Reflections on the 2010 Annual Meeting of the European College of Sport Science in Antalya, Turkey

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This conference was noteworthy for wonderful food in an exotic castle of mirrors. Two of the best studies on sport performance were in basketball: a controlled trial to improve free throws and an analysis of offensive play. A series of case studies of technology for US athletes was also inspiring. Master Class: transformations; uniformity; normality; presentation of results. Acute Effects: pre-cooling; environmental factors; strapping rowers in; unlocked suspension on mountain bikes; breathing with swimmers; post-activation potentiation for shotput; cooling, compression, vibration for recovery. Injury: running style; stretching. Match Analysis: basketball; beach volleyball; volleyball; handball; water polo; judo; squash; football/soccer; rugby. Nutrition: β-alanine; carnitine; caffeine; carbohydrate; protein; bicarbonate; phosphate; beetroot juice; antioxidants. Talent Identification: soccer talent scouts and field tests; AIS rowers. Tests and Technology: computing in sport; jumps; soccer; rowing; training-performance models in triathletes and cyclists; cycling; marathon; race-walking; running; skiing; volleyball; tennis; USOC technology. Training: Ericcson's skill acquisition; new insights on expertise; contextual interference in hockey; focus and gadgets in basketball; ingenious baseball bat; assisted jumps; strength, altitude, single-leg and Smart Cranks for cyclists; intervals for skiers; asymmetric swimmers; sprint, strength, interval, inspiratory, small-sided games, and small-group training for football/soccer; quality of training studies.
KEYWORDS: analysis, elite athletes, ergogenic aids, game, injury, match, nutrition, talent, tests, training.

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The ECSS annual conference is the European equivalent of the ACSM annual meeting, but with more emphasis on sport and less emphasis on medical. This year's meeting in the Turkish coastal resort of Antalya got off to a spectacular start with an ethnic dance show and a magnificent supper. The conference venue was the Adam & Eve hotel, an amazing, up-market, vast and disorienting castle of mirrors that took a day or two to get used to. Conference lunches and the conference dinner were the best ever, but accommodation was not ideal for many delegates: we were isolated in what for some were very ordinary hotels, which were not within walking distance of each other or the Adam & Eve.

This was a large meeting: 1584 attendees, 417 talks, and 1030 posters. For more conference details, including the list of winners of the Youth Investigator Awards, see the official media release. This conference report, which focuses only on presentations relevant to **athletic performance**, is my longest ever. Even so, I have omitted many of the cross-sectional and longitudinal (monitoring) correlational studies showing relationships between fitness tests, training, and/or competition performance, especially if the sample size was too small or the relationships were too obvious to be useful. Reports of interventions without a best-practice control likewise were likely to get the chop, and I have sometimes skipped abstracts of posters that weren't up at the meeting. But it's inevitable that I have missed some important studies, so please get back to me about any and I will add an update.

One of the **best original research studies** was Rasa Kreivyte's intervention to improve free throws in basketball. I did not see Rasa's presentation, but by email she said she has been doing her PhD for three years, and this was her first international conference. Another great study was the analysis of offensive play in basketball, presented by Leonardo Lamas for a group from the School of Physical Education and Sport at the University of São Paulo, Brazil. The most memorable presentation was a series of case studies given by Scott Riewald of the US Olympic Committee, demonstrating how technology has benefited US athletes.

The conference was noteworthy, alas, for poor chairing of **oral sessions**. The chairs should have been given clear orders to stick to presentation times, especially when there were 5-10 parallel sessions with overlapping content. Instead we had chairs who gave ambiguous or no instructions about finishing time, chairs who did not warn speakers they were running out of time, chairs who started the next speaker early, chairs who were still inviting questions or even asking questions themselves after the start time of the next speaker, and worst of all, chairs who advanced to the next speaker plus one when (all too frequently) the scheduled speaker didn't show up. As a consequence I was one of many frustrated attendees who missed part or all of presentations we arrived on time to hear.

The conference organizers made a special attempt this year to improve the **poster sessions** by scheduling two unopposed one-hour sessions in the middle of each day. Unfortunately they did not provide adequate signage for the first poster in each of the 16-17 parallel sessions, and even if you could find the session and poster you wanted and you hadn't missed the chaired presentation, you couldn't hear it over the din. Poster sessions at ECSS don't do the presenters justice: we don't come all this way to showcase our hard work in this kind of fiasco. The ACSM format is the obvious solution. Something will also have to be done in future to punish presenters who fail to show up with their posters: at this meeting it was something like ~15%. The conference abstracts could be published officially only after the meeting, minus all the missing posters and podium presentations. I also heard of two instances of a missing chair! How should they be punished?

The quality of presentation in the **book of abstracts** also needs attention. Many authors apparently did not check the final uploaded version, judging by the many instances of non-rendered fonts and symbols, the missing institutional affiliations, the duplication of title and authors, the glaring cut-and-paste errors, and the bad punctuation and paragraphing. In my view some of the abstracts were so badly presented or so devoid of data that they should have been rejected. Maybe many already were. The obvious errors in all of those that were accepted should have been cleaned up by someone on the conference committee with an eye for detail. The wide, single-column format in the PDF of abstracts is also difficult to read; a two-column format similar to ACSM's is preferable.

And now some criticism for **presenters**–students and faculty alike. Don't use author-defined **abbreviations and acronyms** anywhere, because the trivial saving of space does not make up for the reader's or viewer's substantial frustration trying to decode them. Most of you have got the idea about making **slides** with bullet points in at least 26-pt text, but then you ruin it with a dense table of text in 10 pt, or a graph with symbols and axis labels that can't be read without binoculars. Also, please build your slides using the animation feature in Powerpoint: the audience focuses on each point as you introduce it, and you are less likely to skip an important point. But don't build them with distracting irrelevant animations; wiping down or wiping left to right is animation enough. To improve your **posters**, eliminate any background images that interfere with the text, use mostly dark text on pale backgrounds, and make sure you have a clearly highlighted summary panel with any practical application: it's all you can expect any attendees to read with the current organization of poster sessions.

The quality of **reporting of statistics** in abstracts, slides and posters is still poor, although I have noticed a welcome dramatic increase in magnitude-based inferences this year. In future, please show actual values of effect statistics with uncertainty as confidence limits, not p values and especially not p-value inequalities. Interpret the magnitude of the outcome accordingly (e.g., *possibly small enhancement, trivial but unclear correlation, clear harmful effect…*). In a controlled trial, it's not good enough to state that the experimental group had a significant change while the control group didn't: a difference in significance is not necessarily a significant difference! (Example: $p=0.04$ vs $p=0.06$ obviously doesn't make $p<0.05$ for the comparison.) And try to get your sample size up. Ten in each group of a controlled trial or 10 in a crossover or simple time series is an absolute minimum for a sample that is supposed to be representative of a population, and it's almost always way too few for a clear outcome if the true effect is trivial or small. For a correlational study a total of 50 is a minimum, and you will need up to 270 for a clear outcome when the true effect is small or trivial (and even more for multiple predictor and dependent variables). See the progressive statistics paper for more on design and analysis (Hopkins et al., 2009) and my comprehensive paper and spreadsheet on sample-size estimation (Hopkins, 2006).

Let's hope some of these problems can be addressed for the **next ECSS conference**, in Liverpool, July 6-9, 2011. Regardless, you must come and be bowled over by all the latest and greatest in exercise and sport science. The ECSS conference is too important to miss.

In the following report I have identified presentations by the family name of the first author, in the hope that the organizers will again make the abstracts available as a complete PDF at the conference website on the Scientific Program page. Find the abstract in the PDF by copying the name and initial into the Search form rather than the Find form. If there's still no link to the PDF at the site, contact me. Alternatively, download this PDF or this doc, which I have created from the links to the various sessions at the conference website. Search it for the author's name, as above. When you find the relevant presentation, there is a link there to the abstract.

As in my other recent conference reports, I advise anyone with an interest in a specific sport or phenomenon to search the PDF using the name of that sport or an appropriate key term. Those of you with an interest in population physical activity and health should also search the PDF for appropriate key terms. As noted in my ACSM report and BMS report, a good way to review this and other conferences is to get together a small group (no more than five) with an interest in a specific sport or topic, set up the PDF of conference abstracts on a big monitor, then search for the sport or other keyword and skim each abstract containing the keyword. You can have great fun being critical about everything, and you will learn from each other, as well as from the abstracts.

Master Class

I kicked off the conference between registration and the first talks with a last-moment 2-h master class for six acolytes. We talked mainly about the use of **transformations** to aim for **uniformity** of effects and error, in particular the use of **log transformation** to aim for uniform percent or factor effects and errors. I emphasized that transformations are *not* aimed at getting **normality** of the dependent variable, and that testing for normality is ridiculous. Normality is an important assumption for the distribution of the outcome statistic in our usual analyses (that's how we get the p value or confidence limits), but you can't test for that, and you can assume the central limit theorem delivers it. I pointed out that **rank transformation**, which is implicit in most so-called nonparametric tests that people use when they are worried about non-normality, produces a dependent variable that is anything but normally distributed, but it might help make effects and errors more uniform.

We also talked about **presentation of results** in tables and figures for controlled trials with a continuous dependent variable. In Table 1 you show means and SD of subject characteristics and baseline values of the dependent variable in each group. Never show the standard error. If you used log transformation for any variables, you show the back-transformed mean of the transformed variable (which is effectively a "parametric median"), and you show the SD as a ± percent SD (a CV) for small percents, or a ×/÷ factor SD for larger percents. In Table 2 you show means and SD (or CV or factor SD) of the change scores in each group, after any adjustment for different baseline means and other important subject characteristics in the different groups. The "difference in the changes" with confidence limits and qualitative inference can be squeezed into Table 2 for simple designs, but otherwise show them in Table 3 or a figure that includes the demarcated regions of trivial and small magnitudes, and even moderate and large magnitudes, if relevant. Individual responses can be shown as an SD (or CV or factor SD) in the text, along with the effects of 2 SD of covariates on the response. All this advice and much more is in the progressive statistics paper.

Acute Effects

A **meta-analysis** of 24 controlled trials of various **pre-cooling** strategies revealed benefits for various tests of performance under various conditions [Wegmann, M].

A new **pre-cooling** strategy consisting of consumption of an ice slurry "slushie" made from a commercial sports drink combined with application of iced towels worked better than no pre-cooling in a crossover of a lab time-trial simulating the Beijing cycling time trial with 11 **well-trained cyclists**, whereas the reference treatment of a 10-min cold-water plunge followed by wearing an ice jacket for 20 min had an unclear effect [Ross, M]. The comparison of the two pre-cooling strategies was also presumably unclear.

Pre-cooling with ice jackets enhances p values for ergometer performance of elite male **rowers** in the heat [Tschan, H]–hardly a novel finding.

A sophisticated analysis of the thousands of career performances of the hundreds of elite **runners** in the Tilastopaja database revealed mainly expected effects of various **environmental factors**: altitude, wind speed, importance of the event, method of timing, and indoor tracks [Hopkins, W].

Strapping rowers to their seats improved 1000-m performance on a rowing ergometer by an amount that might only be trivial for a 2000-m race. For the effect on water only start time was investigated, and the caliber of the rowers isn't in the abstract [Hofmijster, M].

Using a mountain bike with **suspension** unlocked vs locked required 2.1% less power to ride a simulated rough terrain on a specially prepared treadmill in a crossover study of seven **elite mountain bikers**. The difference was not statistically significant, so there might be individual responses, but think twice about riding hardtail! This talk was scheduled in a clearly inappropriate session on team sports.

Twelve 16-year old 200-m front-crawl **swimmers** went 1.8% slower when they took a breath every seventh stroke instead of **breathing** free [Tambaki, M]. Reduced availability of oxygen evidently more than offset any hydrodynamic advantage of taking less breaths.

Post-activation potentiation resulted in 2.3% and 2.7% increases in mean and best shot-put distance when 10 national-level **shot-putters** did a set of vertical jumps 30 s before the bout of shot-putting [Karampatsos, G]. This good study would have been great if done in crossover fashion.

Cooling and **compression** combined with active **recovery** after a time trial led to lower lactates compared with active recovery alone, but performance in a second cycling time trial in the **unspecified subjects** was similar with both treatments [de Pauw, K].

The only datum shown was a p value (">0.3", whatever that means), but with 18 well-trained **cyclists** in a cross-over study of **recovery**, there may well have been no substantial difference in the performance of a short-ish time trial after a high-intensity training session was followed by a 10-min session of either cold-water immersion, contrast-water immersion, or passive rest [Stanley, J].

Maximum voluntary contraction was the only measure of **recovery** significantly enhanced by muscle **vibration** following damage-inducing eccentric exercise in this controlled trial of a vibrated vs a control leg in 11 **healthy adults** [Halson, S]. The placebo effect probably contributed something.

Injury

Does **running style** affect the risk of **overuse injury**? A group from the German Sport University addressed this important question prospectively by measuring the kinematics and kinetics of 234 uninjured **runners**, then matching the 29% who developed injuries in the following 24 weeks with uninjured runners who had similar body build and weekly training [Goetze, I]. Main result: "medial patellar pain could be linked to higher adduction moments at the knee joint during running." The authors did not translate this outcome into practical terms.

After 8 wk of static **stretching**, PNF stretching or control training, eccentric exercise produced less signs and symptoms of **muscle damage** in the stretching groups in this controlled trial of 10+10+10 **untrained men** [Nosaka, K]. So will regular stretching reduce muscle damage in trained athletes?

Match Analysis

Synthesizing strategic moves or meaningful dispositions of players is the next important development in game or match analysis. A Brazilian group has achieved it in an exemplary fashion for ten components of **offensive play** in **basketball** that they have identified and named *space creation dynamics* [Lamas, L]. Preliminary findings: the frequencies of "on-ball screens" and "none turnover" indicate the relevance of pick-and-roll and of minimizing turnovers respectively. Much more to come from this group.

The speaker did not show up to present a **neural-net** analysis of **game situations** that result in successful shots in high-level male **basketball** [Russo, L]. According to the abstract, "Offensive field shooting zones [and] quick actions (<6 s) seem to be the 'keys' of a positive shot outcome. These findings reinforce the importance of fast-break strategy in modern basketball."

There's a bit lost in translation, but thorough and practical are appropriate words to describe the design and analysis of a study of top-level **beach volleyball** to set "**technical and tactical goals**" for such things as serving errors and reception efficacy [Palao, J; podium and case-study poster].

The relative contribution of **player actions** in **volleyball** games that can lead to point scoring was estimated for the 15 games of a men's grand champion international [João, P]. Serving aces is the most discriminating variable for winning teams, followed by spikes and kill blocks.

A **methods** study in **volleyball** match analysis also loses much in translation, and there are no data [Raiola, G].

Time-motion analysis of 30 **elite handball** players of unspecified sex must have included some kind of video analysis to determine **time spent** standing, walking, sprinting, changing direction, and so on, in addition to heart-rate monitoring. Main finding: "handball is a high demanding intermittent sport" [Póvoas, S].

In an analysis of **penalty shots** in **water polo**, "the assumption that the goalkeeper jumps first because he chooses in advance in which direction he will move… is confirmed" [Papamargaritis, T].

Differences in the rate and effectiveness of **attacks** in female **judo** athletes of different ages "can be useful to plan technical-tactical as well as physical conditioning training sessions" [Del'Vecchio, F].

Computer-vision software called SAGIT was used for **automatic tracking** of players' movements in 11 matches of an international **squash** championship [James, N]. The software needs operator supervision and manual coding of shot types, but it ought to be really useful for match-play sports and perhaps team sports. Strangely, the software does not appear to have a website; the first report of its use is in the proceedings of a conference as long ago as 2001; and the matches reported here were played in 2003. The findings, at least those presented, did not seem to me to be particularly useful. Isn't there something more recent and interesting to present?

The next talk was about the use of another **automatic tracking** system, AMISCO, to generate information about space around female **soccer** players in Spanish first-division games [Ruiz, C]. According to my notes, I fell asleep. Where is the exciting research that could be done with these systems? Under wraps?

Results of an analysis of **offensive play** in **football** "will be presented" [Sarmento, H]. Unfortunately I didn't get to the poster.

An analysis of **goal-keepers' errors** in Division 1 professional **football** may be useful, but it's hard to follow in translation, and the confidence interval for comparisons is somehow wrong [Lamas, L].

Tries (points) in **rugby** are more likely to be scored from **play** that starts with a lineout than with a scrum, for example [Vaz, L]. Knowledge of any differences between teams in this respect would presumably be helpful in training or strategizing for future matches.

Nutrition

Supplementation with **β-alanine** vs placebo for 7 wk in 9+9 **elite rowers** increased the content of the intramuscular buffer carnosine in muscles and enhanced 2000-m ergometer performance by 4.6 s, or by my calculations ~1% in time or ~3% in mean power [Baguet, A]. Even the baseline content of carnosine correlated strongly with performance in distances of 100 m to 6000 m, something I would not have expected in such a relatively homogeneous group. See also my ACSM report.

The difference wasn't statistically significant, but it looks to me like two months of jump training with **β-alanine** vs placebo supplementation resulted in a clearly bigger improvement in jump performance of young male and female **subjects** [Vieillevoye, S]. The β-alanine group also showed less fatigue with repeated jumps.

Supplementing with **carnitine** (not carnosine) for 24 wk in a controlled trial with 7+7 moderately **trained males** resulted in a huge 10% increase in work in a 30-min time trial preceded by a 30-min preload at 80% VO_2max, apparently because of some kind of change in metabolic control resulting in less lactate production (and therefore less acid?) [Wall, B]. An increase in the rate of fat metabolism is also involved [Greenhaff, P]. But beware, "work output was unchanged in control", and there are no data or p value for the control. I suspect "unchanged" means a big change, with p=0.06 or thereabouts. So check out other published evidence before you add carnitine to your daily β-alanine and beetroot juice (see below), along with caffeine and bicarbonate just before the event. Even without carnitine, the combination might send you into orbit. Disclaimer: see your doctor first.

The authors found no statistically significant effect and concluded there was no effect, but their poster showed a 3% enhancement in a 60-min time trial after a 60-min pre-load when the exercise was performed in the heat with **caffeine** vs a placebo by eight trained male **cyclists** [Roelands, B]. The correct conclusion is that these data are consistent with the kind of ergogenic effect that everyone shows with caffeine at normal temperature.

Caffeine (80 mg) in a sports drink made eight young **soccer referees** more vigilant after fatiguing exercise in a laboratory test [Castle, P]. It's not stated whether the control condition consisted of an isocaloric drink consumed blind.

At last, the first and definitive **meta-analysis** of the acute effects of **carbohydrate supplementation** on **endurance performance** [Vandenbogaerde, T]! Gains of up to 6% in endurance time-trial power output are possible with 1 L/h of a drink containing ~0.8 g/kg/h maltodextrin and ~0.2 g/kg/h protein, taken in multiple boluses starting 3 h before exercise. Fructose at more than 0.25 g/kg/h reduces benefits by ~2.5%. This advice differs a little from what's in the abstract, following a revised analysis. Watch for the full paper in Sports Medicine.

I had to miss the invited session on nutrition, the brain and performance, but so did the first speaker! The second speaker summarized the evidence that "**carbohydrate** is detected in the oral cavity by unidentified receptors and this can be linked to improvements in **exercise performance**" [Jeukendrup, A]. Almost unbelievably, the effect is apparently not linked to a sweet taste.

The second abstract in a symposium on the **marathon** deals with **fuel and fluid** requirements: having full or supercompensated stores of muscle glycogen is important, as are adequate intakes during the race of fluid and several forms of carbohydrate [Jeukendrup, A].

When 7 elite **basketballers** consumed a **composite supplement** containing protein, bicarbonate, creatine, and various omega unsaturated fatty acids for 21 d, they showed greater improvements in various performance tests than a control group, but not unexpectedly for such a small sample size, the differences were not statistically significant [Tønnessen, E]. The athletes were apparently not blind to the treatments (I didn't attend this session to ask), so at least some of the non-significant difference would have been due to a placebo effect.

An unstated number of trained male **cyclists** experienced a possible benefit on recovery from a block of hard training when they consumed a **high-protein diet** compared with a isocaloric normal diet [Witard, O]. It's great to see folks using magnitude-based inferences, even if the reporting is bit wrong.

To investigate the protective effect of a **protein** drink on exercise-induced muscle damage, six male **collegiate athletes** consumed a drink containing 14 g of protein or a placebo before and after a set of five 10-s sprints on a **cycle** ergometer, then performed another set of the same sprints an unspecified time later. Compared with the placebo condition, total work done in all the sprints was 1.7% higher and power in the tenth sprint was 6.1% higher. Serum myoglobin and LDH but not CK (all markers of muscle damage) assayed after the second set were also clearly lower in the protein condition [Fujieda, Y]. There's also a bigger protective effect when the protein is consumed during exercise rather than immediately after [Sanbongi, C].

The same group also investigated the effect of consumption of **soy protein** vs carbohydrate placebo on serum CK and perceived fatigue during 8 wk of a competition season in a randomized controlled trial of 8+8 collegiate **soccer** players [Ambe, H]. I don't know how much trust to put in the significantly lower CK in the soy group, because the sample size is way too low for what is effectively a between-subjects design. Still, it's consistent with other evidence of the beneficial effects of protein for recovery.

It seems strange that **whey protein** added to a carbohydrate drink consumed before and after muscle-damaging eccentric exercise in 12+12 **non-weight trained males** would reduce soreness yet have no effect on the reduction in performance [Jackman, S]. Statistical nonsignificance strikes again? Pertinent data not shown.

Thanks to inexcusable geriatric forgetfulness, I missed what others reported as an outstanding presentation of another **meta-analysis** involving me, on the effects of **bicarbonate** and citrate loading on performance [Carr, A]. Expect 2% gains in power output in **high-intensity races** with bicarbonate but nothing useful with citrate.

Bicarbonate loading over a period of several days had a substantial *negative* effect of 3.2% on mean power in a 2000-m time trial relative to placebo of seven well-trained **rowers**, but worryingly, even acute bicarbonate ingestion had a substantial negative effect of 1.8% in this crossover study [Carr, A]. Let's hope the uncertainty arising from the inadequate sample size allows this finding to be reconciled with the beneficial effects of acute bicarbonate in the meta-analysis presented by the same author.

Will **sodium phosphate** loading reduce the impairment in endurance performance caused by the shortage of oxygen at altitude? Possibly, according to the outcome in this randomized placebo-controlled study of 6+6 trained **cyclists** [Czuba, M], but I missed the poster, the researchers presented no data in the abstract, and because of the inadequate sample size they had to resort to the forbidden ploy of claiming significance in the experimental group but not in the control group.

Supplementation with **beetroot juice** for ~5 d was shown recently to enhance endurance performance and increase exercise economy, apparently via conversion of the nitrate it contains into the cellular messenger, nitric oxide. Here the same group looked at effects on **cycling** economy, VO_2max and "gas exchange" (ventilatory) threshold after 2.5 h, 5 d and 15 d of supplementation in a crossover with 8 "**subjects**" [Vanhatalo, A]. Economy was up equally at all time points on beetroot, but VO_2max and gas-exchange threshold were enhanced "significantly" only at 15 d. Data for 2.5 h and 5 d aren't shown, but the conclusion of "no acute effects" is almost certainly wrong. I wasn't there to ask why they didn't show the most interesting results: peak power in the incremental test. Another study by the same group was aimed at showing the reason for the improved economy is a reduced ATP cost of force production rather than a reduced oxygen cost of ATP re-synthesis [Bailey, S–who won the prize for this best student oral presentation].

There were only two studies worth reporting on the effects of **antioxidants**. Two weeks of supplementing with moderate daily doses of **vitamins C and E** in a randomized placebo-controlled crossover with 10 male endurance **runners** had apparently no statistically significant effect on an 8-km run in hot humid conditions [Gomes, E]. No data are shown, so we don't really know what happened in this study. Supplementation with **cherry juice** for a week prior to and 2 d after muscle-damaging single-leg exercise with 10 trained male **athletes**, presumably in a crossover manner with the other leg, "improved the recovery of isometric muscle strength, perhaps due to attenuation of the oxidative damage" [Bowtell, J]. See my ACSM report for the current understanding of the role of antioxidants in exercise: probably bad chronically, possibly good acutely.

Some remarkable claims for effects on testosterone and performance of 16 **athletes** were made for the supplement **black devil**, but there was apparently no blinding, the abstract does not include any data, and the author did not show up at the poster to defend the claims [Milasius, K].

Talent Identification/Development

I noted during Mark Williams' contribution to a special session on **talent identification** that the politically correct term is currently *early markers of success*. Mark explained the acronym mnemonics used by **soccer** talent scouts when they view games: TABS (talent, attitude, balance, speed), SUPS (speed, understanding, personality, skill) and TIPS (technique, intelligence, personality, speed). He also reviewed the evidence of a direct relationship between level of expertise and accumulated play/training. Mark was a last-minute replacement for an expert whose abstract includes the **10-year rule** for reaching expert level and the observation based on his own research that those who become professionals show a faster rate of progress (unsurprisingly) [Visscher, C]. The other speaker in this session has developed "a multidisciplinary set of field tests" that can enhance the usual approach of talent spotting in **soccer** games [Vaeyens, R]. Note added by reviewer: Vaeyens also offered a framework for talent identification and development that combines the influences of nature and nurture and highlights the multifactorial nature of talent.

Alan Hahn posed this question to kick off his keynote on the **role of sport science** in optimizing elite performance: if some Africans can win medals without sport scientists, are sport scientists important? He answered with another question: if some people can live to 100 without seeing a doctor, are doctors important? The rest of his talk was about the program he helped coordinate in the 1980-90s to identify and develop talent in **rowing**. They used basic anthropometry and field tests to select 12 females and 12 males from ~500 non-rowers, and they included eight existing rowers. "The program culminated in the winning of a gold medal by an Australian women's pair at the 1996 Atlanta Olympic Games" [Hahn, A]. Fine, and much was learned, but strangely the program was discontinued.

More than a little was lost in translation in a qual-quan study of the background of 13 elite Swedish **biathletes**. The most important finding seems to be that "athletes who early in life were introduced to **weapon** more often reached international success" [Carlson, R].

Tests and Technology

An invited session devoted to the role of **computing in sport** featured three presentations. The first, an overview of **computational fluid dynamics** applied to the arm in **swimming** [Dabnichki, P], was hard for me to follow, owing to my bad hearing and eyesight, although I did sit near the front. The second speaker explained how neural-net modeling can be adapted to **analyze motion**, apparently more successfully than would be possible with conventional parametric modeling [Perl, J]. I got a bit lost here too in the maze of phase diagrams. The last speaker described the development of his commercial system to **monitor training and performance** for immediate and continuous remote analysis and presentation to the coach and feedback to the athlete [Baca, A]. Such systems will be valuable in every sense of the word.

If you use a **sledge-jump system** to quantify explosive movements, you might be interested in a new system that reduces the contact time and thereby makes more realistic use of the stretch-shortening cycle [Kramer, A].

A counter-movement **jump test** didn't have sufficient sensitivity to monitor fatigue and recovery in a case-series of 3 female and 3 male **athletes** monitored intensively during baseline, over-reaching and tapering phases of resistance training, each of 4 wk duration [Taylor, K].

The authors claim that their **inertial measurement unit** (a combination of triaxial accelerometers and gyroscopes) is good enough to measure jump height [Picerno, P], but it looks to me like it introduces a random error of 8% in the estimation of **jump height**, which is way too high. A similar "micro electro-mechanical system" performed better, judging by the near perfect correlation with criterion measures in a sample of 30 **soccer** players [Requena, B].

Peak incremental power and performance of a **vertical jump** did not deteriorate on average in 15 high-level **football** players over nearly a year, but there were substantial correlations between change in psychological stress-recovery and change in performance [Faude, O]. Assuming stress was the cause and not the effect, reducing stress on the players from whatever source is a reasonable recommendation the authors could have made.

Fitness tests can tell you something about how far and fast highly trained youth **soccer** players of a given age run in some positions in games, as determined by monitoring 77 such players with global-positioning system monitors [Buchheit, M]. Highest correlations (up to 0.70) were for the second striker.

Interesting: apparently the maximum **running speed** that **youth soccer** players reach in games does not reach the maximum speed in a 40-m sprint test, yet the faster players on the field are faster in the test [Mendez-Villanueva, A]. So, training to increase maximum sprint speed is still important. I would have analyzed the data simply by regressing maximum game speed against maximum test speed, not by comparing faster with slower runners.

If you are the sport scientist for a **soccer** team, you'll need to know that the two versions of the widely used **yo-yo intermittent recovery test** are not interchangeable, nor are they particularly reliable for tracking changes in individuals [Fanchini, M].

Measurement statistics for a test of **soccer kicking accuracy** of players of different ages will be useful for anyone planning an intervention on kicking [Berjan, B].

Peak power in an **incremental test** to maximum effort gave a higher correlation (0.98) than peak power in a step test (0.96) with 2000-m speed on a **rowing** ergometer in an unspecified number of rowers of unspecified sex and ability [Ingham, S]. My guess is that the correlations were inflated by the presence of males and females in the sample. What we need to see is the standard errors of the estimate, the confidence limits for their ratio, and some assessment thereof in relation to smallest effects that matter for rowers.

Post-exercise increases in **cytokines** IL-6 and TNF-α between two tests a year apart correlated highly (0.67, 0.87) with change in 6000-m performance in 9 highly trained **rowers** [Mäestu, J]. It doesn't take much of an outlier to generate such correlations with such a small sample, and in any case, are these cytokines behaving to some extent simply like lactate does as a measure of exercise intensity?

If you are the **rowing** biomechanist, you might be interested in the report on the effects of changing the **spread** between the **oarlock pins** [Draper, C].

A **neural-net** approach has been developed to relate monitored **training and performance** (here, VO2max tests every third day!) in three **triathletes** [Haar, B]. The model needs to be compared with the Banister and PerPot models, and of course, all such models need to be adapted somehow to guide training and tapering for competitions.

The speakers were scheduled 30 min, but were then told needlessly the day before that they had only 15 min, and then the chair needlessly advanced them in the program to take up the slack. I therefore arrived in time to hear the last minute of a study of four **cyclists** showing that the PerPot model of the relationship between **training and performance** continues to be an improvement on the Banister TRIMP model [Pfeiffer, M]. I wonder if this sort of modeling will ever make it into practice.

The ability to deliver **force** to the pedals correlated highly with 50-m sprint performance in 15 world-class **track cyclists**, but four of them were women, so the correlations are confounded by the difference in power between men and women.

Changes in **VO_2 rise times** during a 9-month season within 6 trained **cyclists** had small but non-significant correlations with change in 6-min time-trial performance [Millet, G]. It's not stated how the authors dealt with the repeated-measures problem with such correlations. Anyway, VO_2 kinetics probably aren't useful.

The abstract for the first speaker in the invited symposium on the **marathon** refers to the **physiological determinants** of marathon performance: VO_2max, economy, and fractional utilization of VO_2max (lactate and ventilatory thresholds) [Jones, A]. It also mentions VO_2 kinetics (rise time) as a possible useful determinant of endurance performance, but see above.

In a case study of an elite **race-walker tapering** for three internationals, **heart-rate variability** increased between the beginning and end of the 3- to 4-week taper [Hynynen, E], information that seems to me to be of little use. Yes, nocturnal heart rate is higher and heart-rate variability is lower after a hard training day in 18 male recreational **runners** [Nummela, A], but again, what is the practical application? Do you titrate the training load to produce a certain level of change in heart rate and its variability? Isn't that how the equipment is being marketed already? So what is the point of these observational studies?

By investigating the drag on **skiers** posing in a wind tunnel and measuring their frontal cross-sectional area, it was possible to develop a successful **kinetic model** to predict energy loss in **giant-slalom turns** and apparently to suggest better turning strategies [Meyer, T].

A system for **automatic scoring** of training drills in **volleyball** might be useful [Ilinca, I].

An analysis of forehand **ground-strokes** of six elite and seven high performance male **tennis** players may provide useful information for improving racquet speed [Landlinger, J].

The most inspiring invited presentation for me at this conference was that of Scott Riewald from the US Olympic Committee. Scott presented the following series of case studies (not reported in his abstract) of how **technology** has benefited **US athletes**…

- Use of **video** for a **gymnast** (sorry, the chair started the session early and I missed this one by coming in on time). Apparently they use the Dartfish system for analysis of videos.
- **Monitoring** of power output on line with video in **cyclists'** team-pursuit training to optimize spacing and changeovers.
- **Technology** for **swimming**: 16 cameras,

including a tracking camera, instrumented tethers, and in particular successful training with an instrumented mock-up of the new starting blocks.
- Improving a **Nordic combined** athlete's ski jump, as I recall with **video**.
- Over 5000 **video** clips from 4 wk of training of the **bobsled** team before the Winter Olympics, the result of which was important changes the coach would not have made on the basis of the naked eye.
- Perceptual skills training with stop-motion **video** for **tennis** on clay courts and volleyball.
- **Videos** of white-water **kayaking**.
- Use of **accelerometers** in **BMX** training to enhance speed in the crucial first few seconds.
- Use of **ultrasound** to monitor an individual's recovery (e.g., from MCL **injury**) and adjust rehab to optimize return to training and competition.

In question time, Scott was asked what does *not* work. His reply: don't go in and say you can sort it out; and don't do full-blown analyses of an activity or action, because it takes too long and the athlete and coach don't understand it anyway. Then he was asked what *does* work. His reply: get specific information for a specific question involving the coach and athlete; and it's important to visualize performance to make technical adjustments–it doesn't need an actual measure of performance. Finally, he deferred to an absent colleague for answers to questions about technology for team sports.

Training

We were privileged indeed to have a plenary session on expertise and **skill acquisition** featuring the famous K. Anders Ericsson, in whose view "deliberate practice over extended time modifies virtually all characteristics relevant to superior performance, with the exception of body size and height". In his lecture he made it seem more like *determines* rather than *modifies*. Oddly, he presented several case studies of extraordinary talent that simply cannot be trained, such as learning π to tens of thousands of decimal places. His case studies of exceptional physical performance acquired through deliberate practice were all based on times to exhaustion that aren't actually that remarkable. Anders, deliberate practice would never have got my VO_2max above 80, and if there are allelic variants of genes for body size, why wouldn't there be allelic variants for brain structure that give some people an advantage for skilled movement, mathematics, music, or whatever. What's wrong with needing genes *and* training to be exceptional in most sports and in other fields of human endeavor? To be fair, he did have good evidence-based advice about acquisition of skill: there are "developmental windows" (aka critical periods) for acquiring skills, such as 5-10 years of age for gymnastic flexibility; learn the right way from the beginning; focus on a single domain; have a long-term plan of deliberate practice; start kids with 15 min a day, reaching no more than ~4 h in the adult; optimize training (not too easy or too hard); have lots of sleep; teach athletes to be their own teachers; and build your life around training or whatever endeavor [Ericsson, K]. Reviewer's note: Ericsson's ideas are more appropriate for skill-based sports and activities than for physically demanding sports.

Peter Beek made an equally stimulating contribution to this plenary session on **expertise**. He dismissed the traditional three-stage model of skill acquisition (cognitive, associative, autonomous) by providing examples of new and better insights: a skilled movement evolves not via the acquisition of particular movement forms but rather from the goal state it is working towards; an external focus of attention works better than an internal focus; explicit learning of movement forms may give a head start, but implicit learning (e.g., learning by analogy) produces automated performance that is more robust to stress and distraction; and traditional skill drills are inferior to differential learning, in which the brain is challenged to come up with solutions to unusual or even extreme perturbations to the movement (e.g., weird run-ups in cricket bowling) [Beek, P].

Here's a study illustrating what Peter meant by differential learning. The researchers assigned 52 university students to one of three groups practicing the **field hockey** flick under conditions of low, moderate or high "**contextual interference**", in this case achieved by different mixes of heights for the flick. The group with the highest interference (random order of heights) ended up performing best. "The present study provides further support for the contextual interference effect in applied settings and suggests that practicing variations of one skill at a high level of interference is effective for acquisition and learning of a new motor skill" [Cheung, J]. Admittedly this study may not generalize to athletes who are already reasonably skilled.

And here's one providing evidence about **external vs internal focus**. The 36 young male students were selected as the best throwers at a city **basketball** competition, then assigned to three groups for training of the **free throw** under different conditions of focus of attention for feedback on performance: far external, near external, and internal. (No further information on the feedback is available in the abstract, and I did not attend this session.) Performance tests before and after three sessions of six sets of 10 trials showed that the external far focus of attention was significantly better than the other foci [Karimiasl, A]. No data, and badly formatted abstract, but apparently good research. Authors of another study showing superiority of external focus and self-selected focus failed to include any description of the task! [Micoogullari, B]

Owing to a clash, I missed an inspiring report on improvement of **free throws** in **basketball** through the use of gadgets–a strap to secure the non-shooting arm and/or the use of "special balls" (not described). The subjects were 12+12+12 14- and 15-year olds of unspecified sex who did 100 throws three times a week for an unspecified number of weeks [Kreivyte, R]. There was no control group, unless use of the strap or balls was already best practice with these players. Improvement in percent of accurate shots for strap plus balls (pre 51, post 79) was greater than for strap alone (52, 73) and balls alone (54, 70). All p values were <0.05, but she did not show p values or confidence limits for comparisons of groups. This kind of intervention, successful as it seems to be, is at odds with the approach of deliberate non-specific perturbations described by Peter Beek, unless the special balls qualify as interference.

In a randomized controlled trial, nine varsity **baseball** players training for 8 wk with an ingenious baseball bat that has a sliding weight inside resulted in a significant 6.2% greater swing speed and 6.7% greater hitting distance, whereas eight players training with a normal bat changed only slightly and non-significantly [Liu, C]. As I said earlier, a difference in significance is not necessarily a significant difference, but this bat is certainly an interesting application of **overspeed training** or maybe **interference**.

Assisted jump training with a special pulley system three times a week for 6 wk led to a 7.5% enhancement in jump height, whereas resisted jump training and control jump training achieved only 3% improvements in a randomized controlled trial of 9+13+9 **active young men** [Vuk, S].

Resistance exercise with the arm results in a greater increase in growth hormone when the exercise is performed while breathing hypoxic gas–a finding I missed at last year's ECSS conference. The authors have now done a training study with 6+7 **males**, but no data are shown for the effects on strength, and the outcome was probably inconclusive, given the small sample size [Kurobe, K].

Addition of heavy **strength training** to the usual endurance training in a controlled trial of an unspecified number of well-trained **cyclists** in a 12-wk preparatory period and the first 13 wk of a competition period resulted in higher incremental (?) peak power and better 40-min (sic) time-trial performance [Rønnestad, B]. No data, just p-value inequalities, but there's no doubt cyclists benefit from resistance training. It's a question only of optimizing it.

It was worth a try, but the outcome of six sessions of **single-leg** vs double-leg cycle training over 3 wk in a crossover with nine modestly trained **cyclists** was unclear [Abbiss, C]. There is no mention of washout time, and it looks like it was a pre-post crossover, not a post-only, which reduces the power of the study. And was it enough training?

Six weeks of training with **Smart Cranks** for four training sessions a week resulted in, if anything, better performance in the control group in a controlled trial of 9+9 well-trained **cyclists** [Sperlich, B]. Don't use Smart Cranks.

Twenty-six nights of **live-high train-low** via a nitrogen house increased hemoglobin mass on average by 5.5% in 14 well-trained female **cyclists**, but 8 d later it was down to only 2.3% [Pottgiesser, T]. The authors were keen to invoke increased breakdown of red cells (neocytolysis), which is apparently consistent with the observed rise in plasma ferritin. But the normal turnover rate of red cells is ~1% a day, so red-cell production only needs to turn off on return from altitude to more than account for the rapid loss of hemoglobin. One thing is clear: if the gain in performance with altitude exposure is due to an increase in hemoglobin mass, make the most of it in the week or two (max) after the altitude exposure.

In a randomized controlled trial, 11 d of **high-intensity intervals** resulted in a 9.9% increase in hemoglobin mass in 11 alpine junior **skiers** relative to eight doing control training [Breil, F]. I got into trouble with the supervisor for suggesting in question time that a reviewer might regard this outcome as "rubbish", even though I was publicly friendly *as* with the student afterwards. Some kind of artefact of the carbon-monoxide technique is the simplest explanation for this and other unphysiological short-term changes in hemoglobin mass [Pottgeisser, T; Gough, C], where high-intensity exercise is involved.

Eight **swimmers** showing left-right **asymmetry** in power of their strokes unfortunately did not show any reduction in asymmetry following 8 wk of **strength training** targeting the weaker side with a rope-pulling ergometer [Hermsdorf, M]. Maybe they need a technique rather than a strength intervention.

Ten weeks of soccer training with the addition of **repeated sprint** sessions improved speed and endurance by ~1-2% and vertical jump by ~5% relative to control soccer training in a randomized trial of 10+10 **elite male soccer** players [Tønnessen, E].

Not surprisingly, **sprint training** improves sprinting in non-elite junior **soccer** players who haven't sprint trained before [Shalfawi, S].

Seventeen elite male **soccer** players "divided" into **strength** vs **interval training** groups for 12 wk of pre-season training experienced similar gains in VO_2max [Rodahl, S].

High-intensity intervals were as effective as continuous running at achieving remarkable ~10% improvements in endurance performance in male elite youth **soccer** players [Hackl, M]. What kind of soft training had these boys been doing before?

Four weeks of **inspiratory muscle training** improved performance of the yo-yo test in a controlled trial of 9+9 elite young male **soccer** players, but the control group wasn't a placebo group, and there were no significant differences in the changes in pulmonary function [Ozgider, C]. Little or no data were shown.

Small-sided games appeared to be better than high-intensity intervals for endurance performance during a competitive season in elite youth **football** [Steffen, A]. Adjustment for baseline performance would have improved the analysis, as would a proper comparison of the treatments.

If I haven't oversimplified the jargon, a qualitative study of two "selected" players from the best under-18 team of each of two Danish **football** clubs provided evidence that **small-group position-specific training** was better than team-based training in creating "opportunities for players to experience three key aspects of social practice: ‘playing upwards’, mirroring older players in training, and the feeling of being recognized by the coach" [Christensen, M]. Yes, but how key is *key*, and how typical were these players?

Finally and importantly, a **systematic review** of the **quality of training studies** in **soccer** reached the conclusion that it was generally poor [Impellizzeri, F]. The presenter recommended setting up a register for controlled trials in sport and exercise science, similar to the register for medical research. I agree: it would raise the standard and reduce publication bias by getting more inconclusive, unclear and non-significant findings into print.

Reviewer's Commentary

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