

Research for Athletes at the Virtual 25th Anniversary Meeting of the European College of Sport Science

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Sportscience 24, 28-41, 2020 (sportsci.org/2020/ECSSsport.htm)

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The outstanding feature of this virtual conference is the ability to view all presentations at your convenience and pace. **[The Wow! Factor](#)**: the six best presentations for athletes. **[NHST Strikes Back](#)**: the return of null-hypothesis significance testing and its misinterpretations. **[Accessing Abstracts and Videos](#)**: links to a search engine, registration, and the conference program. **[Acute Effects](#)**: warm-up, re-warm-up, post-activation potentiation, pacing, cryotherapy, recovery, relaxation. **[Injury Risk](#)**: muscle typology, perfectionism, co-activation and asymmetries, fitness, mental fatigue, spinal muscle, gender. **[Injury Recovery](#)**: vibration, hypoxia, blood-flow restriction training, wearable sensors, neuromuscular and on-field rehab, strength training, Naproxen, compression garment. **[Nutrition](#)**: acute effects of beetroot juice, alpha-lactalbumin, caffeine, citrulline malate, thirst vs programmed fluid intake, dehydration; chronic effects of beetroot juice, protein, branched-chain amino acids, HMB, antioxidants, spirulina. **[Performance Analysis](#)**: half-time feedback in soccer, fitness-fatigue models, soccer goals, handball goalkeeping, handball, karate, rugby league, social networks, decision-making and machine learning in soccer, 14 movement analyses, 11 competition analyses, 14 cross-sectional correlates of competition performance. **[Talent Identification and Development](#)**: dual-career pathways, practice hours, muscle typology, self-regulation, deliberate practice, strategic skills, fitness and maturity, relative-age effect, coach-scientist interaction, women in leadership positions. **[Tests and Technology](#)**: maximum-speed profile, 'fatmax', training quality, maturity, Lamberts test, heart-rate variability, ball-tracking, positioning systems, Accel'Rate vs Player-Load, sprint speed, Hamtech, force-velocity measures, isometric mid-thigh pull test, dynamic quads test, machine learning vs meta-analysis, jump height with feedback, cycling posture, magnitude-based decisions, eight miscellaneous technologies. **[Training](#)**: individualized for racket sports, blood-flow restriction, velocity-controlled strength, plyometric, alternation for cycling, altitude, eccentric, strength, core-stability, interval, player-specific, polarized, hypoxic, motor imagery, transcranial stimulation, heat, hot water, stroboscopic, relative energy deficiency, psych support and skills, genetics. KEYWORDS: competition, elite athletes, ergogenic aids, injury, monitoring, nutrition, performance, talent identification, technology, tests, training.

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This virtual conference was—and still is, until the end of the year—a great success. Just how cool is it to be able to stop speakers while you try to understand their slides, or to get them to repeat what they have just said? There are no conflicts with parallel sessions, and you can view the presentations anytime anywhere anyhow you like, all while reducing your carbon footprint and saving your own or your institution's money on travel and accommodation.

OK, there are some downsides. The plenaries,

symposia and young-investigator 10-min presentations were "live", but there was no mechanism for the rest of us to submit live questions or comments, and I soon realized that it was sensible to watch the recordings of these sessions, especially with a 12-h difference in time zone. The message board at the end of every abstract allows for some interactivity, but I suspect that most presenters still won't check for messages, and most people posting a message won't check to see if there has been a response. What's

needed in future is an email notification to the presenter when a message is posted, and an email notification to the person posting when the presenter responds, with links or enough information in the email to find the message board without compromising privacy. A chaired chat-room forum should also be possible immediately after live plenary and invited sessions.

Perhaps the biggest downside of a virtual conference is that you don't get to network and socialize with colleagues and friends in a lovely European city. Social media can make up for that to some extent, but I guess a virtual tour of the city and surrounding countryside is not going to satisfy many people. Let's hope the real conference is on again in 2021, but if it's not, I will enjoy and value another virtual conference.

The Wow! Factor

Once again I have kept the focus of this report on presentations relevant to performance and injury of competitive athletes. I found the quantity and, in all but one respect, the quality to be as good as those of any of the last decade of ECSS conferences. I thought six had the **Wow** factor, the same number as last year: muscle typology predicts [hamstring strains](#); vibration training accelerates [ACL reconstruction recovery](#); intermittent hypoxia accelerates [injury recovery](#) (in rats, but you've got to read it!); a symposium on [dual-career pathways](#); a symposium on [training for racket sports](#); and phenomenal gains in rowing performance following low-intensity [training with blood-flow restriction](#).

NHST Strikes Back

The quality of presentations was worse in one important respect: almost everyone has scuttled back to null-hypothesis significance testing (NHST) and its misinterpretations, following the attacks on magnitude-based inference (MBI) by Kristin Sainani and her colleagues. [My recent arguments](#) (Hopkins, 2020) and [earlier arguments](#) (Hopkins & Batterham, 2018) supporting MBI and dismissing Sainani's assertions are simply being ignored, as are [Janet Aisbett's concerns](#) (Aisbett, 2020) about misrepresentation of the [misuse of MBI](#) (Lohse et al., 2020). For more reassurance about MBI, [see below](#) for links to the talk I presented at this conference.

It's fair enough that researchers avoid mentioning MBI and its probabilistic assertions about magnitudes, pending MBI's rehabilitation as magnitude-based decisions (MBD). What's almost unbelievable is that the call to retire statis-

tical significance (Amrhein et al., 2019) by arguably the world's cleverest statistician, Sander Greenland, has also been ignored. In Greenland's view, you should not present effects as significant or non-significant, because most people—including practically everyone at this conference—interpret such outcomes as "the effect is substantial" and "the effect is not substantial" respectively, and such dichotomization is usually unjustified and misleading. Here's why.

When you say "the effect is substantial", you want pretty good evidence that the effect *is* substantial. If you are a frequentist, good evidence is rejection of the hypothesis that the effect is not substantial (the non-superiority or non-inferiority hypothesis of minimum-effects testing). If you are a Bayesian, good evidence is a reasonably high probability that the true effect is substantial. Entry-level evidence for rejection of hypotheses is usually a p value of <0.05 , and this p value (not the NHST p value) corresponds to a probability of >0.95 (or very likely) that the true effect is substantial, using an entry-level Bayesian approach with a minimally informative prior (Hopkins, 2019, 2020). In both approaches (and in MBD), the good evidence occurs when the 90% compatibility interval of the effect falls entirely in substantial values. So claims that "the effect is substantial" based on statistical significance with NHST have always been inappropriate, except when the 90% CI falls entirely in substantial values. That is going to happen infrequently with small sample sizes, because the 90% CI is wide and will frequently include trivial values, so these inappropriate claims are frequent.

Similarly, when you say "the effect is not substantial", you want pretty good evidence that the effect is trivial. If you are a frequentist, good evidence is rejection of the hypotheses that the effect is substantially positive and substantially negative (the superiority and inferiority hypothesis of equivalence testing). If you are a Bayesian, good evidence is a reasonably high probability that the true effect is trivial. In both approaches (and in MBD), the good evidence occurs when the 90% compatibility interval of the effect falls entirely in trivial values. So claims that "the effect is not substantial" based on non-significance with NHST have always been inappropriate, except when the 90% CI falls entirely in trivial values. That is going to happen very infrequently even with large sample sizes, so inappropriate claims are very frequent.

In summary, NHST is a test of the hypothesis that the effect is zero. If you reject the hypothesis, you can conclude that the effect is not zero, but you should not conclude that the effect is substantial. If you can't reject the hypothesis, you can conclude that the effect could be zero, but you should not conclude that the effect could not be substantial. Forget about NHST. Show the compatibility interval and interpret it.

Accessing Abstracts and Videos

By focusing on athlete performance and injury, I have omitted most of the conference! Unfortunately no-one is summarizing other presentations this year, so if your interests are physical activity of non-athletes or the biology, psychology or sociology of exercise, check out the [scientific program](#), which will take you to the abstracts, or search the abstracts via the [search engine](#) at the [conference site](#). These links are open to anyone, as is the [list of winners](#) of the young-investigator awards.

To find and view the videos, you will need to [register](#) (available until the end of the year). You can then [Join the Congress App](#) from your [ECSS account page](#), which will take you to the conference home page, with links to the various sessions. To find the presentations I have reviewed, copy the presenter's name and initials shown in brackets [...] into the [Search Engine](#) there, or use the session ID (where I have provided it) to find the session.

If the search engine returns an abstract without a link to a video, it's because the presentation was in either a plenary, a symposium, or a session of 10-min presentations for the young-investigator awards (YIA). The videos for each of these sessions have multiple speakers, hence the tech team decided it was too difficult to provide individual video links. To find the video, you will have to note the session ID (e.g., OP-AP19) just above [Read Abstract & Message Board](#), then find that session ID via either the [Plenary & Invited](#), [Sponsored Sessions](#), or [YIA Sessions](#) on the home page. I have tried to include session ID for these sessions in my report.

I spent about 12 full days on this report, but I am bound to have missed some presentations with useful information for competitive athletes. So I suggest you use the search engine, with your sport or topic of interest as the key word. Do it in a small group for more value and fun. Use this report for a conference de-brief, too. If you are an author of a missing abstract that you think should be included, or if I have got something

wrong, please get back to me ASAP and I will augment or amend this report accordingly.

Acute Effects

Twelve national- and international-level [sprint kayakers](#) did a 500-m time trial 1.8% and 2.0% faster after a self-selected [warm-up](#) than after a control and an intermittent high-intensity warm-up. The effect was not significant in the slideshow, where the conclusion was "no differences in time-trial performance" [DINGLEY, A.]. These are large effects for kayakers, according to Malcata and Hopkins (2014), so see my remarks above about retirement of statistical significance. In any case, I suspect a placebo effect, because heart rates and perceived exertion were substantially higher in the self-selected condition.

A specific high-intensity [warm-up](#) gave an improvement of 1.2% in overall time compared with two other warmups when six elite [triathletes](#) (3 females, 3 males) performed a simulated "mixed" triathlon lasting ~20 min in crossover fashion. [PALMER, R.]. See the abstract or slideshow for the warm-up details. The smallest important is probably similar to that of other triathlons, ~0.3% (Malcata & Hopkins, 2014).

A crossover with 12 physically active [men](#) showed that, compared with no re-warm-up control, a 1-min [re-warm-up](#) at half time maintained sprint speed in the second half in tests simulating the demands of a soccer match. [YANAOKA, T.]

A self-selected set of reps produced greater [post-activation potentiation](#) of a barbell squat jump than the same number of reps when it was imposed (!) in 15 male [basketball](#) players.[DELLO-IACONO, A.]. In my comments on the message board (no response so far), I wondered whether the nocebo effect of the imposed condition would be overwhelmed by motivation in competition.

A conditioning squat exercise produced a 5.5% [post-activation potentiation](#) of counter-movement jump height in 15 trained [young adults](#). [BOURGEOIS, H.]

From the symposium on [pacing](#) (IS-AP06)... "Coaches and trainers are advised to incorporate pacing as a performance characteristic in their talent development programs by stimulating their [athletes](#) to reflect, plan, monitor and evaluate their races on a regular basis to build performance templates and as such, improve their performance." [ELFERINK-GEMSER, M.T.]

In a study of ultra-endurance [pacing](#), faster

cyclists in a 24-hour mountain bike race of 837 males and 157 females started with a lower relative speed and showed a less pronounced decrease in the last lap, suggesting that "cyclists should adopt conservative initial speeds to improve performance". [MATTA, G.; YIA Session OP-AP18, 2nd speaker at 20:00]

Over 15 months, 36 elite **tennis** players completed questionnaires about daily training and recovery therefrom. "Independently of training, cooling strategies decreased muscle soreness... and whole-body **cryotherapy** induced greater **recovery** compared to cold-water immersion." [POIGNARD, M.]

Whole-body **cryotherapy** (-135 °C) compared with control (-59 °C) in a multiple group cross-over with 27 male **athletes** may have had a substantial effect on countermovement-jump power an hour or so later, but comparisons of effects on jump height were unclear. [PARTRIDGE, E.; YIA Session OP-AP17, 2nd speaker at 18:00]

Active compared with passive **recovery** the day after a high-intensity exercise session had a negative effect on a countermovement jump 24 h but not 48 h later in a cross-over study of 11 well-trained male **intermittent sport athletes**. There was little evidence of consistent individual responses when the protocols were repeated. "Athletes and their coaches are advised to focus on recovery modalities other than active." [WIEWELHOVE, T.]

Three brief-contact **relaxation** interventions had unclear effects on 3-km run time in a controlled trial of 39 club-level **runners** presented by the third speaker in a symposium (IS-SH08). [BRICK, N.]

Injury Risk

Wow! In a prospective cohort study of 61 Belgian and 34 UK professional **soccer** players over three seasons, players with fast "**typology**" in the soleus muscle had a much higher risk of a new hamstring strain injury: hazard ratios of 5.3 and 2.5 relative to players with slow and intermediate typology. Players with fast typology showed more fatigue of high-intensity efforts in matches, and the authors suggested that they would show more accumulated fatigue in training, hence they propose individualized training and recovery cycles based on muscle typology [LIEVENS, E.; 5th presentation in YIA Session OP-AP19 at 1:05:00]. (Typology is the relative proportion of fast fibers in a muscle, estimated from carnosine concentration measured non-invasively with

magnetic resonance spectroscopy. See [below](#) for another study using this technique.)

A retrospective and 4-month prospective study of **any-injury risk** with 185 and 96 sport-science **students** respectively showed that a cluster of students described as high in **perfectionistic** strivings and concerns had the highest risk retrospectively and prospectively compared with three other clusters [DE-MARIA, A.]. Winner of young-investigator 1st prize in posters.

From a symposium (IS-AP05) on **hamstring injuries** in **soccer**... Assessment of quadriceps and hamstrings **co-activation** could be used for prevention and rehabilitation [NAVARRO, E.], and tension-myography can be used to assess and correct **asymmetries** and thereby reduce injuries (by 40%) [GONZÁLEZ, C.].

Here's a whole symposium (IS-BM02) on injuries in **alpine skiing**. Physical **fitness** reduces the risk across all ages and levels [STEIDL-MÜLLER, L.]. For prevention of **ACL injury**, "assessment of maximal eccentric hamstrings strength and cross-sectional area of the biceps femoris long head may serve as clinically relevant alternative approaches to hamstrings/quadriceps strength ratio" [SPÖRRI, J.].

Mental fatigue induced by the Stroop color-word test caused potentially risky impairment of **tackle technique** in a crossover with 20 **rugby union** players [DAVIDOW, D.]. Now we need to see if mental fatigue in matches makes a difference.

In a 6-month prospective study of 34 elite **golfers** initially free of injury, "poor **spinal muscle recruitment** strategies" were associated with development of **back pain**. "Selective spinal muscle training may prove to be protective against back injury." [QUINN, S.I.]

Male **tennis** players were 1.2 times more likely to get injured than females in 50 years of professional tennis. "Slow" **court surfaces** had only 1.03 times the risk of fast surfaces [BROCHERIE, F.]. The surface effect was significant, but it is decisively trivial (assuming a risk ratio of 1.11 is the smallest important), so "injury prevention strategies should be applied for different surfaces" is not an appropriate suggestion.

In a prospective study of **head, neck and face injuries** in 7673 US **rugby-7s** matches for 2010-2016, injury incidence was similar for women and men, but concussions were more severe for women (lasting 46 d vs 32 d) and were more likely to be due to impacting the playing surface.

[LOPEZ, J.V.]

"Non-contact **soft tissue injuries** to the shoulder and spine have experienced the highest increase in injury prevalence" in 12 years of 77,212 **cricket**-related injuries in New Zealand. [WALTER, S.]

There's useful advice in this review of risk factors, preventive measures and emergency treatment for exertional **heat illness** in recreational and **elite sports**. [GLITZ, K.J.]

I would be wary of the **risk factors** for **tennis injury** identified in the tennis symposium (IS-AP08) by the second presenter [GESCHEIT, D.]: the study they were based on was too underpowered for the large number of factors investigated, and the hazard ratios and confidence limits do not make sense.

Injury Recovery

Wow! A controlled trial of 11+12 **patients** showed that local vibration training improved strength recovery after **anterior cruciate ligament reconstruction** (decline of only 16% vs 30%). Vibration was applied to the relaxed quadriceps of the injured leg for 1 h at the end of each of 24 sessions of standardized rehabilitation over ~10 weeks. [LAPOLE, T.]

Wow! It was only **rats**, but... Gastrocnemius muscle subjected to **surgical injury** recovered its functional capacities after 9 d in rats exposed to **intermittent hypobaric hypoxia** (4 h per day at 4500 m), while function was still deficient in control rats 21 d after injury. [SANTOCILDES, G.]. Studies in athletes are next, she tells me.

The third speaker in the symposium (IS-BM02) on injuries in **alpine skiing** stated that training and monitoring of knee-flexor strength are important following **ACL reconstruction**. [JORDAN, M.]

"Low-intensity blood-flow restriction resistance training improved physical function, pain and effusion to a greater extent than traditional heavy-load resistance training while driving similar improvements in muscle strength and hypertrophy" in a controlled trial of 24 **patients** receiving rehabilitation following **ACL reconstruction** [HUGHES, L.]. Video not available.

"Although some accuracy adjustments are needed, **wearable inertial sensors** represent a valuable alternative to optoelectronic marker-based motion capture" in a study of 34 healthy **athletes** aimed at assessment of **return to sport after ACL injury**. [DI PAOLO, S.]

The second speaker in the Adidas-sponsored

symposium (IS-SP02) on individualized assessment of football athletes gave an overview of the epidemiology of **ACL injuries** and factors affecting **re-injury** and **recovery**, including "targeted **neuromuscular training**" and "systematic **on-field rehabilitation**" [DELLA-VILLA, F.]. His talk starts at 32:00. The sound quality is poor.

From the second speaker (Monika Bayer) in a symposium on **strength training** (IS-AP02)... "Early onset of rehabilitation is crucial for the **recovery from muscle strains**, but despite a gradual progression in loading during rehabilitation, persistent muscle atrophy is seen. How could the loss of muscle tissue be prevented or blunted? Specific heavy strength exercises might be beneficial." [BAYER, M.L.]. Eccentric training combined with nerve stimulation also came up in the discussion.

Pain and function-related measures in **overuse injury of the Achilles tendon** did not recover any faster with a week of a non-steroidal anti-inflammatories (**Naproxen**) compared with placebo after the first week and after three months in a controlled trial of 70 **sports-active individuals**. [JØRGENSEN O.H.]

A full body compression garment reduced delayed-onset **muscle soreness** in some muscles 24 h after a 107-km trail run in this controlled trial of 32 **runners** (19 men, 13 women). [APARICIO, I.]

Nutrition

Nearly two-thirds of 70 recreational male and female **runners** randomized to **beetroot juice** or placebo for a 5-km run were identified as placebo responders, and they were more likely to respond to a placebo if they used sport supplements, reported strong beliefs in their effectiveness, and were male. Researchers doing placebo controlled trials of supplements "should consider measuring and controlling for these variables in their analyses" to reduce error of measurement. [HURST, P.; YIA Session OP-PN11, last speaker at 52:30]

In this crossover study, 16 well-trained female **athletes** experienced modest improvements in some sleep characteristics, retention of aerobic capacity, and reduced mental demand next day when they had consumed **alpha-lactalbumin** vs placebo and control following an evening competition simulation. [MILES, K.H.]

The authors claimed that "different doses of **caffeine** intake did not change the height of any

of the four jumps," presumably based on p values for inappropriate analyses (one-way ANOVAs) in this crossover study of 15 male **physed students** [MARTYNOVA, M.]. But the slideshow shows substantial 2-5% enhancements.

In a meta-analysis of eight studies of 137 mainly **strength-trained men**, acute supplementation with **citrulline malate** produced small increases in the number of lower- and upper-body repetitions to failure of 8.2% and 6.9%. [VÅRVIK, F.T.]

Performance in a 20-km time trial following 5 h of submaximal **cycling** was impaired in the "**thirst-driven fluid intake**" condition compared with "**programmed fluid intake**" (in which they drank a lot more) in this crossover study of eight male endurance athletes [JEKER, D.]. But view the third speaker in the symposium (IS-PN07) on hydration and heat-stress for a summary of the controversy over ad-lib (thirst-driven) vs planned drinking. She described the finding of a meta-analysis, in which there was a 1.0% (95%CI 0.1% to 1.8%) enhancement in endurance-performance power favoring ad-lib drinking, as "a very very small level of favor toward ad-libitum drinking." [BURKE, L.]. For **runners** and **cyclists** this enhancement would actually be borderline trivial-small, based on variability of top athletes in competitions lasting at least an hour (Hopkins & Hewson, 2001; Paton & Hopkins, 2006). In any case, she made the good point that programmed and ad-lib drinking in these studies may not reflect what is achieved or achievable in real races, and that depending on the setting, drinking may need to be planned (along with other nutritional goals), especially to avoid hyponatremia.

In the symposium (IS-SP01) on beating the heat, sponsored by GSSI, Lewis James stated that **dehydration** of >2% body mass degrades **endurance** and cognitive performance, and the effect increases with increasing ambient temperature. There is no abstract, but there is a link to a handout with practical advice: practice drinking strategies to achieve <2% dehydration, and if dehydration is inevitable during competition, perform some training under competition hydration conditions. His presentation starts at 30:00 into the video.

In this crossover, seventeen (11 male, 6 female) elite **judokas** performed worse in a 1-d simulated judo tournament when they were **dehydrated** to an extent (at least 3% of body mass)

sometimes required to stay in a weight category. [AERENHOUTS, D.]

Supplementing with **beetroot juice** vs placebo before high-intensity interval-training on a cycle ergometer (4 wk, 12 sessions) in normobaric hypoxia (3000 m) had little effect on various measures of performance of 6+6 **trained males**, but obviously, "possible performance benefits should be investigated with a higher number of subjects." [SOUSA, A.]

In the symposium on the role of **supplements** in **muscle hypertrophy** (IS-PN02), Ben Wall presented "modern guidelines for how considerations of **dietary protein** intake can optimally support resistance training" [WALL, B.]. **Leucine** is the amino acid primarily responsible, but the apparent effectiveness of combined **branched-chain amino acids** is questionable, and evidence for the effectiveness of the leucine metabolite β -hydroxy- β -methyl butyrate (**HMB**) is limited [PHILLIPS, S.]. **Omega-3 fatty acids** (or lots of fish oil) also have an anabolic effect in aging and disuse atrophy [MITTENDORFER, B.], but data weren't presented for athletes.

Post-exercise ingestion of 30 g of **protein** was sufficient to maximize mitochondrial-protein synthesis during recovery from a single 1.5-h bout of endurance exercise in this controlled trial of 48 healthy young **endurance-trained men** randomized to four doses of protein. [PINCKAERS, P.J.M.; YIA Session OP-PN11, 3rd speaker at 35:00]

From the third speaker in the symposium on **antioxidant supplements** in sport nutrition (IS-PN09)... **Phytochemicals** may attenuate acute exercise-induced muscle damage, "although not always consistently", and there is still "some concern that antioxidant supplementation may actually blunt adaptation to both endurance and eccentric based exercise, and the effects of consuming phytonutrient-rich foods following exercise on subsequent adaptation have not been fully explored." [CLIFFORD, T.]. In the video, he summarized a meta-analysis apparently showing no effects of **vitamins C and E** (I didn't check the published study), and he briefly mentioned several conflicting studies of effects of phytochemical antioxidants.

Supplementation with **spirulina** vs placebo for 7d in a crossover with 11 **trained males** apparently caused substantial increases in hematocrit, upper body VO₂max and exercise efficiency [GURNEY, T.]. It's hard to explain the effect on

hematocrit, because that appears to be a hemato-poietic effect, yet spirulina is not banned by WADA, like EPO is.

Performance Analysis

Here is a well-designed and analyzed qualitative case study involving an intervention to investigate the role of **performance-analysis feedback** when it was introduced at half time with an under-15 academy **soccer** team. Information was provided by interviews with players and support crew pre and post, and by half-time audio recordings of six matches before and six matches with feedback. "Performance analysis was used to develop the players identified as the best", but it was used "with little thought of how or why." [MULVENNA, C.]

The abstract provides an analysis of the performance **effectiveness** of 16 elite female and 16 elite male **épée fencers** in the 2016 world champs [IGLESIAS, X.]. Video has sound only.

The Banister **fitness-fatigue performance prediction** model was applied to 10 "**physically active men**" with a fairly average VO₂max (55 ± 8 ml/min/kg) in an 11-wk interval-training study peppered with 3-km cycle ergometer time trials. Five methods of quantifying training resulted in errors in predicted performance (presumably mean power) of only ~1-2%, which is remarkable, considering the mean improvement was 17% [VERMEIRE, K.]. The best method overall was not stated.

Machine-learning models were better than **Banister** and **Busso dose-response models** for predicting time-trial performance (several times a week over 10 wk) with measures of training of seven Olympic short-track **speed skaters** [IMBACH, F.]. I couldn't understand most of the slideshow.

An analysis of all 401 goals in a season of the **soccer** European Champions League revealed that quarter finalists scored more goals using counter-attacks than teams eliminated in earlier rounds, but there was little difference between the better and worse teams for other potential **indicators of goal scoring**. [MITROTASIOS, M.]

Read and view this study of the 38 female **handball** matches at the Rio Olympics, if you are interested in the issue of whether to let the **goalkeeper** play a field position when a player has been excluded. (It doesn't seem to make much difference.) [TREJO, A.]

See how these researchers used "self-developed **mobile apps**" to record and analyze 168 matches of the German national **handball**

league. "The connection between passes, fouls, and the success of attacks is not linear. This explains why humans have real difficulties to 'understand' team handball." [SCHWENKREIS, F.]

A novel **performance analysis template** applied to **karate** kata performed by the champion at a world championship yielded reliable estimates of the key movement characteristics [CIERNA, D.]. See also a time-motion analysis of the most performed katas at a top-level karate competition [ARGAJOVA, J.] and katas in a premier league [NOVOSAD, A.].

A fabulous dataset of 38 **performance indicators** in 1005 matches over five seasons of national **rugby league** produced some interesting findings: playing styles characterized as "attacking play" and "line breaks" had the greatest association with winning, regardless of team quality, match location or score line [WEDDING, C.]. But it was hard to follow the slideshow with a script that was read, and read too fast. The slides did not clarify. Was it principal components or factor analysis? What did the cluster analysis show?

Social network analysis applied to 16 teams in 240 matches of the Chinese **soccer** super league led to the conclusion that "coaches should train the team members to establish a compact and effective passing network instead of a structure with as many passes as possible." [LI, F.]

Direct observation of 83 practice sessions led by 53 coaches in 16 male youth **soccer** academies in four countries showed differences in types of **decision making** and differences between countries. [ROCA, A.]

Machine learning was used to predict match outcome with 120 match performance features related to shooting, passing, organizing, defending and goalkeeping in 1200 matches of the Chinese **soccer** super league. Winning teams tended to perform more saves, shots on target, clearances, successful transitions, breakthroughs and interceptions. [LI, Y.S.]

Miscellaneous movement analyses...

- **Turns** in six skilled **alpine skiers** [SUGAJIMA, Y.].
- The **forehand smash** in 29 male and 23 female international **badminton** players [AFZAL, I.].
- **Baseball pitching** in 32 junior high-school players [YASUFUMI, T.] and in 15 players [TAKUYA, A.].
- **Change of direction** in 71 (3 in the abstract)

- **basketball** players [BAENA-RAYA, A.].
- Contributions of upper and lower body to **propulsion** in various classic and skating **cross-country skiing** techniques in 7 world-class skiers [STÖGGL, T.].
- Asymmetric **shoulder mobility** and the **golf** swing in 17 proficient players [CHANG, Y.].
- **Throwing** proficiency in 13 adolescent **handball** players [BAUER, J.].
- **Visual search** behavior of 7 experienced female **handball** goalkeepers anticipating penalty shots [HOSHINO, S.].
- The rhythmic **structure and effort** distribution of 69 performances in the men's 400-m world-championship **hurdles** [CASAL, N.].
- **Take-off and hurdle clearance phases** in male and female finalist **hurdlers** of the world championships [NEMTSEV, O.].
- **Postural balance** in 20 male **ice-hockey** players [MAJCEN ROSKER, Z.]. The continuous **thrust** in **karate** kata of an elite and sub-elite player [HAYATA, G.].
- Maximal isometric **finger-hangs** in 25 **rock climbers** [FERRER-URIS, B.].
- Plantar flexor **muscle-tendon behavior** during sprint acceleration in 11 female **sprinters** [WERKHAUSEN, A.].

Various competition-performance analyses...

- External and internal **loads** in elite **badminton** singles match play [EDEL, A.].
- Demands of **home and away** games in Division-1 male **basketball** players [OLTHOF, S.B.H.].
- New **performance indicators** for **handball** matches [HUANG, H.].
- **Biomechanics** of women's 400-m world championship **hurdles** [LÓPEZ, J.L.].
- **Activity profiles** of high-level **ice-hockey** players [BIELMANN, C.].
- **Position-specific characteristics** of running distance for Japanese junior **rugby** players [YOSHIDA, Y.].
- **Running** in male first-division [GARCÍA-CALVO, T.] and female collegiate [MASUI, Y.] **soccer** matches.
- Physical demands of **small-sided games** in male elite youth [HAUER, R.] and young [HIDALGO-DE MORA, J.] **soccer** players.
- **Offensive actions** in six games of women's first-division **soccer**, using a new observation instrument [CRUZ, L.].

Various cross-sectional correlates of performance...

- **Collagen genotypes** of 185 endurance-oriented, sprint/power-oriented and mixed **athletes** [GINEVICIENE, V.] and of 636 **rugby** players (with implications for injury risk) [BRAZIER, J.].
- **Leg strength** predicting jump scores of eight male **figure skaters** in a national competition [WANG, Y.].
- **Difficulty** and **execution scores** in the top 20 male **gymnasts** in four Olympics [ROHLEDER, J.].
- **Genotypes** of 648 male elite **rugby union** and **rugby league** players vs 803 male and female non-athletes [ANTROBUS, M.R.].
- **Lighter legs** in 38 5000-m **runners** [UENO, H.].
- Measures of **strength** of 21 competitors in the **sailing Tour de France** [PHILIPPE, K.].
- **Squat jumps, 10-m sprints and age** in 24 elite junior **soccer** goalkeepers [VOLK, N.R.].
- **Contextual factors** on match running performance in an elite **soccer** team [MANTHOU, E.].
- **Predicting 3000-m steeplechase** time from 1500-m and 5000-m time in 200 males [QUAGLIAROTTI, C.].
- **Age and experience** with finishing position in 10-km races of 1377 elite **open-water swimmers** [RODRÍGUEZ-ADALIA, L.].
- **Biomechanical parameters** predicting start times of 11 elite **swimmers** (probably due to inclusion of males and females in the correlations) [QIU, X.].
- Shoulder rotational strength on **serve velocity** in 12 elite junior **tennis** players [FETT, J.].
- Contributions of swimming, cycling, running and transition **times** to overall time of 175 female [FLORIA, P.] and 205 male [GARCÍA-GONZÁLEZ, P.] world-championship **tri-athletes**.

Talent Identification and Development

Wow! The chair and first speaker of the symposium on optimizing elite **athletes' dual career pathways** in Europe (IS-SH06) pointed out that only one in three junior athletes make it to the elite senior level, only 3% can make a living out of their sport, and there are high career-ending risks associated with professional sport. Sports administrators and educators will therefore find much useful information and insight into dual careers, including the Gold in Education and

Elite Sport project [DE-BRANDT, K.], educational modules for dual-career support providers in an IOC project [JORDANA, A.], and strategies to optimize athlete employability in the Be a Winner in Elite Sport and Employment project [VITALI, F.].

In a comparison of developmental trajectories, engagement activities, and performance of 169 **alpine ski racers** from academies in the US with 209 in Austria, "US-based racers accumulated more **practice hours** than those in Austria, but this was not reflected by superior performance" [COWAN, R.L.]. The video has sound only.

Measuring muscle carnosine content with proton magnetic resonance spectroscopy provides a non-invasive estimate of **muscle typology** (proportion of fast fibers). The association between muscle typology of 38 young athlete and their track-and-field success in the following 10 y "suggests that **young athletes** could have a higher chance of becoming successful when their muscle typology matches the discipline they are practicing" [VAN-DE-CASTEELE, F.]. The association was not strong, and I wonder if there's a more sensitive regression method than that presented.

A prospective study of 74 male youth **soccer** players in an elite professional academy showed that higher scores of reflection and evaluation (two of three dimensions of **self-regulation** of learning) when they signed up had moderate associations with level of progression evaluated at the end of a season. [ELDER, K.]

"This project has enhanced the understanding of how **deliberate practice** [of a team skill with a boys' team and an individual skill with a girls' team in a **soccer** academy] can be enacted." [ANNERSTEDT, C.]

Affective-motivational strategic skills appeared to be associated with **dropping out** of sport by Italian and Spanish **school children** [CONSONI, C.], but "critical number" of skills was not defined.

Fitness (various tests) and **maturity** (age of peak height velocity) were determined for 322 under-14 elite **soccer** players. Those who were subsequently selected into under-15 elite soccer academies were more mature than those not selected, but after adjustment for maturity, most measures of fitness were still important. [GONAUS, C.]

There were presentations on the **relative-age effect** in Polish **handball** [RUBAJCZYK, K.], English youth **rugby** union [KELLY, A.;

DIMUNDO, F.], and elite German youth **soccer** [JAKOBS, J.].

A systematic approach is described for promoting **personal interaction and knowledge transfer** between coaches and sport scientists in a German Bundesliga **soccer** club. [KNORR-HELD, V.]

This presentation doesn't fit well under any of my headings, but it needs including. "**Female sport leaders** at the international level continue to struggle in terms of overall representation and access to **leadership positions**." [SCHOCH, L.]

Tests and Technology

What's the best way to describe **match physical performance** in **team sports** like soccer? The first speaker in the Adidas-sponsored symposium (IS-SP02) on individualized assessment of football athletes stated that the popular measures of total distance in speed bands, number of accelerations, and metabolic load do not capture the stochastic nature of match play (wide fluctuations in speed). He thinks a player's **profile of maximum median speed** (other researchers have used mean speed) achieved in a match in a moving time window ranging from 0.3 s through 45 min is the way to go. A sigmoidal curve fitted to the plot of speed vs time window and the five parameters describing it may be useful. [MAHLER, H.; talk starts at 01:30]. In response to a question about **optimizing individualized training**, he said it's multifactorial (GPS, the player's and trainer's responses, the physio's screening), but he is often unsure about increasing or decreasing the load.

In a symposium (IS-API0) on "**fatmax**", the maximum rate of fat oxidation, we learned that it is a predictor of prolonged **endurance** performance, but it has poor reliability when estimated via expired gas (indirect calorimetry) [WALLIS, G.]. A more precise method based on ¹³C enrichment of muscle glycogen is too invasive and expensive for routine use [ROWLANDS, D.S.]. A method for adjusting the indirect-calorimetry estimate with blood bicarbonate or blood lactate concentration needs further investigation.

Three 10-point scales aimed at an athlete's perceptions of physical, technical and mental **training quality** were highly correlated (Cronbach alpha of 0.85) in 252 sub-elite and elite **athletes** from eight **team- and individual-based sports** [SHELL, S.; 1st presentation in YIA Session OP-API9 at 0:01:20]. Differences between the three qualities in some sessions should have resulted in a lower alpha, seemingly, so there could

be a problem with response bias.

Four commonly used methods to estimate **maturity** had correlations of ~0.8 with the criterion (assessment of MRI of the left wrist by three qualified radiologists) in 32 under-12 and 31 under-14 **soccer** players [LEYHR, D.; last presentation in YIA Session OP-AP19 at 1:24:30]. These correlations imply considerable error when assessing individuals, as highlighted by the presenter: "use of more than one diagnostic is recommended to reduce measurement error at the individual level."

In a correlational study of only three female and three male professional **triathletes**, the **Lamberts submaximal cycle test** predicted triathlon performance time with a between-athlete prediction error of ~3.0% [LAMBERTS, R.P.], which is an extremely large error for this sport (Malcata & Hopkins, 2014). The 90% compatibility interval for an error of 3.0% is 2.0 to 6.3%, so even at the lower limit (borderline extremely large), this test is not useful for predicting one-off performance. But like the old Åstrand submaximal test for VO₂max, the Lamberts test might be great for tracking *changes* in performance. An estimate of the *within*-athlete error for monitoring predicted performance would address this issue.

Some measures of **heart-rate variability** depended on the method of calculation in this acute study of 34 elite **athletes**, so "citing software for computation of these parameters is important." [MAKSJYTOV, N.F.]

"A simple 2-D single camera **ball-tracking system** can be used to track ball position and evaluating lower ball speeds" in **soccer**. [HAYCRAFT, J.]

Random error in two **optical**, two **satellite** (GPS) and one **local** (LPS) **positioning systems** were derived using Vicon 3-D analysis as error-free criterion with 56 **soccer** players performing various activities. Optical systems had higher errors (0.14- 0.34 m/s) compared to GPS (0.11-0.25 m/s) and LPS (0.11-0.18 m/s), but "results do not mean optical systems are inferior to LPS or GPS" [AUGHEY, R.J.].

The **GNSS** positioning system can provide useful information for **ski jumpers**, based on this single-case study. [MIYAMOTO, N.]

"**Accel'Rate™**, based on instantaneous variations of the modulus of the 3-axes acceleration vector, appears more suitable to reflect the mechanical load elicited by various physical activi-

ties than **PlayerLoad™**" in this study of 21 recreational males performing **running**-based movements at both low and high intensities. [HOLLVILLE, E.]

Sprint speed estimated with a wearable **satellite-inertial motion sensor** with nine elite **sprinters** deviated from the criterion speed radar measurement with the random error of 6-8% [APTE, S.]. That seems way too high.

A random error of 8 cm/s (~8%) in estimation of barbell speed of back squats with a **Beast accelerometer** also seems too high. Using the speed with different loads to estimate 1-RM is described as "valid and accurate", yet the prediction random error is 11 kg (9 kg with a linear transducer). [DUCA, M.]

The **Hamtech** device appears to be reliable enough for individualized unilateral or bilateral training or rehabilitation of the **hamstrings**. [PIPONNIER, E.]

Estimates of maximum force, power and limb velocity derived from the linear **force-velocity relationship** in an incremental loading protocol with 100 national- and elite-level **athletes** provided acceptable 1-wk typical error of measurement (4-9%) for leg press, but not for squat jump or countermovement jump. Most measures failed to track each other over 2-6 months [LINDBERG, K.; YIA Session OP-AP17, 1st speaker at 01:00]. Poor tracking was probably due to the high error. Jump height might tell you all you need to know, anyway.

A novel explosive **isometric mid-thigh pull** was more reliable and gave higher values for rate of force development than the traditional dynamic test, but peak force was lower and less reliable in 18 **adults** (10 males, 8 females). [O'MEARA, D.]

"The reliability of the **dynamic quadriceps intermittent function test** [in 13 **participants**] was much lower than that of the original isometric test, which questions its utilization to assess patients and athletes." [ROYER, N.]

Here's a novel and apparently quite successful attempt to replace **meta-analysis** with **machine learning** to predict jump height following different kinds of training with different kinds of **athlete** [HO, I.M.K.]. But without a huge number of studies, meta-analysis is probably better.

Providing **feedback** about **jump height** in repeated jumps substantially improved performance without changing the error of measurement with 16 **subjects** [SUZOVIC, D.]. The effect on jump height itself was not presented!

"Limited information about **cycling posture** has been used in training or competition, even though it is one of the crucial factors related to cycling performance." So this pilot study shows you can use an **inertial measurement unit** to quantify posture. [LUK, T.C.]

Imitation **ski jumps** from a **novel rolling platform** were better than stationary jumps in terms of biomechanical agreement with real jumps in this study of nine professional ski jumpers. [KETTERER, J.]

"**Researchers** can make **magnitude-based decisions**, confident that the decisions have a sound Bayesian or frequentist theoretical basis and acceptable inferential properties with the current probability decision thresholds" [HOPKINS, W.]. There are two links to the video; the second one loads quicker. The video is available on YouTube [here](#). A slides-only pptx version of the talk (including a description of error rates) is available [here](#).

Miscellaneous technology...

- Microtechnology to quantify **load** of high-intensity activities in **basketball** games [PERNIGONI, M.].
- Automated recognition of **sport-specific movements** in **basketball** [JIAN, F.].
- **Padding** [NORHEIM, K.L.] and **saddle design** [HERRERO-MOLLEDA, A.] in women's **cycling**.
- Comparison of **Polar** and **Fitbit** devices for **heart rate** [MUGGERIDGE, D.J.].
- Validation of **Whoop wearable device** for quantifying **sleep** and **autonomic function** [BELLENGER, C.].
- **Swimming** analysis with a single **sensor** [HAMIDI RAD, M.].
- Simple **video analysis** to measure velocity of descent under the barbell during the snatch in **weightlifting** [ROMAGNOLI, R.].

Training

Wow! The symposium on **racket sports** (IS-AP08) began with Alex Ferrauti's inspirational presentation of the strategies he has researched for **individualizing training** in the development of tennis and badminton players. He finished with "most players and coaches are still far away from using all these possibilities." [FERRAUTI, A.]. In question time, he thought that measures provided by algorithms for wearable technology need more development, and that cold-water immersion and compression garments have useful but only small effects on recovery from hard

matches, so players can have some freedom of choice. The third speaker combined research with practical advice on **high-intensity interval training** for racket sports [FERNANDEZ, J.]. In question time he allowed that there is still room for more traditional approaches to training, depending on the individual player and competition load.

Wow! **Blood-flow restriction** during 15 sessions of low-intensity **rowing** over 5 wk increased peak power and VO₂max in a controlled trial of 16+15 highly trained rowers assigned in balanced fashion (great design!) to intervention and control groups. The effects were extremely large: 15.3 vs 3.1% and 9.1 vs 2.5% respectively [HELD, S.]. There were similar SDs of change scores in both groups, which is consistent with no individual responses (surprisingly). Pity about the p values. Here's Steffen's response to a question I posted on the message board... "The athletes in the BFR group were indeed successful in the subsequent competitions: some athletes were able to qualify for the national team for the first time and others were even able to win the corresponding world championships for the first time."

From the symposium on **new strength-training methods** (IS-AP02)... "Gains in skeletal muscle mass and maximal muscle strength induced by resistance training with **blood-flow restriction** may match or even exceed that observed with conventional types of heavy-resistance strength training" [AAGAARD, P.]. **Velocity-controlled resistance training** allows for better quantification of training load by accounting for decline in velocity of the reps (performed at maximum velocity) in a set of reps, thanks to a linear relationship between velocity (percent of first rep velocity) and rep number (percent of maximum number). The effectiveness of resistance training may be best quantified via the shift of the force-velocity relationship with different loads [GONZÁLEZ-BADILLO, J.J.]. The video was a bit hard to follow.

Conclusions of a literature review: "Despite a low overall training volume, **velocity-based resistance training** involving high intended movement velocity and low velocity loss results in comparable or superior adaptations in maximal muscle strength and power compared to conventional resistance training." [METZSCH JENSEN, A.]

Compared with control, 10 sessions of **futsal**

training with leg **blood-flow restriction** applied immediately after every two sessions increased futsal-specific test performance in 6+6 male players [FARHANI, F.]. There were only p values and probably a difference of significance rather than a significant difference in the abstract. There was only sound in the video, so I did not watch it to clarify the outcome.

After 8 wk of **plyometric training**, eight college-level **basketball** players improved their jump height and agility, but the changes in five control players were not presented in the abstract or slideshow. [GUPTA, A.]

Cycling consists of alternating contractions in the legs, so these researchers asked the sensible question of whether **strength training** with similar **alternation** would improve cycling performance compared with the usual strength training with bilateral movements. The 20 **triathletes** and **cyclists** (3 females, 17 males) were balance-assigned to unilateral or bilateral strength training for 20 sessions over 10 wk or to a control group (no strength training). There were confusing comparisons of significance and it's hard to assess comparisons without compatibility limits, but it looks like there were similar performance improvements in both strength-training groups. [JI, S.]

Three weeks of **power-oriented resistance training** in 12 **judokas** staying at **moderate altitude** produced obviously bigger and more rapid improvements in the force-velocity profile of a squat jump than those of 10 judokas who trained at sea level, "although there were no differences between groups" (you know why). [ALMEIDA, F.]

In a study of 21+21 physically **active men** aimed at the demands of team sports, "**resistance training with eccentric overload** appears to be a good strategy to improve physical performance", but adding variable inter-set load "may cause undesired adaptations." [GALIANO, C.]

It was hard to compare the effect of three kinds of **strength training** on double poling performance in this controlled trial of 28 adolescent **cross-country skiers**, because there weren't enough data in either the abstract or the slideshow. "All three methods were effective", but block training appeared to have the edge. [VAHTRA, E.]

Sling exercise training is an effective method for **core stability** training, and in this controlled trial of 14 male **judo** athletes "it seems to be

more efficient than conventional free-hand training" to improve the technique of seoi-nage. [MAO, S.S.]

Short **high-intensity interval training** was obviously better than sprint interval training for mean performance times in 200-, 500- and 1000-m time trials on a **kayak** ergometer (by 3.0%, 1.6% and 1.7%, respectively, from the slideshow) [PAQUETTE, M.]. But the conclusion that "greater improvements in performance can be obtained with short high-intensity intervals" was based on a difference in significance, which is a double deadly sin. I calculated 90% compatibility limits of $\pm 4.8\%$ for the 1000-m effect. The smallest important is 0.3% for kayakers (Malcata & Hopkins, 2014), so the only justifiable conclusion is that there's too much uncertainty, arising from the small sample size and the high error of measurement with kayak ergometry.

Rugby players who added 15 **sprint-interval sessions** to their usual training over 5 wk showed higher gains in repeated-sprint ability but lower gains in a 12-min run than players who added sessions of aerobic running in this controlled trial of 33+32 players. [SATO, T.]

The take-home message from the first abstract in the Adidas-sponsored symposium (IS-SP02) on individualized assessment of football athletes is that there is "solid evidence of the superior effects of **high-intensity training**," and that demands of elite **soccer** "differ markedly between individual players, which calls for a **player-specific fitness training** approach where technical and tactical elements are integrated in the physical drills" [MOHR, M.]. The speaker was unable to present his talk live, and at the time of writing his recorded video was not available.

Here's a well-designed controlled trial comparing performance effects of 6 wk of **polarized training** (low and high intensity, little moderate) vs control pyramidal training (low > mod > high intensity) in 15 trained **triathletes** (4 females, 11 males) who were balance-assigned to the two groups. The claim was made that "there were no practically relevant interaction effects in all performance outcomes between both groups", based presumably on non-significance of the interaction [RÖHRKEN, G.]. But when I read the changes in the two groups off bar graphs (should have been line diagrams) in the slideshow, I found ~5% greater peak power in the incremental cycling test and ~4.5% faster running speed in the incremental running test with polarized vs

control training. These differences are practically very relevant.

Key point from the first speaker in a symposium on **hypoxic training** (IS-PN05)... "Natural moderate hypoxia induces faster and higher enhancements in **muscle power** capacity after training... More studies are needed to clarify the roles of natural and simulated hypoxia." [FERICHE, B.]

It looked to me like there was likely impaired performance (VO₂max and lactate-threshold speed) when 10 male **runners** did a 14-d training camp while living in **normobaric hypoxia** for 16 h a day vs control (normobaric normoxia) in a single-blind pre-post crossover. The authors, of course, concluded there was no effect. [TOWNSEND, N.]

Main points in a symposium (IS-AP04) on non-physical approaches to training: mechanisms of training by **motor imagery** [GROSPRETRE, S.], possible use of such training in rehabilitation [MARUSIC, U.], and little evidence as yet for training with **transcranial direct-current stimulation** to enhance athletic performance [PERREY, S.].

Does **dehydration** enhance **heat training** adaptations? You have to view the video of the second presenter in the symposium (IS-PN07) on hydration and heat stress response to get the answer. On the basis of one study, yes for 30-min time-trial performance in the heat, and not significant for performance in cool conditions. [PÉRIARD, J.D.]

Does **recovery in hot water** after training in the heat further enhance **heat adaptation**? Good question. The authors found "no difference" in 10,000-m time when six racewalkers trained in the heat for 15 d with recovery for 30-40 min in hot water at 40°C after eight sessions, compared with a control group of six **racewalkers** who recovered in air at 21°C [STEVENS, C.]. Using the data in the slideshow, I calculated 4.7% mean enhancement in the heat group and 6.1% in the control group. The difference of 1.4% would represent a moderate *impairment* for these athletes. Compatibility limits would also have been informative.

On the other hand, here's where a **hot bath** *does* work: in the symposium (IS-SP01) on beating the heat, sponsored by GSSI, Neil Walsh told us that "conventional exercise **heat acclimation** interventions are costly and impractical for athletes residing in cooler climates," but that a prac-

tical alternative is "taking a hot bath in 40°C water after exercising in temperate conditions, on six consecutive days, which provides heat acclimation... in **highly trained athletes** for at least 2 wk." There is no abstract, but there is a link to a handout. Neil's presentation starts at 59:20 into the video.

In a controlled trial of 13+12 trained males, five sessions of **repeated-sprint training** at 40°C over 7 d worked better than the same training at 20°C for a shuttle run and peak sprinting, so this **heat-acclimation** strategy would be useful for **team-sport athletes**. [PÉRIARD, J.D.]

In this uncontrolled study, nine well-trained male **cyclists** performed a very short-term (3-d) **heat-acclimation** protocol. Time to exhaustion at 75% of peak power improved by 9% at 18°C (unclear) and by 17% at 35°C (likely beneficial). [CALLOVINI, A.] The slideshow shows very nicely the individual differences in the changes in performance, although they are probably all attributable to error of measurement in the test. The method of deriving smallest important was not stated; for time-trial cyclists, it's about 1% for mean power, and this is equivalent to a ~15% change in time to exhaustion (Malcata & Hopkins, 2014).

Ten weeks of **stroboscopic training** improved the speed of visuomotor reactions to stimuli on a computer screen by 6.8% (my calculation) compared with a control group in a controlled trial of 16+16 elite German youth **badminton** players. "Future research will evaluate transferability of performance improvements to real game situations." [HÜLSDÜNKER, T.]

There was a mix of changes in eight "markers of **relative energy deficiency**" when nine highly trained male **cyclists** reduced their training by 70% for 3 wk following a competition season, but "all biochemical markers were within normal range at pre-testing and substantial changes were thus not expected", so I'm not sure what to conclude. Are the markers of relative energy deficiency related to performance?

The topic of the symposium (IS-SH08) for the European Federation of Sport Psychology (FEBSAC) was **psychology support** (and **skills**) for **endurance athletes**. The first speaker, Carla Meijen, described an underpowered post-only controlled trial (11+13 women, each group measured only after the treatments) in which motivational self-talk had a very unclear outcome on ultra-endurance performance. She then described how a "**psyching team**" can provide

mental support pre, during and post races [MEIJEN, C.]. Make sure you listen to the discussion after her talk, when Andy Lane made an important observation that "the stand-alone effectiveness [of an intervention] independent of the quality of the practitioner is unclear... it would be useful to have studies that 'the quality of the practitioner accounted for this much variance'." Carla replied that few sport psych courses focus on the importance of the psychologist's counseling skills. Andy then presented his experience with **on-line videos** to teach psych skills to athletes. "Evaluation shows positive endorsement and an increase in belief in mental capacity to cope with the demands of endurance performance." [LANE, A.M.]. Ironically, his presentation is hard to follow in places.

In the plenary (PS-PL02) on **genetics of training adaptations** (that would be relevant to **endurance athletes**), Claude Bouchard argued for a heritable influence: "Training experiments performed with pairs of monozygotic twins have generated highly concordant findings with a substantial degree of within twin pair resemblance in [VO₂max] training response... The HERITAGE Family Study showed that the heritability of [VO₂max] response to a 20-wk exercise program reached 47%.... It is [still] not possible to define the molecular basis of the genetic component... [but] now is not the time to quit trying!" [BOUCHARD, C.]. Michael Joyner argued that "there is little current data to suggest that DNA variation explains more than a tiny fraction of the physiological factors that operate at every level of the so-called oxygen transport cascade" [JOYNER, M.J.]. I guess absence of genomic evidence is not evidence of genomic absence, and I didn't hear a convincing dismissal of Bouchard's heritability evidence, so I conclude that you need great genes and great training to be a great athlete. But you knew that already.

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Acknowledgements: ECSS waived my registration fee. Many thanks to the reviewer for additions and corrections.

Published Nov 2020

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