World Congress of Performance Analysis of Sport XI

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Generic Issues: areas for further research; application of genomics methods; medal-winning enhancements; social network analyses; Olympic performance analysts; limitations of reliability. Basketball: fixture congestion; jump shots; playing styles; 3x3 game. Football/Soccer & Futsal: past and future; fatigue; perturbations; types of goal; defensive control; Golden Ball award; corner kicks; role of international age-group experience; strategies when losing; turnovers; self-organizing maps; penalty kicks; percentiles; Gaelic football. Rugby: case study of performance analysis; performance indicators; strategies. Other Team Sports: badminton, handball, hurling, netball, squash, volleyball, water polo. Non-team Sports: archery, hurdles, javelin, swimming, taekwondo, tennis, transgender performance. KEYWORDS: competition, elite athletes, performance, tests, training.

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The venue for the eleventh biennial conference of the International Society of Performance Analysis of Sport (ISPAS) was the University of Alicante on the sunny Mediterranean coast of Spain. Our hosts made us very welcome, the tapas were terrific, Spanish wine tastes like the real thing in Spain, and winter there felt like summer.

Alicante is dominated by Santa Barbara Castle, an old fort dating back 1000 years to the time of the Arab conquest of the Iberian Peninsula. The climb to the top was rewarded with spectacular views of sea and city, and of a parched hinterland in the grip of a long-term drought. The south of Spain now survives on water piped in from the north, apparently.

I attend conferences in the hope that at least one inspirational idea, method or finding will justify the time, expense and effort of attending (and of writing this report). Here there were two, both addressing the issue of the complex data that come from team sports: the application of genomics analyses to match analyses, and use of self-organizing maps to guide team-sport strategy in real time.

The conference website has links to the program and to videos of the entire morning and afternoon sessions in the main lecture theatre. The abstracts and some keynote slideshows are available via a dropbox, which includes two PDFs (Oral Session IDs, Poster Session IDs) that will allow you to find the abstracts of talks and posters with interesting titles. I have also provided direct links to the abstracts of talks and posters summarized in this article.

I have summarized only those presentations that had an element of performance analysis with a reasonably semantically and statistically clear outcome. I have omitted several presentations focusing only on biomechanics, physiology or psychology. I apologize to those presenters and to any others I have omitted through my failure to understand or value their findings.

Generic Issues

In the opening keynote, Mike Hughes reviewed the past 10 meetings of ISPAS before identifying the following areas for "urgent" **further research**: objective definitions of performance indicators; clarification of the complex statistical procedures in use; attention to issue of "sensitivity" (to smallest important changes) of the measures; and development of more models. He finished with a plea for innovations in gathering and analyzing data, for interpreting rather than just counting actions, for better communication with the coach, and for the ability to listen to others.

You need potentially thousands of variables to characterize performance of all the players throughout a match, but you usually have only

hundreds of observations (e.g., game outcomes). **Genomics** researchers have a similar problem, so their analytical procedures could be useful for performance analysts. Great idea! McInerney

I spoke on the topic of the **magnitudes of performance enhancements** that increase a top athlete's or team's chances of winning more medals. Different approaches to defining and researching the magnitudes are needed in non-interactive sports, interactive non-team sports, and team sports. The slideshow is a minor updated version of my talk at the ICSEMIS conference. Hopkins

In a review of 12 recent studies using **social network analysis**, "increased interactions, such as passes between players, lead to success of a team" and one study showed that "a [more] homogenous distribution of links (passes) is associated with a greater probability of success of the team". Roscillo

If you are a practicing performance analyst, you might like to compare your modus operandi with that of **Olympic and Paralympic analysts**. Nicholls

In a closing keynote, Peter O'Donoghue presented some of his recent work using simulation to show how poor **reliability** (reproducibility) of performance indicators can seriously impact their interpretation. O'Donoghue.

Basketball

In NBA **basketball**, shooting efficacy and chances of winning decrease when fixture congestion results in less than two days between games. Esteves

Several kinds of footwork leading into a jump shot had no significant effect on the successful shooting percentage in eight university-level **basketball** games. But the poster showed the comparison was done non-parametrically, which reduces power and prevents proper estimation of magnitude. Li-Yao

Two independent discriminant functions based on the usual performance indicators collected in **basketball** matches revealed clear differences in the playing styles in African, American, Asian and European championships. González-Espinosa

"In contrast to traditional 5x5 **basketball**, 3x3 competition doesn´t induce fluctuations in heart rate and also, causes more impacts and jumps per minute." Reina-Román

Football/Soccer & Futsal

Nic James gave a keynote in which he reviewed performance analysis of **football**. The game itself has changed from direct play (more shots at goal) to possession-based (more passes). Recent useful metrics include the "high press" (number of passes a team is allowed to make in its own half per defensive action), counter-attacks, and playing styles based on offensive and defensive variables. The future is in data-mining analytics for the big data sets representing movement of all the players in a match and accounting for strategy and tactics.

In a keynote on fatigue in **soccer**, we learned that distance covered in the second half of a game is not consistently down on the distance in the first half, but there is evidence of less high-speed running in the second half. Players also slow up for a few minutes following intense bursts of running. Lago (PDF of full talk)

The notion that certain game actions can be regarded as perturbations leading to unstable states ending potentially in scoring is still a promising work in progress in **soccer**. Kim

The types of goals scored did not differ between winners and losers in 63 qualifying matches in the Spanish **futsal** league. Agras

I could not understand a potentially important abstract on factors affecting goal-scoring in **soccer** when the opposition exhibits low defensive control. Tenga

If the usual player performance indicators in **soccer** really do measure performance, players' mean values ought to have reasonable correlations with the number of times the players have been nominated for the Golden Ball award. The abstract seems to have some ambiguous results, but the positive correlates were number of goals, shots, dribbles, thrown penalties and passes. Prieto-Ayuso

In a study of 750 long corner kicks in the English **football** premier league, it was evident that "near post guards play an important role when defending corner kicks, as they regularly perform defensive clearances (31.5% of total corners)." Pulling

The majority (64%) of team members in the European **football** championships had no youth international age-group experience. The authors hint that the football associations should spend less money on youth football. Bacon

See what a survey of 129 professional and semi-professional **futsal** coaches revealed about

strategy when you're near the end of a losing game. Domínguez

In an analysis of turnovers in elite **soccer**, "teams should press high to win turnovers and create scoring opportunities… Immediate player actions after winning the turnover are critical to the outcome." Lovell

Self-organizing maps were touted as a useful way to visualize match performance indicators in **football** World Cups, but I missed the presentation and there are no findings in the abstract. Choi

In a season of Spanish 2nd B Division **soccer**, penalty kicks directed at the top third of the goal are "most effective" (presumably highest rate of success) while those directed at the bottom third are "most used". But all we're given is a chi-squared statistic, and we don't know which direction gives the biggest payoff (frequency×effectiveness). Pérez Aleixandre

Presenting individual-player match performance indicators as percentiles is the right idea, but I can't see how can you develop percentiles with only six **soccer** players. A full mixed-model analysis with a large number of players is required. Guerra Puente

A comprehensive set of performance indicators for **Gaelic football** has been developed. Browne

Rugby

In a qualitative case study of delivery of performance analysis in a professional **rugby** team, "considerable emphasis was placed on the importance of player learning and engagement in the PA process, [but] delivery was often ad hoc, coach-driven and results-focused." Personal relationships were important for effective delivery. Croft

With only eight men's and eight women's matches from the knockout stage of the last **rugby** World Cup in the analysis, the identification of performance indicators that discriminate winning and losing is interesting but a long way from definitive. Barnes

Although 12 out of 30 performance indicators were "significantly different across match outcome" in two seasons of international **rugby** union, apparently only (?) "tackle effectiveness and missed tackles could predict match outcome" in logistic regressions. Why the disparity? Fitzgerald

The findings in a study of strategies in **rugby** union leading to point scoring for the four most successful teams in the last Rugby World Cup are probably useful, but I missed the presentation and I have been unable to understand the abstract. Barnes

A performance score consisting of unspecified weightings of unspecified offensive and defensive actions had different median scores for various player positions and replaced vs non-replaced **rugby** players. Smyth

Other Team Sports

A between-group comparison of gaze behavior with only three athletes in each group (international, senior league, junior) would be a joke, except that there was a lot of repeated measurement and results were so consistent that it changed the advice of **badminton** coaches: rather than watch the shuttle, they now say to watch the racket head. Dednam

The top eight teams at the men's **handball** world championships threw the ball with higher speed in the central position than the bottom eight teams. It looks like there was no significant difference in number and effectiveness of throws, but the abstract appears to be poorly edited, and the use of non-parametric inference makes these findings untrustworthy. Cortés

Not surprisingly, match statistics related to goal shots, technical fouls and steals predicted match outcomes in Olympic women's and men's **handball**. Saavedra Saavedra

An analysis of the defensive retreat in European championship **handball** did not seem to result in recommendation for strategy. Sousa

"**Hurling** teams demonstrating higher skill levels with 'clean' sequences are likely to create more shots and ultimately win more games." Clear

Self-organizing maps have been applied to **netball** games to identify game styles associated with winning and losing and to implement and monitor (with a dashboard interface) strategies to change the style and thereby apparently increase the chance of winning. Groundbreaking! Croft

Differences in passing revealed by network analysis in three "critical" matches in the Commonwealth Games "suggest that tactical approaches differ between the World's top four international **netball** teams." Uncertainty in standardized estimates would be preferable to chi-squared statistics in conveying some sense of magnitude. Butterworth

Knowing the shot and error rates for different

parts of the **squash** court at the international level could be useful, but it seems to me that it needs a sophisticated analysis that accounts for differences between individual players. Ghani

It looks like service points, block points, service errors and attack errors are unsurprisingly important predictors of outcomes in (men's?) world-league **volleyball**, but I can't really understand the abstract. Vicente

Differences in success of attacks between positions might help inform strategy in men's world-championship **volleyball**. Millán-Sánchez

The "set" area and tempo in men's World Championship **volleyball** affected the number of players blocking the attacker, and therefore potentially the success of the attack (although this aspect was not reported). Fernández-Echeverría

There were various significant differences between winning and losing teams in shots at goal in 69 Olympic **water-polo** matches, but it was all done non-parametrically, so there are no magnitudes and the non-significant effects aren't necessarily trivial. Menescardi

Non-team Sports

A six-month **archery**-specific resistance-training program involving rubber bands improved competition scores by 2.9%, whereas a control resistance-training group and a control usual-training (?) group improved by only 1.0% and 0.2% respectively, in this randomized balanced controlled trial of 24 archers with at least 4 y experience. If the data after the "±"signs are standard deviations, the within-athlete competition-to-competition SD was $1.2/\sqrt{2} = 0.8\%$, which makes the specific-training effect very large and, remarkably, the non-specific training effect moderate. Monzoni

On the basis of analysis of the run-up to the first hurdle in the Spanish and world indoor championships, the authors propose use of midpoint marks at 4.65 and 4.55 m for approach run phase for eight-steps **hurdlers**. González Frutos

The authors argued for the use of Kohonen feature maps (a neural-net data-mining technique) to combine various physical tests to predict throwing performance of 35 **javelin** throwers on two occasions separated by 1 y, but the evidence doesn't seem to be presented. Maszczyk

Raúl Arellano presented his long experience of tracking and predicting performance of **swimmers** in a keynote address. There is no abstract. A video is available, but unfortunately the view of the speaker obstructs part of the slides.

Automatic tracking of **swimmers** using eight cameras and algorithms for image recognition appears to estimate split times with high validity. Ruiz-Teba

Even splits is definitely not the way to **swim** 400 m freestyle: the lap times of Kathleen Ledecky, the best of the 20 elite swimmers analyzed here over their competitive careers, displayed the most negative quadratic curvature and the slowest first lap. "There were otherwise no clear associations between ability of the swimmers and the pacing parameters," but up to one-half of the swimmers might improve their times by up to 1% by changing one or more parameters of their pacing profile. Lipinska

Sequences of tactical actions in 75 Olympic male matches of **taekwondo** "can provide an insight for athletes' patterns" but it's not clear how they can inform strategy or tactics. Menescardi

In an analysis of nearly 30,000 points in matches between **tennis** star Novak Djokovic and his opponents, Djokovic's scoring was modified by game status (winning, losing, equal score, breaking opponent and facing break-point) but apparently not by different opponents, rounds, sets or server. It would be good to know how many points need to be analyzed for this approach to provide useful strategies for other players. Cui

Transgender female athletes lose the testosterone advantage after a year or two and end up with age-graded scores (percent of world record for their age) similar to what they had as males. "The data offer further support for the recent IOC decision to allow transgender women to compete against cisgender women in the 2016 Olympics after one year of hormone-replacement therapy." Harper

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