Applications of GPS in rugby union matches and training

World Rugby Science Network Conference 2015

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GPS is here to stay

Investment from football will likely lead to rapid advances in

- Validity and reliability of tracking
- Automation of analysis
- Live tracking applications
Comparison
GPS vs. automated camera systems

GPS
(e.g. GPSports, Catapult)

- Portable (matches and training)
- Use with youth and academy players
- Cost effective relative to camera systems

Semi-automated camera systems
(e.g. Prozone)

- Stadium dependent
- Often home match data only
- Expensive
Absolute vs. subjective speed thresholds

“Individualisation of velocity bands increases the high-speed running attributed to slower players and decreases the high-speed running attributed to faster players.”

Gabbett (2015) JSCR
Absolute vs. relative speed thresholds
Normative data

Journal of Sports Sciences
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http://www.tandfonline.com/loi/rjsp20

The movement characteristics of English Premiership rugby union players
Nicola Cahill a, Kevin Lamb a, Paul Worsfold a, Roy Headey b & Stafford Murray c
a University of Chester, Sport and Exercise Sciences, Chester, UK
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European Journal of Sport Science
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http://www.tandfonline.com/loi/tejs20

Quantifying positional and temporal movement patterns in professional rugby union using global positioning system
Marc R. Jones a,b, Daniel J. West c, Blair T. Crewther d, Christian J. Cook e & Liam P. Kilduff a

Movement and impact characteristics of South African professional rugby union players

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Corresponding author: J C Tee (jasonctee@gmail.com)
Professional rugby match GPS norms

Table 1 - Representative sample of data from professional rugby union match play

<table>
<thead>
<tr>
<th></th>
<th>Forwards</th>
<th>Backs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative distance (m.min(^{-1}))</td>
<td>69 ± 8</td>
<td>69 ± 9</td>
</tr>
<tr>
<td>Maximum speed (m.s(^{-1}))</td>
<td>7.6 ± 1.3</td>
<td>8.8 ± 1.1</td>
</tr>
<tr>
<td>Low-speed distance (m.min(^{-1}) &lt;4m.s(^{-1}))</td>
<td>58 ± 7</td>
<td>56 ± 6</td>
</tr>
<tr>
<td>High-speed distance (m.min(^{-1}) &gt;4m.s(^{-1}))</td>
<td>11 ± 5</td>
<td>14 ± 4</td>
</tr>
<tr>
<td>Repeated high intensity efforts (RHIE)</td>
<td>12 ± 8</td>
<td>6 ± 6</td>
</tr>
</tbody>
</table>


* Significant differences regularly found between players in different positions
Professional rugby training GPS norms

Table 2 – Typical training variables during a 1 week micro-cycle for professional rugby union players

<table>
<thead>
<tr>
<th></th>
<th>Forwards</th>
<th>Backs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total distance (m)</td>
<td>7800 ± 950</td>
<td>9600 ± 1200</td>
</tr>
<tr>
<td>Low-speed distance (m &lt;4.4m.s⁻¹)</td>
<td>6950 ± 900</td>
<td>7900 ± 1300</td>
</tr>
<tr>
<td>High-speed distance (m &gt;4.4m.s⁻¹)</td>
<td>850 ± 350</td>
<td>1550 ± 500</td>
</tr>
<tr>
<td>Repeated high intensity efforts (RHIE)</td>
<td>19 ± 8</td>
<td>15 ± 10</td>
</tr>
</tbody>
</table>


* Significant differences regularly found between players in different positions
Variability of physical performance and player match loads in professional rugby union

Shaun J. McLaren\textsuperscript{a}, Matthew Weston\textsuperscript{a}, Andrew Smith\textsuperscript{b,c}, Rob Cramb\textsuperscript{d}, Matthew D. Portas\textsuperscript{a,}\textsuperscript{*}

<table>
<thead>
<tr>
<th>Absolute physical performance</th>
<th>Within-player CV (%)</th>
<th>Between-player CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD (m)</td>
<td>10.0; ±2.1</td>
<td>5.5; ±1.5</td>
</tr>
<tr>
<td>LSR (m)</td>
<td>8.7; ±1.9</td>
<td>2.2; ±5.3</td>
</tr>
<tr>
<td>HSR (m)</td>
<td>27.6; ±6.9</td>
<td>16.5; ±5.1</td>
</tr>
<tr>
<td>VHSR (m)</td>
<td>68; ±19</td>
<td>58; ±63</td>
</tr>
<tr>
<td>TI (n)</td>
<td>24.0; ±5.9</td>
<td>15; ±16</td>
</tr>
<tr>
<td>RHIE (n)</td>
<td>18.7; ±4.4</td>
<td>16; ±12</td>
</tr>
</tbody>
</table>

Forwards

<table>
<thead>
<tr>
<th>Absolute physical performance</th>
<th>Within-player CV (%)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>TD (m)</td>
<td>10.8; ±2.1</td>
<td>6.7; ±4.7</td>
</tr>
<tr>
<td>LSR (m)</td>
<td>10.1; ±2.0</td>
<td>6.1; ±4.4</td>
</tr>
<tr>
<td>HSR (m)</td>
<td>20.1; ±4.1</td>
<td>32; ±19</td>
</tr>
<tr>
<td>VHSR (m)</td>
<td>34.1; ±7.5</td>
<td>19; ±17</td>
</tr>
<tr>
<td>TI (n)</td>
<td>36.4; ±7.9</td>
<td>39; ±22</td>
</tr>
<tr>
<td>RHIE (n)</td>
<td>39.5; ±8.8</td>
<td>47; ±31</td>
</tr>
</tbody>
</table>

Backs
Reasons for large variability

Reliability of measurement

• At low-speeds (<4m.s\(^{-1}\)) GPS units display adequate reliability (CV < 3.0%)
• At high-speeds (>4m.s\(^{-1}\)) data “interpreted with caution” (CV 5 – 20%, depending on model)

Game related factors

• Ambient conditions
• Opposition
• Match situation
• Contact
Contact

Increased contact leads to reduced total and high intensity running distance during game play – Johnston et al., (2014) JSCR
Match applications - pacing

Total distance covered

* indicates significant difference between backs and forwards, # indicated significant different from all other match periods. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) respectively.
Match applications - pacing

High-intensity distance covered

High Intensity Distance (m/min)

1st Half 2nd Half

Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4

T T M S V L S M T

* indicates significant difference between backs and forwards, # indicates significant different from match period 2nd half Q4. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) respectively.

Tee (PhD Thesis)
Match Applications – fatigue profile

Pacing strategies of rugby union forwards and backs

<table>
<thead>
<tr>
<th>Pacing profile</th>
<th>Forwards</th>
<th>Backs</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Slow positive”</td>
<td>“Flat”</td>
<td></td>
</tr>
</tbody>
</table>
Match Applications – effect of substitutes

* indicates significant difference between whole game players and substitutes. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) respectively.
Match applications –

Measuring exertion

- Determine fatigue and modify recovery protocols
- Determine metabolic power (kJ/kg)
- Estimate energy expenditure adequate energy replacement

Determining physical demands at various standards of play
Physical Demands of Competition

- Average Demands
  - Work:rest ratio ~ 1:5
  - ~100-120 m/min

- Worst Case Scenario
  - Work:rest ratio ~3:1
  - ~160 m/min
  - Repeated-High-Intensity Effort Bouts

- Train for the average demands → under-prepared for the most demanding passages of play
## Maximum match demands

Table 2 - Maximum observed values for movement variables during match play and percentage difference from average match play values for five positional groups.

<table>
<thead>
<tr>
<th></th>
<th>Tight Forwards</th>
<th>Loose Forwards</th>
<th>Scrumhalves</th>
<th>Inside Backs</th>
<th>Outside Backs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative distance</td>
<td>81 (15%)</td>
<td>86 (25%)</td>
<td>99 (23%)</td>
<td>86 (26%)</td>
<td>78 (17%)</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>9.9 (36%)</td>
<td>10.8 (35%)</td>
<td>9.2 (15%)</td>
<td>9.4 (18%)</td>
<td>11.3 (20%)</td>
</tr>
<tr>
<td>Walking distance</td>
<td>45 (33%)</td>
<td>45 (47%)</td>
<td>41 (15%)</td>
<td>43 (17%)</td>
<td>41 (16%)</td>
</tr>
<tr>
<td>Jogging distance</td>
<td>39 (35%)</td>
<td>33 (37%)</td>
<td>33 (31%)</td>
<td>28 (36%)</td>
<td>25 (41%)</td>
</tr>
<tr>
<td>Striding distance</td>
<td>11 (59%)</td>
<td>20 (75%)</td>
<td>25 (53%)</td>
<td>14 (56%)</td>
<td>15 (71%)</td>
</tr>
<tr>
<td>Sprinting distance</td>
<td>1.5 (198%)</td>
<td>4.8 (128%)</td>
<td>5.8 (85%)</td>
<td>9.1 (276%)</td>
<td>7.3 (87%)</td>
</tr>
<tr>
<td>Sprint frequency</td>
<td>1 every 10 minutes (246%)</td>
<td>1 every 4 minutes (175%)</td>
<td>1 every 4 minutes (69%)</td>
<td>1 every 3 minutes (213%)</td>
<td>1 every 4 minutes (73%)</td>
</tr>
<tr>
<td>Acceleration frequency</td>
<td>1 every 7 minutes (86%)</td>
<td>1 every 3 minutes (159%)</td>
<td>1 every 3 minutes (41%)</td>
<td>1 every 2 minutes (185%)</td>
<td>1 every 3 minutes (63%)</td>
</tr>
</tbody>
</table>

Data from Tee et al., GPS comparison of training activities and match demands of professional rugby union, International Journal of Sport Science and Coaching (In press)
Determining training specificity

Figure 1 - Magnitude of differences between match exertions and common training activities

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Diversity of Physical Requirements

There is a **diversity of skills and positional requirements** among rugby players.

To ensure quality conditioning and recovery programs, it is essential to understand the **physical demands placed on players in different positions**.

@JasonCTee #RSN2015
Training for positional specificity

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Training for positional specificity

Scrumhalf training activity and match comparison

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Training for positional specificity

Outside back training activity and match comparison

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Thanks for listening!

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