

Running Efficiency: What's the deal?

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What requires physical preparation behind running efficiency and economy and what can be done to achieve it?

What needs it:

- Foot
- Ankle
- Calf
- Knee
- Hip
- Pelvis

What can be done for it:

- Strength
- Power
- Skill

Intra-joint/Intra-muscular
Inter-joint/inter-muscular

Key messages:

- Move efficiently by applying appropriate forces in the right direction
- Strength is for generating force and withstanding forces
- Power is using elastic energy to generate forces more quickly
- Skill is about applying the force quickly and in the right direction with as little wasted as possible



- Nothing works in isolation as a body part or training stimulus
- This is good news as we can get a lot of output from good quality input



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Sports Med. 2004;34(7):465-85.

Factors affecting running economy in trained distance runners.

Saunders PU¹, Pyne DB, Telford RD, Hawley JA.



- Running economy (RE) is typically defined as the energy demand for a given velocity of submaximal running.
- Runners with good RE use less energy and therefore less oxygen than runners with poor RE at the same velocity.
- There is a strong association between RE and distance running performance, with RE being a better predictor of performance than maximal oxygen uptake (VO_{2max}) in elite runners who have a similar VO_{2max} .



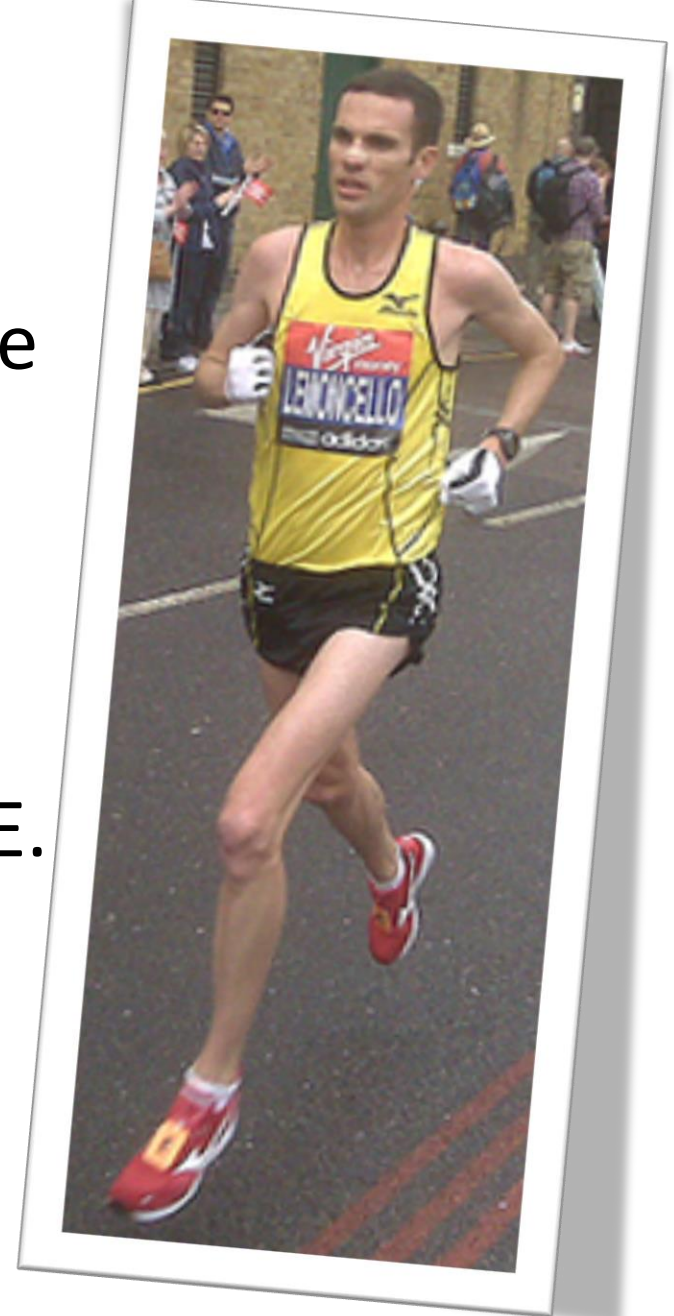
A number of physiological and biomechanical factors appear to influence RE in highly trained or elite runners.

These include:

- metabolic adaptations within the muscle such as increased mitochondria and oxidative enzymes
- the ability of the muscles to store and release elastic energy by increasing the stiffness of the muscles
- more efficient mechanics leading to less energy wasted on braking forces and excessive vertical oscillation.



- Interventions to improve RE are constantly sought after by athletes, coaches and sport scientists.
- Strength training allows the muscles to utilise more elastic energy and reduce the amount of energy wasted in braking forces.
- The importance of RE to successful distance running is well established, and future research should focus on identifying methods to improve RE.
- Interventions that are easily incorporated into an athlete's training are desirable.





David McHenry a former Penn State University quarterback, became his conditioning coach. A regime of strength training gave him a new physical strength and confidence. Squatting and deadlifting with weights in excess of 200lb become routine as did Pilates to maintain flexibility and range of movement. "Not bad for a skinny kid," laughs Salazar. "And all year round."

Farah recalled last summer's momentous race in Monaco when he erased Steve Cram's time, which had stood as the British record for 1,500 metres since 1985, from the record books. "I lifted weights up to four days before Monaco," he said.

Farah's instinct is right. All too often athletes limit their strength and conditioning phase to a relatively small window in the training year. Then they wonder why in the two crucial months of the competitive season they lose power and strength. This has in Salazar's view been the game changer — that and a focus on running far quicker in training on both road and track.



As we watch Radcliffe power up the hill on her fourth repeat, Hartmann elaborates on some of the intense background training that has taken the British star to a whole new level. "One of the reasons Paula is the best in the world is her willingness to subject herself to rigorous hours of core exercises and plyometrics in the gym. Paula runs twice a day, and that may account for 1.5 to two hours of her day. On top of that she is spending between another two and five hours between her treatments, her stretching routine, her plyometrics, her core stability, and her strength training."

PERFORMANCE IN DISTANCE RUNNING

Running economy

Training

Plyometrics

Resistance

Training phase

Speed, volume, intervals, hills, etc

Environment

Altitude

Heat

Physiology

Maximal oxygen uptake (VO₂max)

Adolescent development

Metabolic factors

Influence of different running speeds

Biomechanics

Flexibility

Elastic Energy Storage

Mechanical Factors

Ground Reaction Force

Anthropometry

Limb morphology

Muscle stiffness, tendon length

Bodyweight and composition

The Physiology of the World Record Holder for the Women's Marathon

By Andrew Jones, International Journal of Sports Science & Coaching, 2006 *Designed by YLMSportScience*

PAULA RADCLIFFE

BORN IN 1973
173cm - 54kg

2H15'25"
London 2003

VO2MAX

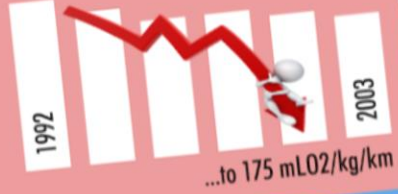


BEST RESULTS

- 3x London marathon winner
- 3x NYC marathon winner
- World champion (cross-country & marathon)

Running economy (AT 16km/h)

From 205 mL O₂/kg/km...



CHANGES IN RUNNING SPEED AT VO2MAX

From 20.5 km/h in 1992...

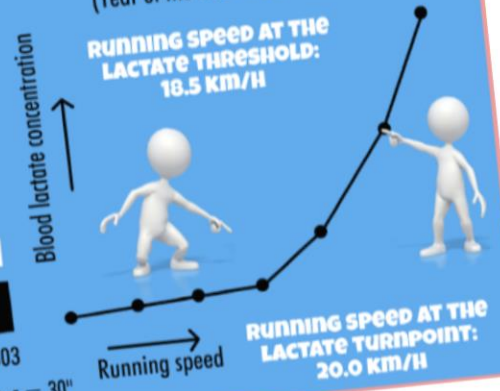


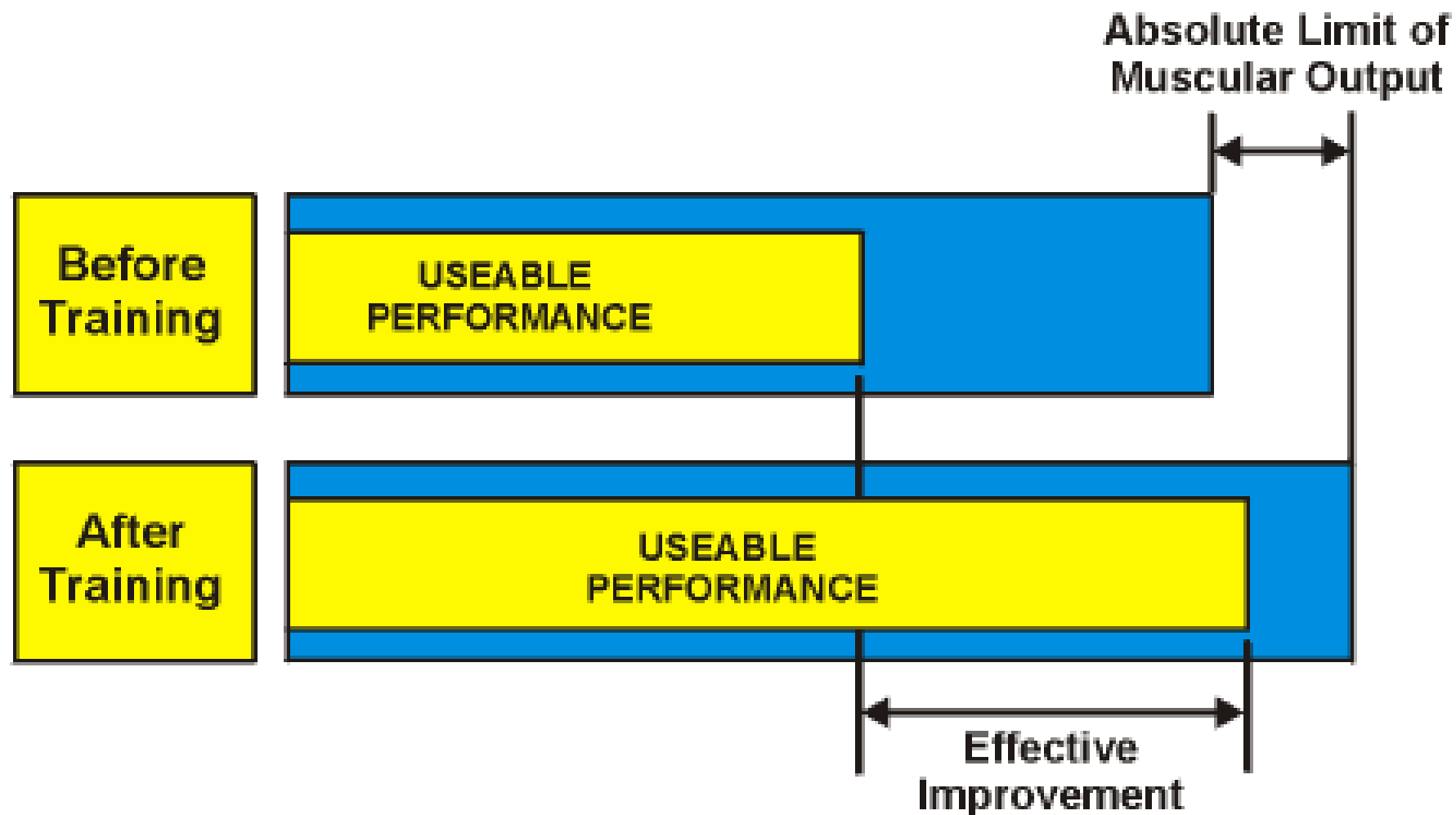
TO 23km/h
in 2003

7-9x 3min stages with +0.5 to 1km/h increase, $r = 30"$

in 2003
(Year of the marathon world record)

RUNNING SPEED AT THE LACTATE THRESHOLD: 18.5 km/h





When an athlete trains, their absolute limit of muscular output does not change significantly. However, their useable performance can increase dramatically.

The evidence.....Strength

Effects of heavy and explosive strength training on endurance performance

Designed by
@YLMSportScience

Improved exercise economy

PROVEN

Improved lactate threshold

Improved maximal speed

No increased body mass

No reduced capillarization

Improved anaerobic capacity

Reduced or delayed fatigue

Improved maximal speed

No compromised relative VO2max

Improved endurance performance

By Ronnestad & Mujika, Scand J Med Sci Sport, 2014



STRENGTH TRAINING FOR ENDURANCE PERFORMANCE

By Aagaard and Raastad, Endurance Training: Science & Practice, 2012

Designed by
@YLM Sport Science



Strength training can be successfully used to increase short-duration and long-duration endurance capacity in untrained and well-trained individuals, as well as in highly trained top-level endurance athletes



- Fast-twitch type IIX fibres are converted into fatigue resistant type IIA muscles fibres along with improved muscle strength and rapid force characteristics

- Improvements in neuromuscular function and musculotendinous stiffness, the latter being especially important in sports involving stretch-shortening cycles as in running may also contribute to improved endurance performance

Strength training should involve multiple exercises (at least 2) for main targeted muscle groups

5-8 RM

Using heavy loadings performed in 3-5 sets



6-16 weeks

using a periodized training progression

The Evidence.....Power



PERFORMANCE

81%

Studies reported an increase in muscle power after a plyometric training program (observed in both athletes & non-athletes).

PLYOMETRIC TRAINING

By @YLMSPortScience

Plyometric training involves performing bodyweight jumping-type exercises and throwing medicine balls using the so-called stretch-shortening cycle (SSC) muscle action.

- Employed to
➤ jumping ability
- sprint performance
- performance in endurance athletics events
- agility performance

Reduces ground reaction test times

Improves running economy

INJURY PREVENTION

IF TRAINING LOAD IS WELL CONTROLLED

- NEUROMUSCULAR CONTROL
- MUSCLE STRENGTH
- MUSCLE-TENDON STIFFNESS
- BONE DENSITY
- INJURY RISKS (ACL, etc.)

WORKS FOR

2-3 SESSIONS PER WEEK
>8 WEEKS

SURFACES

"Aquatic- or sand-based plyometric training could elicit similar increases in jumping & sprinting perf as traditional plyometric training, but with substantially less muscle soreness."

Reference: Markovic & Mikulic Sports Medicine, 2010

KBS1 HD

올림픽 대표방송



Today's Session.....

- Some strength work
- Progressions and variations of power development drills
- Progressions and variations of running skill drills

