimental to performance. This if often the case with respect to recovery practices as there is currently little quality published scientific evidence specific to the area of recovery.

For the purpose of this review, interventions were examined from post-exercise recovery perspective only. Some interventions may have different applications during alternate time points and/or settings (e.g. pre or during exercise, rehabilitation, training phase).

INTRODUCTION

Professionalism in sport has provided the foundation for elite athletes to focus purely on training and competition. Furthermore, high performance sport and the importance of athletes' successful performances have led athletes and coaches alike to continually seek any advantage or edge that may improve performance. It seems that optimal recovery from training and performance may provide numerous benefits during repetitive high-level training and competition; and that the rate and quality of recovery in the high performance athlete may be as important as the training itself. Therefore, investigating different recovery interventions and their effect on fatigue, muscle injury, recovery and performance is important.

Adequate recovery has been shown to result in the restoration of physiological and psychological processes, so that the athlete can compete or train again at an appropriate level. Recovery from training and competition is complex and involves numerous factors and is typically dependent on the nature of the exercise performed and any other outside stressors that the athlete may be exposed to. Performance is affected by numerous factors and therefore, adequate recovery should consider such factors (See Table 1).

"Despite the obvious popularity, there is a lack of scientific evidence for the validity of many recovery interventions. Because of this, the ability to prescribe discrete and specific recommendations for recovery interventions in elite sport is not feasible"

"As research in the area of recovery is in its infancy it would be inappropriate to suggest that certain recovery interventions may not be beneficial simply as a consequence of limited scientific investigation"

Vaile et al. *J. Aust. Strength Cond.* Suppl. 2: 5-21, 2010

Environmental factors and the taper

Environmental factors and the taper

- Environmental stressors like travel across time zones, heat and altitude may interfere with the taper of athletes preparing for international competition
- A training load reduction can help an athlete cope with jet-lag, and this training reduction should be integrated into the taper program
- Tapering in hot environments before competition seems to be compatible with the reduction in training volume recommended when facing heat stress
- Altitude training camps also require an initial reduction in training load, which may in itself constitute a form of tapering

Pyne et al. *J. Sports Sci.* 27: 195-202, 2009

Communication

Listening to your athletes

Some experienced athletes know exactly what they need

- **2005, week 36:** 2nd XTerra Spain
- **"I need leg strength after all this IM training"**
- **Weeks 37-47:** 20 sessions 2-3x8@75-80%1RM

- **2005, week 40:** Winner XTerra US Championships Lake Tahoe

- **2005, week 43:** 2nd XTerra World Championships Maui, after riding 50% of the bike leg on a flat tire

- **2005, week 48:** 2nd Ironman Western Australia, Busselton

Listening to your athletes

- **2005, week 42:** DNF Ironman World Championships Hawaii
- **"I feel flat tapering off to the last day before the Ironman"**
- **2006, weeks 26-28:** Advanced taper + reloading
- **2006, week 28:** 2nd Ironman Austria, 8:13:43, marathon 2:47:03

- **2006, week 20:** DNF Ironman Lanzarote
- **"I don't like reloading before the Ironman, I like feeling completely rested, exactly like we did for ITU World Championships in Ibiza in 2003"**
- **2006, weeks 26-28:** Progressive taper
- **2006, week 28:** 3rd Ironman Austria, 8:15:11, marathon 2:51:20

Conclusions and practical implications

Summary of optimal tapering strategies

- Minimise fatigue AND IMPROVE fitness
- Maintain training intensity
- Reduce training volume by 41-60%
- Maintain training frequency at >80%
- Individualise taper duration between 4 and 28 days
- Use progressive, nonlinear tapering designs
- Expect performance improvements of ≈3% (range 0.5-6.0%)

Mujika & Padilla, *Med. Sci. Sports Exerc.* 35:1182-1187, 2003

Final Comment

"I am very relaxed and well rested. I have great sensations and I am competition hungry."

Eneko Llanos, 24 hours before winning the 2003 ITU Long-Distance World Championships

We can’t plan everything!

Tapering and Peaking for Optimal Performance

Iñigo Mujika

Foreword by Miguel Indurain

ESKERRIK ASKO!
(“Thank you very much!” in Basque Language)

Iñigo Mujika
PHYSIOLOGY & TRAINING