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Athletic Performance Research at the 2011 Annual Meeting of the Teenage European College of Sport Science in Liverpool

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Reviewer: Robert P Lamberts, Sport Science Institute of South Africa, University of Cape Town, South Africa.

A sport philosopher's insight on the divide between scientist and coach was the highest point of this top conference. Novel strategies for performance enhancement included stiff insoles for cyclists and psychological assessment for identifying young talent. Acute Effects: pacing; cold-water immersion; stretching; post-activation potentiation; shoe stiffness; carbon insoles; cycle cranks; site of fatigue; menstrual cycle; hologram bracelets. Nutrition: carbohydrate; protein; HMB; beetroot juice; caffeine; bicarbonate; NAC; astaxanthin, probiotics. Tests, Technology and Monitoring: power on the pedal; virtual reality cycling; incremental cycling test; training-performance models; running tests; heart-rate recovery; instrumented kayak paddle; throwing in water polo; visual search in volleyball; perceived exertion; hormone and damage markers; soccer tactical skill; GPS; skiing eccentric ergometer. Performance and Game Analysis: kinematics, movements and actions in various sports; team dynamics; soccer scores; rhythmic gymnastics scores; rowing times. Talent Identification and Development: AFL draft camp, young soccer players; physiological tests and psychological skills for soccer; sporting talent in children; coordination for gymnasts; infrastructure for gymnastics; career transition for basketball players; genotypes. Training: load-guided system; interval training; hyperoxia; interference for golf putting; Pilates for dancers; resistance for swimmers; post-altitude optimum; electrical stimulation; core exercises, deliberate practice; resistance and intervals for soccer. KEYWORDS: elite athletes, ergogenic aids, nutrition, talent identification, tests, training.

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Updated Aug 12 with information about a new search form at the conference site.

A modern conference center on the upgraded old docks of Liverpool was the venue for this top conference in the sport scientists' calendar. The adjoining cityscape was post-apocalyptic in places, but the contrast only heightened my appreciation of the privileges that come with affluence and education. I also have a genuine sense of privilege when attending any scientific conference. The annual meetings of the European College of Sport Science (ECSS) are special in this respect, because they are a particularly rich seam of discoveries, insights and techniques in our discipline.

I got to the closing ceremony feeling it was another great conference but without having attended a presentation that I was bursting to tell people about. The closing ceremony opened with the young investigator awards, which are always a highlight and give those of us with grey hair the warm fuzzies that come with nurturing talented young people. The winning oral presentation was an observational study of biomechanics of fast bowling in cricket by Helen Crewe. See the congress debriefing for the full list of awardees.

The awards were followed by the closing address of the outgoing president, Hans Hoppeler, who brought his teenage daughter of the same age as ECSS up onto the stage as an entertaining gesture to emphasize the youthful vitality of this 16-year old organization. And then, by way of introducing the new chair, he said something rather special: "the members of the executive board are scientists, not politicians." With that, Sigmund Loland came to the podium and gave a talk about his research on sport philosophy that was the inspirational presentation I had been waiting for. Sigmund explained the rational basis for fair play in terms of equality of opportunity that has resulted in sex, weight or height classifications for some sports and the ban on performance-enhancing drugs. That was interesting enough, but then he moved on to the challenging notion that certain gestalts (integrated or emergent aspects) of skilled movement, such as the sense of rhythm in skiing, are accessible to an experienced coach or born athlete but do not emerge from any analysis of the component skills of balancing, finding support, and gliding. He drew a parallel with the Cartesian mind-body problem and referred to the "theoretical and methodological incommensurability" between the current reductionist approach of the scientist and the phenomenological approach that needs to be developed to study the gestalts of skilled movement. His concluding assertion: a good coach or athlete may have mastery of both worlds.

This report, alas, is only a reductionist's summary of the presentations relevant to anyone interested in athletic performance. I have omitted studies of rodents and untrained humans, and I have tended to omit studies of athletes where design flaws, uncertainty in the estimates due to a tiny sample size, or a confusing abstract prevent any practical application of the findings. Most of the report is based on the abstracts, supplemented where possible with notes taken at the podium and poster presentations I was able to attend. The reviewer (Rob Lamberts) also made valuable suggestions and corrections.

There was the usual crop of overviews and original research showing benefits of such strategies as training with intervals, competing with carbohydrate and caffeine, and recovering with protein. Make sure you are up to speed with the current best practice for these strategies. Here are my choices for the more novel approaches to performance enhancement that you should follow up: shoe stiffness for sprinters, carbon insoles and crank separation for cyclists, supplementing acutely with NAC for recovery in tournaments or between heats and finals, assessing psychological and technical skills to identify sporting talent in children, rejigging your sport's infrastructure, improving the transition from youth to adult sport, doing altitude training at the right time (3-5 wk before the competition), and it probably wouldn't hurt to add core exercises for soccer and similar team athletes.

I am bound to have missed the occasional useful discovery amongst the 1760 abstracts. Many abstracts will also contain information about methods that would be valuable for your assessment of athletes or your research using the method. I therefore strongly advise you to supplement this report with your own search for specific words in the abstracts. There is no downloadable book of abstracts for this purpose, but individual abstracts are now accessible via a search form on the conference program homepage. "Water polo", for example, brings up links to eight abstracts, while "cheating", "climbing" and "NIRS" will link you to 7, 11 and 12 abstracts. As I say in the ACSM report, it's fun and instructive to display the abstracts found in this manner on a large screen and discuss them with a small group of budding or experienced sport scientists. ECSS has generously made the search form freely accessible until around mid-September, the start of the promotion campaign of the next congress. After that you will need to log in as a member of ECSS to access individual abstracts via EDSS, the European Database of Sport Science. If you are not already a member of ECSS, I urge you to join: the annual fee is a bargain, especially for students. Find out more on the ECSS membership page.

Use the search form to find the abstracts I refer to in my report, with the author's name and initial(s) shown in brackets […] as the search term. You can also search the titles of the abstracts in their scheduled sessions by downloading the conference program from the conference website. Unfortunately this PDF does not have links to the abstracts: for that you will have to search each of the four kinds of presentation (plenaries, invited, oral, poster) separately via the program homepage. To make searching easier, you can copy the four sections of the program into a single Word doc with active links, but note that these links will soon expire, as above. I used a doc in this manner to find and link to the 25 abstracts with "injur" in the title. Surprisingly, none was a good study of injury incidence in athletes.

The conference was a resounding success, thanks to Tim Cable and his team. There was no shortage of wisdom from big shots, there were few serious timetable clashes even for my wide-ranging interests, the lecture rooms were all reasonably close together, there were few technical delays, and the stand-up dinner made it easy to wander around and build strategic alliances without getting bored! However, I can't do a report without some suggestions for improving the conference logistics.

- Some chairs of **oral sessions** still didn't realize the importance of keeping to the scheduled time for each presenter, no matter what. Some of us do actually plan to see specific presentations in different sessions, so a dependable timetable is crucial.
- There were too many **missing posters**. Examples: five of the eight posters in a session on swimming-related activity, and five of the 13 on performance analysis. We need a poster police person to note the no-shows and ban their registration for at least the next conference, or something. Such action would also reinforce the importance of posters.
- The **poster sessions** were more successful than in previous ECSS conferences, largely because there was more space to stage the 20 concurrent chaired sessions. Navigation was still too confusing to start with, but the organizers responded promptly with handout maps and bigger signs for each session. In my opinion, the poster sessions still did not do justice to the presenters. One of each of the 20 chaired poster sessions was presented as a trial of an e-poster format on what looked like a 45-inch screen, but what I saw did not represent any real improvement and was regarded by one of my colleagues as a joke. What's needed is more opportunity for attendees to interact with the authors informally at scheduled times. I hope the organizers of the Brugge meeting next year do something about it.

Authors, here are some complaints and advice for you.

- Show enough data to communicate the **magnitude of the effect**. Show **confidence limits** to communicate its uncertainty, not p values. In any case, in a controlled trial a difference in significance is not a significant difference.
- Show **standard deviations**, *never* standard errors of the mean. The compelling reasons are listed in the progressive statistics article (Hopkins et al., 2009).
- **Don't use abbreviations**. They make your abstract, poster or slides harder to read. Sometimes it was so bad I gave up.
- Don't forget to use **big fonts and symbols**. If you copy a published graph, you should sometimes redraw it completely.
- Hopefully the organizers of the next conference will ensure that we can **check the formatting** of the uploaded abstract. One quarter of the abstracts had the title, authors and affiliations repeated at the top of the abstract, and the Methods etc headings were embedded without **bold** or UPPER CASE fonts, making them that much harder to skim-read.

Acute Effects

The aerobic energy contribution was greater when eight elite **rowers** used an even **pacing** strategy vs the usual positive pacing profile (fast-slow-fast) or its inverse over the first 1600 m of what would have been a 2000-m time trial. But does even pacing mean better performance? Possibly, but "coaches are afraid to try it" [Donovan, T].

The self-selected **pacing** profile is apparently the best on average for 13 high-level junior 400-m freestyle **swimmers** compared with a forced faster or slower first 100-m split, but two did best times with a faster split and four did best with a slower split [Skorski, S]. Sabrina (the author) checked her data after the conference and told me that there was no obvious useful relationship between the individual differences and the self-selected pacing profiles.

Various protocols of **cold-water immersion** after a 30-min **cycling** performance test were better than active or passive recovery for a second performance test 1 h later [Vaile, J, presented by Dawson, B]. And **cold-water immersion** following intermittent-sprint exercise in the heat by 10 male **team-sport athletes** resulted in faster recovery than passive control in the first few hours, but by 24 h maximum voluntary force was higher in control. "Prolonged use of CWI recovery warrants further investigation. of effects on muscle repair and adaptation" [Pointon, M]. Indeed. Exposure in a **cold room** at -110°C was more successful for recovery of **trail runners** over 24 and 28 h, but it's hardly a practical strategy [Louis, J].

Five subjects is lamentable, but there was a reasonably clear superiority of **cold-water immersion** over the other recovery strategies (passive, cold and warm water, active) in a **climbing** test to exhaustion, but the effects on grip strength were presumably unclear [Balas, J].

It's hard to tell when all you've got to go on is p values, but it looks various kinds of **stretching** (static, dynamic, static plus dynamic) "used in athletics training practice" had little effect relative to no stretching on 20-m sprint performance in this crossover study of 10 **sprint and jump athletes** [Bampouras, T.M.]. Passive **stretching** for flexibility also had little effect on vertical jump performance in a crossover with 14 **ballet dancers** [Ciarrocchi, D.M.]. When static vs dynamic **stretching** mimicked what is commonly done in gymnastics training, there were negligible differences in split jump performance in this crossover study of 12 female competitive **gymnasts** [Harper, E].

A systematic review of the effects of acute static **stretching** on maximal **muscular performance** was based largely on a count-up of significance [Kay, A.D.], and I think the author reached the wrong conclusion. It's obvious to me from the data presented that the longer you stretch, the more the impairment of performance. What matters are the smallest important effects on the different measures of performance and the trade-off between reducing the risk of injury and increasing the impairment of performance with more stretching.

Post-activation potentiation had only small effects at best on explosive performance, and it was all over after the first few minutes in this crossover study of six potentiating exercises plus control with 12 **volleyball players** [Behm, D.G.].

Shoe stiffness matters for a **sprinter**: in a case study, a female sprinter was a whopping 1.6% faster (over an unspecified distance) with the two stiffest Puma sprint spikes vs Asics [Smith, G]. How simple and effective is that? See Stefanyshyn and Fusco (2004) for a comprehensive study using stiffening insoles.

A stiff **carbon insole** also produced a spectacular clear increase in cycling 8-s sprint power of 6.9% after the 25 **cyclists** wore them for two weeks [Schmidt, A]. OK, it wasn't a properly controlled trial, but apparently the cyclists weren't interested in going back to their usual footwear, so it's definitely worth evaluating with your cyclists.

Cycling is substantially more efficient when the distance between the **cranks** (the Q factor) is narrower than usual (90 mm vs ~150 mm) [Disley, B.X.].

Is **endurance fatigue** peripheral (in the heart or muscles) or central (in the brain or mind)? It could be a practical issue, if it's a question of training your muscles or your brain. I'm a peripheral fundamentalist, so I am happy to report a study showing that muscle activation (EMG activity) was *higher* rather than *lower* in the slower of two self-paced time trials in all seven well-trained **cyclists** [Renfree, A]. The spirit was willing but the flesh was weak.

The abstract states no significant difference, but when I viewed the poster I estimated 2.0% better mean power in a 2000-m time trial in the luteal phase of the **menstrual cycle** vs the follicular phase for eight normally menstruating **female rowers** [Vaiksaar, S]. I didn't get to her poster presentation in time to challenge her conclusion that "normally menstruating rowers and rowers taking oral contraceptive pills should not be concerned about the timing of their menstrual cycle with regard to optimized sport-specific endurance performance." Check for recent reviews of this topic.

In case there was any doubt, "power-balance **hologram bracelets**" don't work, and in this study there wasn't even evidence of a placebo effect [Pisch, M].

Nutrition

The first session of the conference was a symposium on **sports nutrition "before, during and after"** training or competition. Gareth Wallis spoke of the "watershed investigation" of Hansen et al., in which previously untrained individuals improved their endurance more when they performed some training sessions with low muscle glycogen. However, the design of that study had questionable relevance to trained athletes, and the jury needs more evidence (see Burke, 2010).

Asker Jeukendrup focused on **carbohydrate** intake during a competitive performance. His recommendations for intake depend on the duration of the competition: >2.5 h, up to 90 g/h; 2-3 h, up to 60 g/h; 1-2 h, up to 30 g/h; 30-75 min, a carbohydrate mouth rinse; and <30 min, nothing. You can train your gut to absorb the highest doses, which need to be in the form of multiple carbohydrates to make use of the multiple transporters in the gut. Glucose and fructose are best, in whatever form (gels, fruits, drinks), and the effective concentration with all fluid taken into account needs to be ~10% (g/100ml). These intakes and concentrations are higher than those recommended by ACSM

(Rodriguez et al., 2009). [Jeukendrup, A]

Repeated mouth rinsing combined with some ingestion of **glucose** to activate receptors in the gut as well as the mouth enhanced 30-s cycle sprint peak power by ~6% relative to aspartame placebo in a crossover with 12 male **cyclists** [Chong, E], so Asker might have to revise his recommendations for short-term performance.

For fastest replenishment of muscle glycogen after competition, Luc Van Loon recommended intake of **carbohydrate** every 20-30 min at a rate of 0.8-1.2 g/kg/h in multiple forms. Adding protein does not speed the process at the highest rates of carbohydrate intake, but intake of protein is certainly important for muscle protein synthesis, as we found out in a nutritional symposium on the last day. Stuart Phillips summarized what's known about **protein** for increasing muscle mass post exercise: **milk** or **whey protein** are best, mainly because of their content of the amino acid leucine, and take 20-25 g bolus servings of protein 4-5× throughout the day. Ron Maughan promoted milk preferably with extra salt as better than water or sports drinks for **rehydration**. [Maughan, R]

Replacing some of the carbohydrate with **protein** in a high-carbohydrate drink consumed during 2.5 h of training in the morning resulted in a massive 2.2% faster time trial in the afternoon in a crossover with eight male **cyclists** [Shing, C].

In a crossover with 10 **soccer players**, 8 d of supplementation with the anabolic amino acid **β-hydroxy β-methylbutyrate** (HMB) resulted in the expected better performance in tests and possibly less muscle damage [Garcia, F.J.]. What about its effects in matches?

Beetroot juice continues to enhance endurance performance: here the gain was 2.7% in mean power and 0.8% in time in a 10-km cycle time trial following a 1-h preload with nine trained **cyclists** and triathletes [Cermak, N.M.]. This presentation won the young-investigator prize for best poster.

I disapprove of the analysis of this crossover study of 40-km time trials of 14 male **cyclists**, but it looks like you should perform 1 h after taking **caffeine** and not wait for another hour, when caffeine peaks in blood [Skinner, T.L.].

Caffeine at the usual research dose (6 mg/kg) produced 2.9% enhancement in cycling endurance power (over what looks like ~45 min) relative to placebo, whereas half the dose produced 4.2% enhancement in a crossover with 16 **cyclists** [Desbrow, B]. The performance difference between the doses wasn't "significant", but a proper analysis would probably show a clear substantial benefit of the lower dose. This result tallies with other caffeine research, although 4.2% is a bit high.

Caffeine had only a slightly greater effect (3.5% vs 2.8%) on mean power in eight 5-min intervals when the 12 **cyclists** performed in a glycogen-depleted vs control state. The caffeine came nowhere near restoring the reduced power (8.4%) in the glycogen-depleted state [Lane, S].

Caffeine enhanced performance of resistance exercises to failure in 11 **resistance-trained** individuals [Duncan, M.J.].

Compared with placebo, **caffeine** and **sodium bicarbonate** had similar beneficial effects of 2.4% and 2.6% on mean power in a 3-km time-trial, but the effect of taking them together was only 2.7% in this crossover study of 10 **cyclists** [Kilding, A.E.]. Take your pick.

Performance of the Yo-yo test declined following a team-sport simulation on each of three consecutive days in six **males** supplementing with a placebo, but the decline was prevented in six males who supplemented acutely with the antioxidant **N-acetylcysteine** (NAC). Creatine kinase ended up higher in the NAC group, so the NAC apparently did not protect against muscle damage. Whether it would affect training adaptations is unclear. [Cobley, J]

Astaxanthin looks set to be an antioxidant that reduces the oxidative stress of intense exercise while enhancing rather than attenuating the effects of training. In a randomized double-blind placebo-controlled trial of 30+30 young elite **soccer players**, astaxanthin supplementation for 90 d abolished training-induced increases in markers of muscle damage (in a subgroup of 32) [Baralic, I]; the net effect on peak speed in an incremental test was not significant [Radivojevic, N], but from what I could see in the talk, harm was not an issue and there was the possibility of a small benefit.

Probiotics taken for 4 wk before a run to exhaustion of unspecified duration in the heat appeared to reduce signs of gut damage in this placebo-controlled crossover with 12 male **runners** [Shing, C.M.], but it looks to me like the effect is at least partly an artefact of an unusually high gut permeability prior to the run in the probiotic trial and no gut damage in the placebo trial. More research needed.

Tests, Technology and Monitoring

A measure of how evenly **power** is applied to the **pedal** around the whole pedal revolution ("dead center size") correlated better with efficiency than the more common measure of force effectiveness in this study of 21 **cyclists** [Leirdal, S]. How to train it remains to be studied.

Adding **virtual reality** via a video to a lab-based 48-km cycling time trial had a slightly negative effect (0.5% slower) in this crossover study of 17 male **cyclists** [Borghouts, L.B.]. What they should try next is a beautiful young female lab assistant: in the legendary anecdotal experience of Dave Martin of the Australian Institute of Sport, there will be a substantial improvement. Seriously, someone has to do the study, in some appropriately deceptive manner. Include measurement of testosterone. What about two beautiful assistants? What about reversing sex roles? PhD anyone?

Peak power in an **incremental test** has long been a contender for the overall best predictor of endurance performance. The prediction can be improved by taking into account the **cyclist's** body mass (dividing by mass to the power of 0.32) [Lamberts, R.P.]. The resulting typical error of the estimate of 1.3% for time is still a bit disappointing, considering the error for 40-km mean power is probably 2-3× greater and the smallest important difference in power for an endurance cyclist is ~1% (Hopkins et al., 2009; Paton and Hopkins, 2006). The good news is that the test-retest typical error for peak power with this continuous incremental protocol is only 0.9% (Lamberts et al., 2009), so it's great for tracking changes. Rob Lamberts also points out that this test is less stressful than a time trial and also predicts maximum oxygen consumption better than a step incremental test.

An attempt to relate training to performance with the **Perpot model** in six **swimmers** was claimed as a success [Pfeiffer, M], but a prediction error of ~4% in swimming speed is far too high, in my opinion.

A training-stress score based on actual training gave better prediction of time-trial performance with the **Busso model** than measures based on perceived exertion and heart rate in seven **runners** over 15 wk of intensive monitoring and testing [Coutts, A.J.]. But is the error of the estimate low enough for such monitoring to be useful?

A **neural-net modeling** approach to the relationship between intensively monitored training and performance in three **triathletes** over three months produced an absolute prediction error of ~5%, which is way too high to be useful [Haar, B]. Part of the problem was the use of maximum oxygen uptake as the measure of performance; peak power in the same test would be closer to what matters to cyclists and would have less error.

It's possible to combine various maximal **running** tests to get independent measures of **endurance and repeated-sprint ability** ("intermittent effort") in maturing boys trained in a sport academy setting [Buchheit, M, presented by Alberto Mendez-Villanueva].

If you're using **heart-rate recovery** to monitor overload training, changing the test-exercise intensity to get heart rate up to ~90% of maximum results in the lowest error of measurement for tracking changes in **runners** and **interval sports players** [Lamberts, R.P.].

Instrumentation of the **kayak** paddle to permit **mobile ergometry** comparable to that in cycling would be a fantastic advance for the sport, but a group taking up the challenge has so far only used a single strain gauge to measure force (not power), and there seems to be too much error [Sturm, D].

Throwing distance on water and on land had a reasonably high correlation (0.91) [Komori, Y], but the huge range in the age and ability of the **water polo** players means that the prediction error within each group will be way too large. The appropriate conclusion is NOT to test throwing ability on land, the opposite of what the authors concluded.

Differences between the **visual search** strategies of **volleyball players** in lab and live-action settings led the authors to conclude that you should collect visual search data in live-action settings [Afonso, J].

Perceived exertion is being used to monitor training sessions in **water polo** [Lupo, C], **basketball** [Schultz de Arruda, A] and **Australian rules football** [Coutts, A.J.].

Hormone and **muscle-damage markers** in 47 **Australian rules football** players apparently had little relationship with physical performance tests during a season [Bilsborough, J.B.].

A field test to assess **tactical skill** in **soccer** (no details in the abstract) did not have particularly impressive measurement properties: correlation of only 0.63 with coaches' assessments, and reliability correlations of ~0.79. [Costa, I.T.]. Still, it might be useful. Contact the author.

GPS devices need a sampling rate of at least 15 Hz for acceptable accuracy when tracking movements of **team-sport players** [Rawstorn, J; Platen, P]. The gradual introduction of devices with higher sampling rates is presumably deliberate planned obsolescence. A "high-end" Leica GPS system integrated with video appears to be successful for monitoring the training of **alpine skiers** [Supej, M].

In a symposium I missed because of a program clash, there was a presentation about development of an **eccentric ergometer** that improved measures of explosive power in elite **skiers** when used once a twice a week during summer training [Vogt, M]. The device appears to be a servo-controlled cycle ergometer.

The **Yo-yo intermittent recovery test** is popular for assessment of endurance performance in **team sports** and featured in 10 abstracts. Two contained normative data: rugby league [Pyne, D.B.] and elite handball [Michalsik, L.B].

Performance and Game Analysis

Authors of observational studies of the **kinematics** of **race walkers** [Smith, L.C.], **distance runners** [Smith, L.C.], and **shot-putters** [Aoyama, S] made conclusions that seem useful for improving performance of such athletes.

The following time-motion studies of **movement speeds** in team games might be useful for training prescription: male elite team **handball** [Michalsik, L.B.], national-level field **hockey** [Morgan, S], national-level **futsal** [Dogramaci, S], elite **hurling** [Collins, K], elite female **rugby** sevens [Suárez-Arrones, L], elite **Australian football** [Coutts, A.J.; Burgess, D].

The following analyses of **player actions** from video recordings or official match statistics could also be useful…

- **Basketball**: space-protection dynamics in defense [Lamas, L]; offensive and defensive tactics around turnovers [Tsamourtzis, E]; games with balanced vs unbalanced ability of teams [Ferreira, A.P.].
- **Canoe polo**: tactics used by national teams in the pressing vs the zone game [Vastola, R].
- **Futsal**: differences between high- vs low-caliber teams [Dogramaci, S].
- **Handball**: transition from defense to offense [Ichimura, S]; 40 years of Olympic matches [Skarbalius, A].
- **Japanese martial arts**: distance between opponents in various moves at black-belt level [Fujiwara, T].
- **Rugby union**: tackling [Hendricks, S].
- **Soccer**: visualizing player positions with a surface map [Moura, F.A.]; interruptions of play [Lames, M]; match statistics of national teams in the soccer world cup [Cascone, S]; goal-keepers in the world cup [de Paola, M]; four studies of temporal ("T") patterns in counter-attacks, goal scoring and offense maneuvers in soccer [Sarmento, H; Barbosa, A].
- **Volleyball**: interactions between a setter and a middle blocker in national-level games [Buscà Safont-Tria, B].

Leonardo Lamas gave a great presentation at ECSS last year, and this year he again demonstrated his creativity with a comprehensive **model** for analysis of **dynamics** in **team games**. The model is still being validated, but it looks set to "provide support for a more structured match analysis and contribute to defining training focuses" [Lamas, L].

Soccer scores are so inherently noisy that, even with the latest technique of **generalized mixed linear modeling,** it took five years of data with each of three intakes of boys to determine that the teams of the Aspire academy have improved relative to their opponents [Malcata, R]. The technique will be more useful for game scores or performance indicators with higher counts than soccer scores.

An analysis of **performance scores** at a **rhythmic gymnastics** world cup led the authors to conclude that "either the judges were not evaluating what they were supposed to, or the code of points made the judges evaluate the same aspects twice" [Ávila-Carvalho, L].

In an analysis of 11 years of international **rowing** competitions, mean race times varied by ~3.0% between competitions, owing to **environmental effects**. After adjustment for these effects, the within-athlete variation in performance between competitions was ~1.0%, depending somewhat on boat class and sex. **Smallest worthwhile changes** in performance time are therefore ~0.3%. [Smith, T.B.]

Talent Identification and Development

Performance of **Aussie-rules football** (AFL) **players** in fitness tests at a **draft camp** and especially in a tournament just before the camp had a moderate to large relationship with subsequent career success: poor performers played in only 10% of available matches they were available for, whereas good performers played in 60% [Burgess, D]. Players and coaches should find this study useful.

Elite young **soccer players** in all age groups (Under-12 through Under-18) made greater gains in various measures of fitness over three seasons than subelite players, presumably reflecting **differences in training** and underscoring its importance [Wrigley, R].

In a symposium on talent identification, "there are plenty of unique individuals who aren't the fittest but they are the best" sums up what has to be at best the minor role of testing and training of **physical capacities** in **soccer** [Buchheit, M, as presented in his absence by his colleague Alberto Mendez-Villanueva]. Still, performance in soccer tests "has a small but crucial impact on future career success of elite soccer players" in a longitudinal study of thousands of players tested between ages 13 and 18 [Gonaus, C; not part of the symposium].

What else can you measure in youth **soccer players** that will tell you who is going to be the best? In the 10-year Groningen sports talent study, good predictors were **technical skills** at age 12 and **psychological skills** along the lines of "how can I make myself a better player" (high levels of reflection and effort; aspects of self-regulation of learning) [Elferink-Gemser, M]. Reflection was also the skill that distinguished those who rose to senior international level in a 4-y prospective study of 54 elite youth athletes by these researchers [Jonker, L].

What about identifying **sporting talent** at an even younger age? A factor-analytic study of what 165 physed teachers think is important in **children** aged 6-8 resulted in seven dimensions: psychological ability, ability to respond, creativity, psychomotor ability, self-regulation, interpersonal and intellectual ability [Platvoet, S]. There's some resonance here with the Groningen study above: it's the same research group! Stay tuned to this line of enquiry.

In a study of 33 female **gymnasts** aged 7-8, only a non-sport-specific **motor coordination** test (an athletic-ability "motor quotient") predicted performance score 2 y later, with a correlation of 0.62 [Vandorpe, B]. The study was a bit underpowered to exclude the possibility of other useful predictors. Not in the abstract but also presented was the study on the development of the motor quotient in 200 kids.

Women's **artistic gymnastics** took off in Brazil after implementation of an **infrastructure model** "imported from the Soviet Union". This qualitative evaluation of the implementation identified centralized preparation as the main reason for the success, but many problems were also identified [Oliveira, M.S.].

In a qual-quan study of 168 apparently male **basketball players** of age 17-20 and 57 coaches in Russia, the focus was the **transition** from **junior to adult** teams. The problems that needed addressing were: big losses of talented sportsmen who weren't taught to work without any assistance; no special inter-season training camps; players transitioning from student teams weren't ready for the tough competition; and players lost too much technical and physical form during holidays. [Likhachev, O].

I confess to losing interest in studies of the **genotypes** of **athletes**, but don't let me stop you viewing the seven posters [PP-PM42, starting with Cupeiro, R].

Training

In an 8-wk parallel-groups training study that ended up with 20 **cyclists** (10+10?), a Polar **load-guided training** system produced what looks like a ~4% increase in the individual anaerobic threshold power compared with control training [Bruch, A]. Once again the data were presented as a difference in significance. There were "less too intense" sessions in the Polar group, and they did 49 training sessions vs 55 in the control group. Looks good for Polar, but it's a bit worrying that the effect on peak power was measured but not reported, and that one of the researchers was a Polar stakeholder.

Six **cyclists** in each of three groups is a recipe for inconclusiveness in a training study, but it looks like **low-cadence interval training** twice a week for 4 wk is as good as control training and better than high cadence training for a 20-min hill time trial, whereas high-cadence training is (a bit) better than low-cadence and better than control for a 20-min time trial on the flat [Nimmerichter, A]. The findings hang together, but please treble the sample size.

Twelve weeks of twice weekly sessions of 5× 6-min **low-cadence intervals** (40 rpm) added to usual training tended to have harmful effect on a 30-min time-trial in this study of 12+12 veteran **cyclists** [Kristoffersen, M]. Shorter intervals at higher resistance are known to work.

Training twice a week for 4 wk in **hyperoxia** (60% oxygen) to increase the training intensity relative to that in normal air (21%) tended to *impair* performance in this randomized placebo-controlled study of 8+8 endurance **cyclists** [Kilding, A.E.].

It's hard to evaluate what looks like a really interesting study of the effects of **contextual interference** in learning of **golf** putting, because the authors reported no outcome statistics [Mendes, R].

In a randomized controlled trial of 13+13 11-y old **dancers**, addition of 40 min of **Pilates** mat exercises three times a week for 12 wk probably resulted in substantial improvements in stability and jump height [Lee, A.J.Y.].

Swim coaches are always going to use **dry-land resistance training**, so it's sensible to compare two different kinds: high-resistance low-repetition vs low-resistance high-repetition. Sample size was a bit small (17 total), but they were elite junior **swimmers** (15 y). And the outcome after 6 wk? Who knows? All we're told is that "best times at 25 and 50 m but not at 100 m of their competitive stroke improved to the same extent in both groups ($P<0.05$)" [Nikolopoulos, A]. Percent effects in each group and the confidence limits for the comparison would give us a better idea.

When does performance peak after **altitude training**? An analysis of performance points of 45 elite **swimmers**, 25 of whom participated in 1-3 altitude camps over a 2-y period, revealed the greatest benefit 25-35 d after returning from altitude. The benefit was 42 points on a German 1000-pt scale. A similar opposite effect was seen 2 wk after illness or injury [Wachsmuth, N.B.]. If the German points system is similar to that of FINA, 10 points is a swim time of ~0.6% (Pyne et al., 2005), so the effects here would be an unrealistically high ~3%.

Does **electrical stimulation** of muscles during **resistance training** improve performance? In this study of 10+10 already "**strength-trained subjects**", differences in changes between groups were "not significant" [Doermann, U]. There was a tendency for throwing to be enhanced that I couldn't evaluate properly because of inadequate reporting.

Addition of **core exercises** to usual training produced significant improvements in agility, balance, and muscle strength but non-significant differences in soccer skills in a 12-week study of 12+12 14-year old male **soccer players** [Lee, H.J.]. An abstract about a neuromuscular training program aimed at improving whole-body and core stability had too little data for me to evaluate its apparent lack of effects on performance tests and injury in a randomized controlled trial of 90 elite youth soccer players [Borghuis, A.J.].

Here's evidence that experts left to their own devices engage in appropriate **deliberate practice**: a skilled group of **Gaelic footballers** chose to practice their weakest free-kick shot 66% of the time, whereas a less-skilled group practiced theirs only 27% of the time, the outcome being that the skilled group improved their weakest shot more [Coughlan, E.K.].

Youth **soccer players** who had engaged in 4 years of **deliberate practice** had "a more positional style of play, with a larger ball circulation between players" in small-sided games, whereas a group that had experienced apparently no deliberate practice (I can't imagine what that means!) had "faster offensive sequences, where individual actions were predominant" [Almeida, C.H.]. This abstract would have benefitted from a clear definition of *deliberate practice*.

In this randomized controlled trial of 8+8 already resistance-trained professional **soccer players**, which group would you predict got bigger gains in strength: the group who averaged six **explosive reps** per set (stopping each set when speed dropped by 15%) or the group who averaged 10 (stopping at a 30% drop in speed)? Well, who knows? The authors reported a difference in significance rather than a significant difference, but it looks like the first group did better, amazingly [Pareja-Blanco, F].

Junior **soccer players** get better improvements in the Yo-yo intermittent recovery test with twice-weekly **interval training** at a higher intensity, but after 6 wk they can sustain the improvement with one session per week [Impellizzeri, F.M.].

Jens Bangsbo dedicated the last plenary session to the memory of Tom Riley. He presented the evidence that even well-trained elite **soccer players** can improve running performance with additional **high-intensity training** [Bangsbo, J]. Jens and his team will be hosting the next World Congress on Science and Football in

Copenhagen in 2015. Don't miss it.

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