# The effectiveness of repeated sprint training to enhance international rugby league player fitness and performance: A case report

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Case Study | Repeated Sprint | Rugby League | Elite level

## Headline

The physiological demands of Rugby League (RL) are complex and position specific (1). Players' must be fast, powerful and agile, whilst maintaining a highly developed maximal aerobic capacity (2,3). The full-back position covers the greatest total (≈6800m) and high-speed running distances (583 m) during match-play (4). Given these physical prerequisites, this case-report documents the effectiveness of a two-week, repeated-sprint training (RST) micro-cycle to supplement the normal training regime of a male, semi-professional full-back prior to a major international tournament.

**Aim.** The substantial number (n = 9 [37%]) of part-time professional RL players selected within one squad for a major international tournament (2016 Rugby League Four Nations) against full-time professional players, implies that there is a likely a problem and, or deficit to in training status to be resolved. Therefore, the necessity for a short-term, supplementary training intervention which has the capacity to enhance multiple components of player physical fitness and match-play performance characteristics, which can run concurrently with part-time players' regular domestic club training regime is of relevance and desirable. Consequently, the primary aim of this case-report was to explore and present the effectiveness of implementing a two-week RST intervention to enhance discrete physical fitness and match-play characteristics during the lead in phase of a major RL international tournament.

## Methods

**Athletes.** One male, international, semi-professional RL full-back player (Age: 23.4 yrs.; Stature: 175 ± 0.6 cm; Body-mass: 83 ± 0.6 kg) completed a two-week RST intervention during the end of the last trimester of his domestic Championship season (June to September 2016), preceding the 2016 Rugby Football League (RFL) Four Nations international competition. Given its time-efficient design and ability to enhance multiple components of fitness concurrently (5), the RST was specifically selected to supplement the players' part-time, domestic training (concurrent gym based conditioning and field based technical work three times weekly) to prepare the player to compete with his full-time, professional counterparts. Informed consent was given by local board of ethics for this study and conforming to the Code of Ethics of the World Medical Association (Declaration of Helsinki) (6).

**Design.** *Pre and post field based testing procedures.* Anthropometric (stature, seated height and body-mass) measures were taken in a rested state, followed by physical movement skill tests (vertical counter movement jump (CMJ), 5-0-5 agility and linear sprints). The players' explosive leg power was measured using a CMJ on a digital contact-mat (SmartJump©, Fusion Sport, Cooper Planes, Australia), according to previously outlined procedures (7). Interspaced by 3 minutes passive recovery, the players' agility (5-0-5 agility test (7)), 10, 20 and 30 m sprint times were recorded using infrared digital timing gates (Brower Timing System, Salt Lake City, Utah, U.S.A). The player performed each test three times with the best time retained for analysis. To individualise the players match running speed thresholds (8), the player performed a graded, motorised treadmill test to volitional exhaustion to identify his running velocity (v) achieved at the second ventilatory threshold (vVT2) and maximal aerobic capacity ($VO_{2max}$) (see Hunter, Bray, Towlson, et al. (8)). The players' anaerobic speed reserve (ASR) was then determined as velocity at $VO_{2max}$ minus the players estimated maximal sprint speed (MSS) recorded during the 30-m sprint field test. The ASR, therefore represented the functional limits of the players endurance and sprint capacities (9).

*Locomotor activities.* Given the notion that an individualised approach for the determination of GPS speed thresholds might better represent a players dose-response to exercise (8), the speed values were used to individualise the players GPS speed thresholds that equated to low (0.0 to 16.5 $km \cdot h^{-1}$), high (16.6 to 17.2 $km \cdot h^{-1}$), very high (17.3 to 21.9 $km \cdot h^{-1}$) speed running and sprinting (22.0 to 33.0 $km \cdot h^{-1}$) bandings. Subsequent match-play analysis (8) was completed across 11 (pre RST: n = 6; post RST: n = 5) full, RFL Championship matches over a 10 week period using a Micro-Electro-Mechanical System (MEMS) device (Minimax S4, Catapult Sports, Melbourne, Australia).

*Two-week repeated-sprint training (RST) intervention.* Wearing a MEMS device to ascertain sessional PlayerLoadTM ((AU) Figure 1), the player completed a RST intervention three times a week, for two weeks, (Tuesday, Thursday and Friday), which supplemented the players' normal, part-time RL weekly training regime. As per Taylor, Macpherson, McLaren, et al. (5), the player completed three sessions per week (interspaced by 24 hours) that consisted of three (week one) and four sets (week two (except for session four due to player constraints)) of 7 x 30 m timed (Brower Timing System, Salt Lake City, Utah, U.S.A) maximal sprints over the entire course of the RST training intervention (Figure 1). After each training session, the player provided session ratings of perceived exertion (sRPE) (10) (Figure 1).

**Statistical analysis.** Using a custom-made spreadsheet (11) (see accompanying spreadsheet), changes in fitness and match running were assessed against the smallest worthwhile change (SWC) and typical error (TE). Subsequent percent chances of improvement were then interpreted using the following scale: 25–74.9% possibly; 75–94.9% likely; 95–99.4% very likely; ≤ 99.5% most likely (12). All SWC values for pre and post fitness tests were established by multiplying the between-player standard deviation (SD) calculated for values derived from unpublished test-re-test reliability data (See Table 1) by 0.2

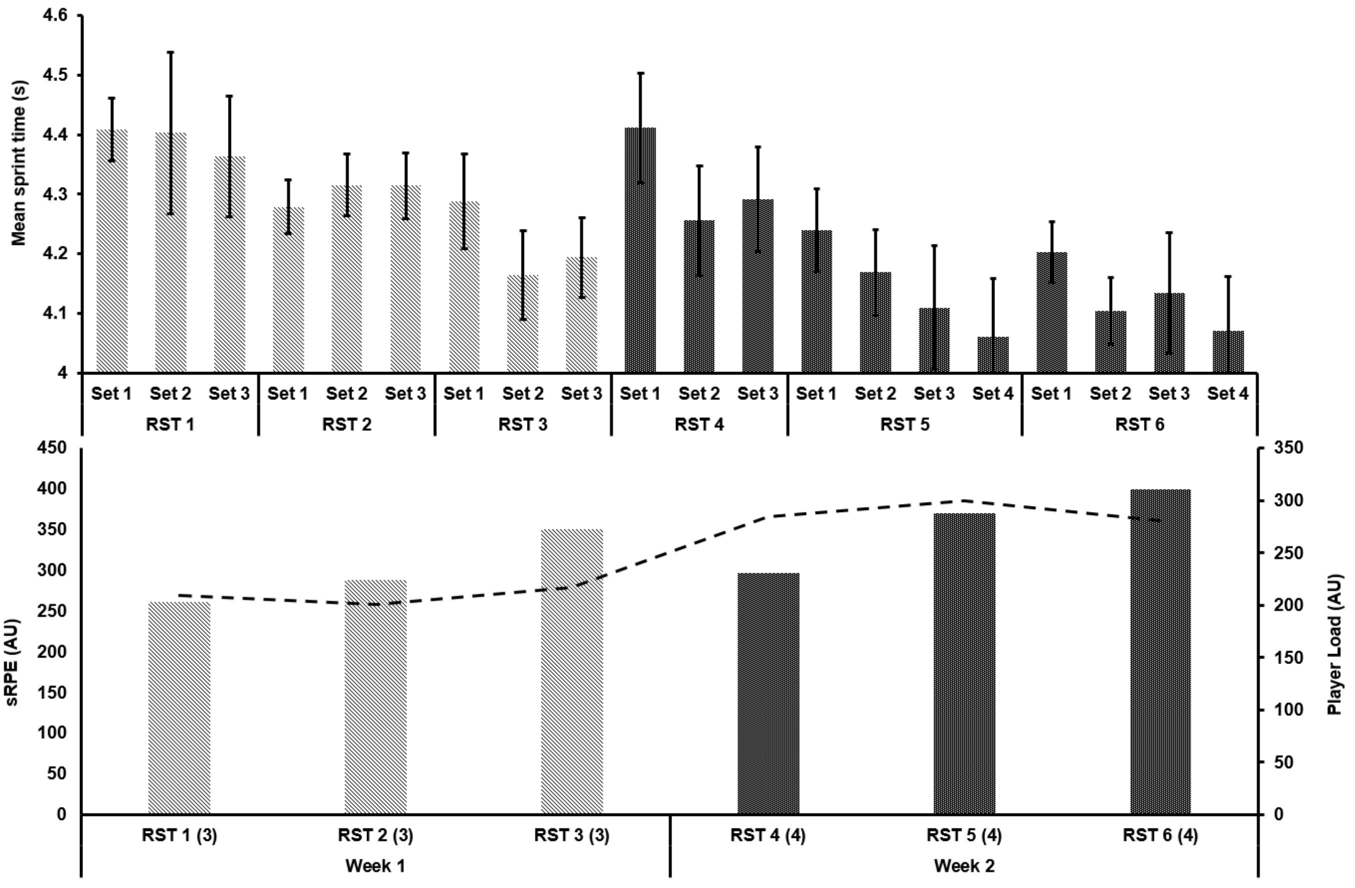


**Fig. 1.** Figure 1. Players mean (SD) sprint time (top) and associated sessional ratings of perceived exertion (sRPE [AU]) and PlayerLoadTM (AU) (dashed) according to chronologically ordered repeated-sprint training (RST) sessions (and sets) over a 2-week period (Grey bars = Week 1;Black bars = Week 2)

**Table 1. Players pre and post repeated-sprint training (RST) physical fitness test scores, accompanied by absolute and relative (%) changes in performance parameters, smallest worthwhile (SWC), typical error (TE) and practical significance of a true positive change (>SWC) occurring.**

| **Parameter** | Pre RST | Post RST | SWC | TE | Absolute Change (%) | *Qualitative* |
|---|---|---|---|---|---|---|
| ∗**Agility (s)** | 2.37 | 2.16 | 0.08 | 0.17 | -0.21 (-8.9) | *Possible* ↑ |
| ∗**30 m (s)** | 4.02 | 3.93 | 0.02 | 0.08 | -0.09 (-2.2) | *Possible* ↑ |
| ∗**20 m (s)** | 2.90 | 2.81 | 0.06 | 0.08 | -0.09 (-3.1) | *Possible* ↑ |
| ∗**10 m (s)** | 1.69 | 1.65 | 0.03 | 0.08 | -0.04 (-2.4) | *Possible* ↑ |
| ∗**CMJ (cm)** | 49.9 | 50.9 | 0.6 | 2.0 | 1.0 (2.0) | *Possible* ↑ |
| ∗∗**VO2max (mL·kg$^{-1}$·min$^{-1}$)** | 47.25 | 50.35 | 1.50 | 3.10 | 3.1 (6.6) | *Possible* ↑ |

SD, standard deviation; CMJ, Counter Movement Jump; VO2max, Maximal oxygen consumption; SWC, Smallest Worthwhile Change; TE, Typical error. ↑, fitness improvement.
SWC and TE data is based upon repeat measures (interspaced by 7 days) of ∗40 academy (age: 13.5 ± 1.5yr; body-mass: 49.2 ± 10.3 kg; stature: 160.8 ± 11.1) soccer players and ∗∗21 normal healthy adults (age: 38.1 ± 7.1 yr.; body-mass: 70.1 ± 7.8 kg; stature: 174.0 cm ± 6.7 cm).

(12). The TE was calculated as the between-trial SD divided by squared root of two. This method was then modified for the match-play variables, whereby MEMs data derived from the players pre RST matches (n = 6) were used to establish the SWC and TE for match-play metrics (12). The TE for these metrics was determined as the pre-RST SD divided by the square root of the number of pre RST matches (n = 6). Percentage change was used to report variations in the play-

**Table 2. Summary table of the eight selected GPS metrics to monitor the players match-play performance before (6 match mean [SD]) and after (5 match mean [SD]) two weeks of RST according to the first- and second-half's of match-play, accompanied by absolute and relative (%) change in GPS metrics, smallest worthwhile change (SWC), typical error (TE) and practical significance of a true positive change (>SWC) occurring.**

| GPS and MEMs device metrics | Mean (SD) Pre RST | Mean (SD) Post RST | SWC | TE | Absolute Change (%) | *Qualitative* |
|---|---|---|---|---|---|---|
| **First Half** | | | | | | |
| Total distance covered (m) | 4406.5 (297.6) | 4270.2 (426.6) | 59.5 | 121.5 | -136.3 (-3.1) | *Possible* ↓ |
| Total high speed distance (m) | 448.5 (56.4) | 507.6 (144.0) | 11.3 | 23.0 | 59.1 (13.2) | *Likely* ↑ |
| Total relative distance (.min$^{-1}$) | 91.7 (10.9) | 95.0 (9.9) | 2.2 | 4.4 | 3.3 (3.6) | *Possible* ↑ |
| Total relative high intensity running (%) | 10.2 (1.3) | 11.8 (2.9) | 0.3 | 0.5 | 1.6 (3.1) | *Likely* ↑ |
| Maximum velocity (km·h$^{-1}$) | 28.4 (3.2) | 25.9 (3.2) | 0.6 | 1.3 | -2.5 (-9.4) | *Likely* ↓ |
| No of RHIE (n) | 9.8 (5.7) | 8.4 (1.5) | 1.1 | 2.3 | -1.4 (-13.8) | *Possible* ↓ |
| PlayerLoadTM (AU) | 429.7 (11.7) | 412.7 (39.1) | 2.3 | 4.8 | -17.0 (-3.9) | *Very Likely* ↑ |
| Relative PlayerLoadTM (AU.min$^{-1}$) | 8.8 (0.4) | 9.2 (0.8) | 0.1 | 0.2 | 0.4 (4.4) | *Likely* ↑ |
| **Second Half** | | | | | | |
| Total distance covered (m) | 4386.8 (449.1) | 4551.2(216.1) | 89.8 | 182.3 | 164.5 (3.7) | *Possible* ↑ |
| Total high speed distance (m) | 488.5 (141.5) | 559.6 (103.3) | 28.3 | 57.8 | 71.1 (14.6) | *Possible* ↑ |
| Total relative distance (.min$^{-1}$) | 89.7 (7.1) | 89.0 (6.5) | 1.4 | 2.9 | -0.7 (-0.8) | *Possible* ↓ |
| Total relative high intensity running (%) | 11.2 (3.1) | 12.3 (2.6) | 0.6 | 1.3 | 1.2 (10.7) | *Possible* ↑ |
| Maximum velocity (km·h$^{-1}$) | 28.4 (3.2) | 30.6 (2.5) | 0.6 | 1.3 | 2.1 (7.6) | *Likely* ↑ |
| No of RHIE (n) | 11.0 (3.4) | 9.2 (3.1) | 0.7 | 1.4 | -1.8 (16.4) | *Possible* ↓ |
| PlayerLoadTM (AU) | 413.8 (37.8) | 437.4 (27.4) | 7.6 | 15.4 | 23.6 (5.7) | *Possible* ↑ |
| Relative PlayerLoadTM (AU.min$^{-1}$) | 8.4 (0.8) | 8.6 (1.0) | 0.2 | 0.3 | 0.1 (1.5) | *Possible* ↑ |

RHIE = Repeated high intensity exercise; AU = Arbitrary units; SWC = smallest worthwhile change; TE = Typical error.

ers' pooled (week one versus week two) mean (SD) sprint time, sRPE (AU) and PlayerLoadTM during the RST intervention.

## Results

There was a progressively, increasing pattern between the players mean repeated-sprint time, PlayerLoadTM and sRPE across the two week RST intervention (Figure 1). Mean repeated-sprint time showed a 2.6% decrease whilst sRPE increased by 18.3% across weeks one and two, respectively (Figure 1). Pre and post RST physical fitness and match-play characteristics (accompanied by absolute and relative (%), SWC, TE and practical significance of a true positive change (>SWC) occurring are presented in tables 1 and 2, respectively.

## Discussion

This case-report has shown that the RST was a time-efficient intervention can be successfully delivered to supplement a part-time, semi-professional RL players pre-existing training regime, in preparation for a major international tournament, competing against full-time, professional opponents. Although only statistically possible, the studied player showed improvements across all of the tested fitness attributes, and subsequently outperforming the Australian National Rugby League (NRL) benchmark data for timed agility (-2.7%), 10 m sprint (-4.1%), 20 m sprint (-16.9%) and VO2 max (16.3%) (7). However, given the possible practical significance of these improvements, it remains unresolved to what extent the RST directly contributed to improvements in all of the tested physical fitness characteristics considered important for an international RL full-back player.

The effects on physical match performance were inconsistent and likely reflective of the inherent variation observed in a small sample of time-motion analysis data (13). That said, match-play analyses showed that total high speed running distance and percentage of high intensity running demonstrated (*possible-likely*) improvements (3.1 to 14.6%) across the entire match-play. With substantial *likely* improvements determined for maximum velocity (7.6%) in the second-half that surpassed the thresholds set for SWC. Unsurprisingly, resulting in greater (*likely* to *very likely*) PlayerLoadTM for both the first (3.9%) and second (5.7%) halves of match-play following the RST, respectively. However, broader inferences pertaining to the effectiveness of the RST intervention are limited to the individual, studied athlete. The players' sRPE became progressively higher for each RST session. Such patterns may well signify that this type of high volume and high intensity training might contribute negative physiological effects and therefore likely sustainable for short microcycles of training, before posing a possible enhanced risk of the player suffering a fatigued related, non-contact injury or symptoms of overtraining (14).

## Practical Applications

- The supplementary RST, demonstrated a possible ability to improve multiple components of international rugby league players' fitness and *possible-likely* improvements is match-play high-speed running metrics across a two-week microcycle.
- The individualised approach taken for determining match-play speed thresholds was justified at the time of data collection. That said, given the practical nature of this journal platform, practitioners should also consider the recent work by Scott and Lovell (15)

## Limitations

- The single case nature of this report prevents inferences being made to anyone other to than the studied player.
- It is acknowledged that the SWC and TE values used for the statistical analyses of the pre and post fitness tests are regarded as a limitation, given the nature of the sample from which they were taken from (See Table 1).

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