

*FACTORS AFFECTING PERFORMANCE IN
PROFESSIONAL RUGBY LEAGUE*



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"Doctors and scientists said breaking the four-minute mile was impossible, that one would die in the attempt. Thus, when I got up from the track after collapsing at the finish line, I figured I was dead."

Roger Bannister

DECLARATION

I certify that the work contained in this thesis has not been previously submitted either in whole or in part for a degree at the University of Technology, Sydney or any other tertiary institution.

I also certify that the thesis has been written by me, Thomas Kempton. Any help that I have received in my research work and in the preparation of this thesis has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Production Note:

Signature removed prior to publication.

Thomas Kempton

5 February, 2016

Date

PREFACE

This thesis for the degree of Doctor of Philosophy is in the format of published or submitted manuscripts and abides by the 'Procedures for Presentation and Submission of Theses for Higher Degrees – University of Technology, Sydney; Policies and Directions of the University'. All manuscripts included in this thesis are closely related in subject matter and form a cohesive research narrative.

Based on the research design and data collected by the candidate, five manuscripts have been accepted for publication and a further two have been submitted in peer-reviewed journals. These papers are initially brought together by an *Introduction*, which provides background information, defines the research problem and the aim of each study. A *Literature Review* then follows to provide an overview of previous knowledge regarding physical, technical and tactical components of rugby league match performance. The body of the research is presented in manuscript form (*Chapter Three to Chapter Nine*), in a logical sequence following the development of research ideas in this thesis. Each manuscript outlines and discusses the individual methodology and the findings of each study separately. The *General Discussion* chapter provides an interpretation of the collective findings, makes some practical recommendations and acknowledges the limitations from the series of investigations that comprise this thesis. Finally, a *Summary and Recommendations* chapter presents the conclusions from each project and directions for future research to build on the findings of this thesis are suggested. The APA 6th reference style has been used throughout the document and the reference list is at the end of the thesis.

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LIST OF ARTICLES SUBMITTED FOR PUBLICATION

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- **Kempton, T.**, & Coutts, A.J. (2015). Factors affecting exercise intensity in professional rugby league match-play. *Journal of Science and Medicine in Sport*, *in press*. Doi:
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- **Kempton, T.**, & Coutts, A.J. (2015). Technical performance indicators related to winning professional rugby league matches. *Journal of Sports Sciences*, *in review*.
- **Kempton, T.**, Sirotic, A., & Coutts, A.J. (2015). An integrated analysis of match-related fatigue in professional rugby league. *Journal of Sports Sciences*, 33(1), 39-47.
- **Kempton, T.**, Sirotic, A., & Coutts, A.J. (2015). A comparison of physical and technical performance profiles between successful and less-successful professional rugby league teams. *International Journal of Sports Physiology and Performance*, *in review*.

ABSTRACT

Rugby league is a physically demanding, high-intensity team sport that is played professionally in several countries worldwide. In addition to high physical demands – which are characterised by high speed running, rapid accelerations and frequent collisions – rugby league players also require specific technical and tactical competencies during match-play. A conceptual model of performance for team sports has been proposed where match outcome is considered as the overall performance indicator, and it is thought to be contingent on three key constructs; technical, tactical and physical performance. This thesis contains seven independent studies which develop this conceptual model and investigate the factors that affect match performance in rugby league. *Study One* investigated the typical variability and smallest worthwhile changes in common performance indicators. These findings have implications for determining sample size, identifying reliable performance measures and selecting appropriate time periods for future applied studies that involve observational match analysis. The *second study* examined the independent effects of match-related and individual player characteristics on running performance in professional rugby league matches. There was a complex interplay of factors affecting match-running performance in rugby league. The results underline the importance of considering contextual factors when analysing rugby league match-activity profiles. The next three studies developed rugby league specific causal indicators of both physical, tactical and technical performance constructs. *Study Three* adopted a new “metabolic power” approach for analysing time-motion data which considers the cost of accelerated running efforts. The results showed that the analysis of metabolic power may complement traditional speed-based classifications and improve our understanding of the demands of rugby league match-play. *Study Four* estimated the expected point value for starting possessions in different field locations during rugby league match-play and calculated the mean expected points for each subsequent play during the possession. The results showed that possessions commencing close to the opposition’s goal line had the highest expected point equity, which decreased as the location of the possession moved towards the team’s own goal line. The expected point values framework from the model has applications for informing playing strategy and assessing individual and team performance in professional rugby league. *Study Five* examined the variability and association with the probability of winning for technical performance indicators over 384 matches from two National Rugby League seasons. This study identified important technical performance indicators related to winning rugby league matches which can be used to guide match analyses, and inform playing and training strategies. The *Sixth study* examined the changes in external outputs, including metabolic power variables, and internal response whilst considering contextual factors on physical performance variables during rugby league match-

play. The results showed temporal changes in physical performance, heart-rate response and collisions during rugby league match-play, although these are affected by contextual factors. *Study Seven* compared a range of physical, tactical and technical performance parameters between a successful and a less-successful rugby league team to determine which performance constructs are most related to winning. There were differences in physical and technical performance indicators between the two teams, with the successful team performing less running and fewer collisions but superior technical performance during the match. This thesis examined the physical, tactical and technical constructs of match performance in professional rugby league. It demonstrated that these constructs are often variable and contextual factors need to be considered when analysing match profiles. Indeed, valid and reliable parameters are required to represent the respective performance constructs when assessing overall match performance. Further, the validity of performance measures can be established by demonstrating their relationship with successful match performance. However, increased physical output is not associated with either winning individual matches or obtaining a high final competition ranking; rather, technical proficiency is likely a more important determinant of success in professional rugby league.

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LIST OF ABBREVIATIONS AND ACRONYMS

$\%HR_{\text{peak}}$	Percentage peak heart rate
χ^2	Chi square
ANOVA	Analysis of variance
$b \cdot \text{min}^{-1}$	Beats per minute
CI	Confidence interval
CV	Coefficient of variation
ES	Effect size
ESL	European Super League
GPS	Global positioning satellite
HSR	High-speed running
HSR:Trimp	High-speed running:training impulse ratio
HP	High-power
Hz	Hertz
ICC	Intra-class correlation coefficient
kg	Kilograms
$\text{kJ} \cdot \text{kg}^{-1}$	Kilojoules per kilogram
$\text{km} \cdot \text{h}^{-1}$	Kilometres per hour
LPM	Local position measurement
LSR	Low-speed running
m	Metres
m^2	Metres squared
min	Minutes
$\text{m} \cdot \text{min}^{-1}$	Metres per minute
$\text{m} \cdot \text{s}^2$	Metres per second squared
MRS	Maximal running speed
NRL	National Rugby League

NSW Cup	New South Wales Cup
NYC	National Youth Competition
P_{met}	Average metabolic power
r	Pearson's correlation coefficient
RHIE	Repeat high-intensity efforts
RMSE	Root-mean-square error
Q Cup	Queensland Cup
s	Seconds
SD	Standard deviation
SWC	Smallest worthwhile change
TD:TRIMP	Total distance:training impulse ratio
TRIMP	Training impulse
VHSR	Very high-speed running
$W \cdot \text{kg}^{-1}$	Watts per kilogram
y	Years
Yo-Yo IRT1	Yo-Yo Intermittent Recovery Test Level 1

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