

# A comparison between the acute effects of different recovery techniques on the mood states of university-level rugby players

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Dissertation submitted in fulfilment of the requirements for the degree *Magister Scientiae* in *Sport Science* at the Potchefstroom Campus of the North-West University

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# Acknowledgments

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“Not by might, nor by power but by My Spirit”, says the Lord (Zachariah 3). Thank you Abba Father.

I dedicate this thesis to my loving parents, Theo and Erika van Rensburg, to whom I will forever be grateful for the opportunity they provided for me to get an education. Thank you, Mom and Dad. I thank my ever-supportive and inspiring husband, Wouter van der Bijl, who believes in life-long learning and encourages me to live life to the full.

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I thank my friends and colleagues for all their love, interest, encouragement and understanding throughout this study.

# Declaration

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This dissertation serves as a fulfilment of the requirements for the degree Magister Scientiae in Sport Science at the Potchefstroom campus of the North-West University. The co-authors of the two articles that form part of this dissertation, Prof. Ankebé Kruger (supervisor and co-author), Prof. Ben Coetzee (co-supervisor and co-author) and Prof. Johan Potgieter (assistant supervisor and co-author), hereby give permission to the candidate, Mrs Erika van der Bijl (née Van Rensburg), to include the two articles as part of a master's dissertation. The contribution (advisory and supportive) of these three co-authors was kept within reasonable limits, thereby enabling the candidate to submit this dissertation for examination purposes.

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# Summary

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## **A comparison between the acute effects of different recovery techniques on the mood states of university-level rugby players.**

Rugby union training and match-play are physiologically and psychologically very demanding and the execution of post-exercise recovery techniques in players' training regimes are therefore necessary to aid in the physiological and psychological restoration of athletes' training and performance abilities. However, despite numerous research findings with regard to the efficiency of especially cold water immersion (CWI), contrast water therapy (CWT) and passive recovery (PAR) on the physiological recovery of athletes post-exercise, only a limited number of researchers have examined the possible benefits of these recovery techniques on the psychological recovery of athletes. Consequently, the objectives of this study were firstly to determine the difference between the acute effects of CWI and PAR on the mood states (anger, confusion, depression, fatigue, tension and vigour) and the energy index of university-level rugby players post-exercise, and secondly to determine the difference between the acute effects of CWT and PAR on the mood states and the energy index of university-level rugby players post-exercise.

Twenty-three under/21 university-level rugby players (age  $20.1 \pm 0.41$ ) of a South African university club voluntarily participated in this study. The players were randomly divided into a control group (PAR) and an experimental group (CWI or CWT). Participants completed the Stellenbosch Mood Scale (STEMS) questionnaire over four time periods: during the morning (baseline); before completion of a high-intensity anaerobic training session (pre-anaerobic); after completion of a high-intensity anaerobic training session of 15 minutes (post-anaerobic) and after completion of a 20-minute recovery session (post-recovery). Blood lactate measurements were also taken 3 minutes after completion of the anaerobic session. To test the first objective, the experimental group completed 20 minutes of CWI, whereas the control group recovered passively for the same time period. For the purpose of the second objective, the experimental group completed 20 minutes of CWT, whereas the control group recovered passively for the same time period.

Although the dependent *t*-test and effect size results of the first study showed that the experimental group (CWI) experienced no significant changes from the pre-anaerobic to post-recovery time periods for any of the STEMS subscale values or the energy index, the control group's (PAR) confusion, depression and tension subscale values decreased significantly ( $p < 0.05$ ) from the pre-anaerobic to the post-recovery time periods. Despite these changes, the one-way between groups' analysis of covariance (ANCOVA) revealed no significant differences, except for the vigour subscale, which obtained a medium practical significant increase [Effect size (ES) = 0.65] for the experimental compared to the control group when the pre-anaerobic and post-recovery changes in the STEMS subscale and energy index values between groups were compared.

The dependent *t*-test and effect size results of the second study indicated that neither the experimental (CWT) nor the control group (PAR) experienced significant changes from pre-anaerobic to post-recovery time periods for any of the STEMS subscale or energy index values. However, the ANCOVA revealed that the experimental group showed a statistically significant higher value for the vigour subscale ( $p = 0.05$ ) when compared to the control group. In addition, for vigour, the experimental group recorded a large practically significant higher value (ES = 0.92) for vigour as well as a large practically significant lower value for fatigue (ES = 0.88) compared to the control group.

To the researchers' knowledge, this was the first study to compare the efficacy of CWI, CWT and PAR on the recovery of athletes' STEMS-derived mood states. Previous studies mainly focused on perceived fatigue, muscle soreness, Profile of Mood States- (POMS-) derived mood states and rate of perceived exertion (RPE) when investigating psychological recovery in athletes. However, despite the uniqueness of this study, results showed that when compared to PAR, CWI and CWT did not aid more in the acute psychological recovery of university-level rugby players' mood states. Vigour was the only mood state subscale for which both the CWI and CWT groups showed a practical or statistically significant higher value compared to the PAR group, while fatigue obtained a higher practical significant value for only CWT when compared to PAR. Therefore, although the study results support the use of CWI and CWT to alleviate vigour and fatigue post-exercise when compared to PAR, further research is required to gain understanding into the psychological mechanisms of both CWT and PAR, with an emphasis on knowledge and information in recovery of mood disturbances after exercise.

**Keywords:** cold water immersion; contrast water therapy; passive recovery; psychological recovery; rugby union

# Opsomming

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## **'n Vergelyking tussen die akute uitwerking van verskillende hersteltegnieke op die gemoedstoestand van universiteitsvlak-rugbyspelers.**

Rugby-unie-oefening en kompetisiedeelneming is fisiologies en psigologies baie veeleisend en die uitvoering van na-oefening-hersteltegnieke in spelers se oefenroetines is daarom nodig ter ondersteuning van die fisiologiese en psigologiese herstel van atlete se oefen- en kompetisiedeelnemingsvermoë. Ten spyte van verskeie navorsingsbevindinge met betrekking tot die effektiwiteit van spesifiek kouewater-onderdompeling (KWO), kontrasterende waterterapie (KWT) en passiewe herstel (PH) op die fisiologiese herstel van atlete na-oefening, het net 'n beperkte aantal navorsers egter die moontlike voordele van hierdie hersteltegnieke op die psigologiese herstel van atlete ondersoek. Die doelwitte van hierdie studie was eerstens om die verskil te bepaal tussen die akute uitwerking van KWO and PH op die gemoedstoestand (woede, verwardheid, depressie, uitputting, spanning and lewenskragtigheid) en die energie-indeks van universiteitsvlak-rugbyspelers na-oefening, en tweedens, om die verskil te bepaal tussen die akute uitwerking van KWT and PH op die gemoedstoestand en die energie indeks van universiteitsvlak-rugbyspelers na-oefening.

Drie-en-twintig onder/21-universiteitsvlak-rugbyspelers (ouderdom  $20.1 \pm 0.41$ ) van 'n Suid-Afrikaanse universiteit klub het vrywillig aan die studie deelgeneem. Die spelers is blindelings verdeel in 'n kontrolegroep (PH) en 'n eksperimentele groep (KWO of KWT). Deelnemers het die *Stellenbosch Mood Scale*- (*STEMS*-) vraelys voltooi oor vier tydperodes: gedurende die oggend (basislyn); voor die aflê van 'n hoë-intensiteit anaërobiese oefensessie (voor-anaërobies); na die aflê van 'n hoë-intensiteit anaërobiese oefensessie van 15 minute (na-anaërobies) en na die aflê van 'n 20-minute herstelsessie (na-herstel). Bloedlaktaatmetings is ook geneem 3 minute na die voltooiing van die anaërobiese sessie. Om die eerste doelwit te toets, het die eksperimentele groep 20 minute van KWO voltooi, terwyl die kontrolegroep vir dieselfde tydperiode passief herstel het. Vir die tweede doelwit het die eksperimentele groep 20 minute van KWT voltooi, terwyl die kontrolegroep vir dieselfde tydperiode passief herstel het.

Alhoewel die afhanklike  $t$ -toets en effekgrootte resultate van die eerste studie getoon het dat die eksperimentele groep (KWO) geen betekenisvolle veranderinge ervaar het vanaf die voor-anaërobiese tot na-hersteltydsperiodes vir enige van die *STEMS*-subskaalwaardes of die energie indeks nie, het die kontrolegroep (PH) se verwardheid-, depressie- en spanningssubskaalwaardes betekenisvol gedaal ( $p < 0.05$ ) vanaf die voor-anaërobiese tot na-herstel-tydsperiodes. Ten spyte van die veranderinge het die eenrigting tussen groepe se analise van kovariante (ANKOVA) geen betekenisvolle verskille getoon nie, behalwe vir die lewenskragtigheidssubskaal, waar die eksperimentele groep 'n matige praktiese betekenisvolle toename [Effekgrootte (EG) = 0.65] getoon het in vergelyking met die kontrolegroep.

Die afhanklike  $t$ -toets en effekgrootteresultate van die tweede studie het getoon dat nie die eksperimentele groep (KWT) of die kontrolegroep (PH) betekenisvolle verskille ervaar het vanaf die voor-anaërobiese tot na-herstel-tydsperiodes vir enige van die *STEMS*-subskaal of energie indeks-waardes nie. Die ANKOVA het egter 'n statisties betekenisvolle hoër waarde vir die lewenskragtigheidssubskaal ( $p = 0.05$ ) getoon vir die eksperimentele groep in vergelyking met die kontrolegroep. Vir lewenskragtigheid het die eksperimentele groep verder 'n prakties betekenisvolle hoër waarde (EG = 0.92) getoon, sowel as 'n groot prakties betekenisvolle laer waarde vir uitputting (EG = 0.88) in vergelyking met die kontrolegroep.

Volgens die navorsers se beste wete is hierdie die eerste studie wat die effektiwiteit van KWO, KWT en PH op die herstel van atlete se *STEMS*-afgeleide gemoedstoestand vergelyk het. Vorige studies het hoofsaaklik gefokus op persepsies van uitputting, spierseerheid, *Profile of Mood States*- (*POMS*-) afgeleide gemoedstoestand en die tempo van perseptuele uitputting om psigologiese herstel by atlete te ondersoek. Ten spyte van die uniekheid van hierdie studie, het resultate egter getoon dat in vergelyking met PH, KWO en KWT nie meer tot die akute psigologiese herstel van universteitsvlak-rugbyspelers se gemoedstoestand bygedra het nie. Lewenskragtigheid was die enigste gemoedstoestand-subskaal waarvoor beide KWO- en KWT-groepe 'n praktiese of statisties betekenisvolle hoër waarde getoon het in vergelyking met PH, terwyl uitputting 'n hoër prakties betekenisvolle waarde getoon het vir slegs KWT in vergelyking met PH.

Dus, alhoewel hierdie studie se resultate die gebruik van KWO en KWT ondersteun om lewenskragtigheid en uitputting na-oefening te verbeter in vergelyking met PH, is verder

navorsing noodsaaklik om die psigologiese meganismes van beide KWO en KWT beter te verstaan, met die klem op kennis en inligting oor die herstel van gemoedstoestand na-oefening.

**Sleutelwoorde:** kouewater-onderdompeling; kontrasterende waterterapie; passiewe herstel; psigologiese herstel; rugby-unie

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# List of abbreviations

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<b>ANCOVA</b>	Analysis of covariance
<b>Bpm</b>	Beats per minute
<b>CK</b>	Creatine kinase
<b>CWI</b>	Cold water immersion
<b>CWT</b>	Contrast water therapy
<b>°C</b>	Degrees Celcius
<b>DOMS</b>	Delayed onset muscle soreness
<b>ES</b>	Effect size
<b>M</b>	Mean
<b>N</b>	Participants
<b>PAR</b>	Passive recovery
<b>PANAS</b>	Positive and Negative Affect Schedule
<b>POMS</b>	Profile of Mood states
<b>POMS-A</b>	Profile of Mood states for adolescents
<b>P-values</b>	Probability values
<b>R</b>	Correlation coefficient
<b>RESTQ-Sport</b>	Recovery-Stress Questionnaire for Athletes
<b>RPE</b>	Rate of perceived exertion
<b>SD</b>	Standard deviation
<b>STAXI</b>	State-Trait Anger-expression Inventory
<b>STEMS</b>	Stellenbosch Mood scale
<b>TQRP</b>	Total quality of recovery perception
<b>VAS</b>	Visual analogue scale
<b><math>\dot{V}O_{2max}</math></b>	Aerobic capacity

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# **Chapter 1**

## **Introduction**

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# 1. Introduction

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- 1.1 Problem statement**
  - 1.2 Objectives**
  - 1.3 Hypotheses**
  - 1.4 Structure of the dissertation**
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## **1.1 Problem statement**

Rugby union is one of the most popular sports in South Africa (South African Rugby Union (SARU), 2011), with an estimated 387 009 registered players (International Rugby Board (IRB), 2014). During a rugby match, which usually lasts 80 minutes, players perform regular bouts of high-intensity (anaerobic) activities such as sprints, accelerations from a static position, rucking, mauling, tackling and breaking through tackles, which are separated by short bouts of low-intensity (aerobic) activities such as walking and jogging (Gill *et al.*, 2006:260; Suzuki *et al.*, 2004:436). Due to the requirements of rugby union match-play and training, players not only need to deal with the physical demands but also with the psychological, emotional, social and behavioural demands of the sport (Suzuki *et al.*, 2004:436; Venter *et al.*, 2010:133). The complete recovery of rugby players' physiological and psychological capacities is especially vital during the in-season periodisation phase when multiple matches are played in a short period of time and players follow a vigorous training regime (Reilly & Ekblom, 2005:626).

Inadequate recovery between matches and training sessions may lead to overtraining, which can be detrimental to players' performance and health (Kellmann, 2010:97). The risk and the possible disadvantages of overtraining have led to the design and use of structured post-exercise and -match recovery techniques that enhance the recovery process and shift the stress-recovery balance away from the stresses induced by training and match-play (Barnett, 2006:782). The primary recovery techniques currently used include cold water immersion (CWI), contrast water therapy (CWT) and passive recovery (PAR) (Barnett, 2006:782). Although a number of researchers have investigated the physiological responses to different recovery techniques,

uncertainty still remains with regard to the exact influence of these recovery techniques on the mental (psychological) recuperation of athletes.

CWI, which is a popular and frequently used post-exercise recovery technique for many team sports (Leeder *et al.*, 2012:233; Pointon & Duffield, 2012:206), involves the immersion of the athlete's whole body or parts of the body in cold water with water temperatures of 15 °C or less (Koekemoer & Terblanche, 2010:9; Wilcock *et al.*, 2006:748). Research evidence suggests that CWI reduces perceived fatigue at 1 hour and 24 hours post-exercise and restores fatigue to baseline levels after 48 hours post-exercise in Australian football players and soccer players (De Nardi *et al.*, 2011:613; Elias *et al.*, 2012:361; Stacey *et al.*, 2010:663). Furthermore, CWI seems to act as an analgesic for up to 96 hours following high-intensity exercise by reducing the perception of muscle soreness by an average of 16% (Leeder *et al.*, 2012:238; Pointon & Duffield, 2012:214). Despite the positive findings with regard to the psychological benefits of CWI, researchers express concerns that CWI may provide a false sense of well-being due to the fact that athletes believe and expect a positive outcome and therefore "think" they feel better (Leeder *et al.*, 2012:238; Stacey *et al.*, 2010:663).

Another post-exercise recovery technique that has become popular in recent times is CWT (Ingram *et al.*, 2009:417). During CWT athletes alternate intermittently between cold and hot water immersion following exercise (Barnett, 2006:789; Vaile *et al.*, 2007:697; Versey *et al.*, 2012:130). Sayers and co-workers (2011:301) found that CWT reduced the perception of fatigue and the sensation of delayed onset of muscle soreness (DOMS) in male state-level hockey players, which is particularly important for psychological recovery. Similar results were found by Elias *et al.* (2012:360-361), who reported that a single post-exercise exposure of 14 minutes to CWT effectively reduced perceived fatigue at 1 hour, 24 hours and 48 hours post-exercise in Australian football players. Furthermore, De Nardi *et al.* (2011:613) found that the greater benefit of CWI and CWT was the decrease in perceived fatigue post-exercise in young soccer players, with CWI being more effective than CWT.

Some coaches encourage players to rest passively post-exercise and allow the body to recover without any intervention (Lambert & Van Wyk, 2009:1). A comparison between the effects of PAR, CWI and CWT showed that CWI resulted in significantly lower levels of perceived fatigue compared to PAR, with no significant differences between PAR and CWT (De Nardi *et al.*,

2011:613). Suzuki *et al.* (2004:439) observed that rugby players experienced psychological recovery over time when PAR was used post-exercise, but also found that players who applied active rest as a recovery technique had a lower Profile of Mood States (POMS) tension score compared to players who made use only of PAR. Furthermore, Kenttä *et al.* (2006:251) observed that PAR did not lead to complete recovery of the energy index (ratio of POMS vigour to fatigue scores) to baseline values during the second and third week of a three-week training camp. The same researchers also reported low POMS depression scores despite higher fatigue and lower vigour scores after a period of PAR post-exercise following a three-week training camp (Kenttä *et al.*, 2006:251).

Despite uncertainty, the above-mentioned findings regarding the possible benefits of post-exercise recovery techniques on the psychological make-up of participants would suggest that these recovery techniques may have the potential to recuperate the psychological state of team sport players after exhaustive exercise. In this regard Kenttä *et al.* (2006:252) emphasised the importance of examining the psychological responses to recovery after intense exercise and training by frequently measuring and monitoring different psychological markers. Researchers agree that markers of mood states and perceived exertion may serve as useful indicators of overreaching or stress (Halson & Jeukendrup, 2004:973) and may therefore provide researchers with a way of evaluating the psychological responses of athletes post-exercise (Morgan *et al.*, 1987:113). However, as far as the author can establish, no researchers have investigated or compared the acute effects of different recovery techniques on the mood states of university-level rugby players until now.

It is against this background that the following research questions were posed: Firstly, what is the difference between the acute effects of CWI and PAR on the mood states (anger, confusion, depression, fatigue, tension and vigour) and the energy index of university-level rugby players post-exercise? Secondly, what is the difference between the acute effects of CWT and PAR on the mood states (anger, confusion, depression, fatigue, tension and vigour) and the energy index of university-level rugby players post-exercise?

Answers to these questions could possibly provide coaches, sport psychology consultants, sport scientists and rugby players with clarity concerning the potential of CWI, CWT and PAR to serve as acute post-exercise recovery techniques for psychological recuperation. In the long run a

positive outcome with regard to the last-mentioned recovery techniques may also aid in the prevention of overtraining in order to maintain optimal performance in rugby players.

## **1.2 Objectives**

The objectives of this study were to determine:

- The difference between the acute effects of CWI and PAR on the mood states (anger, confusion, depression, fatigue, tension and vigour) and the energy index of university-level rugby players post-exercise.
- The difference between the acute effects of CWT and PAR on the mood states (anger, confusion, depression, fatigue, tension and vigour) and the energy index of university-level rugby players post-exercise.

## **1.3 Hypotheses**

This study was based on the following hypotheses:

- Compared to PAR, CWI will have statistically and practical significantly more positive acute effects on the mood states (anger, confusion, depression, fatigue, tension and vigour) and the energy index of university-level rugby players post-exercise.
- Compared to PAR, CWT will have statistically and practical significantly more positive acute effects on the mood states (anger, confusion, depression, fatigue, tension and vigour) and the energy index of university-level rugby players post-exercise.

## **1.4 Structure of the dissertation**

The dissertation will be submitted in article format as approved by the Senate of the North-West University and is structured as follows:

- Chapter 1: Introduction to the study. A reference list is provided at the end of the chapter in accordance with the guidelines of the North-West University.
- Chapter 2: Literature overview entitled “The need for recovery and the effects of cold-water immersion, contrast water therapy and passive recovery techniques on the psychological well-being of athletes”. A reference list is provided at the end of the chapter in accordance with the guidelines of the North-West University.
- Chapter 3: Research article entitled “The difference between the acute effects of cold-water immersion and passive recovery on the mood states of university-level rugby players”. This article will be submitted for publication in the *International Journal of Sport and Exercise*

*Psychology*. This chapter and the reference list at the end of the chapter were compiled in accordance with the guidelines of the last-mentioned journal (see Appendix E). Although not in accordance with the guidelines of the journal, tables and figures were included in the text to make the article easier to read and understand. Furthermore, the line spacing of the article was set at one-and-a-half lines and the first line of a paragraph was not indented to conform to layout of the rest of the dissertation.

- Chapter 4: Research article entitled “The difference between the acute effects of contrast water therapy and passive recovery on the mood states of university-level rugby players”. This article will be submitted for publication in the *Journal of Applied Sport Psychology*. This chapter and the reference list at the end of the chapter were compiled in accordance with the guidelines of the last-mentioned journal (see Appendix F). Although not in accordance with the guidelines of the journal, tables and figures were included in the text to make the article easier to read and understand. Furthermore, the line spacing of the article was set at one-and-a-half lines and the first line of a paragraph was not indented to conform to layout of the rest of the dissertation.
- Chapter 5: Summary, conclusions, limitations and recommendations of the study.

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## **Chapter 2**

# **Literature review: The need for recovery and the effects of cold water immersion, contrast water therapy and passive recovery techniques on the psychological well-being of athletes**

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## **2. Literature review:**

# **The need for recovery and the effects of cold water immersion, contrast water therapy and passive recovery techniques on the psychological well-being of athletes**

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## 2.1 Introduction

Success in team sports such as rugby union is dependent on the maintenance of optimal performance and fitness levels throughout a long competitive season (Higgins *et al.*, 2011:1049). A high frequency of training sessions per week is required from players to meet the high demands of match-play and to prepare them for these demands (Schwellnus *et al.*, 2012:816). In addition to provincial and club matches, many elite rugby players also participate in national and international tournaments, which may increase the number of matches per season to as much as 35 (Viljoen *et al.*, 2009:97). This competitive environment may leave players mentally, physically and emotionally drained and can lead to a decrease in performance and expose the players to an increased risk of injuries (Cresswell & Eklund, 2006a:228; Reilly & Ekblom, 2005:626). Furthermore, rugby players are often expected to push themselves through extensive training and match demands without adequate rest and recovery (Cresswell & Eklund, 2006a:226). However, an imbalance between the stress of training demands and recovery over time could lead to overtraining (Barnett, 2006:782; Lambert & Van Wyk, 2009:1).

Recovery is vital in the prevention of overtraining, and increased recovery must occur concurrently with increased stress of high-intensity training loads to prevent players from developing burnout (Kellmann, 2010:96). Recovery refers to a period of physiological and psychological restoration which brings an athlete's level of training ability back to baseline level (Hanin, 2002:201; Vaile *et al.*, 2008:539). In rugby union, recovery allows players to train without being hampered by sore muscles or increased risk of injury (Burgess & Lambert, 2010:259; Lambert & Van Wyk, 2009:5). Therefore, recovery allows athletes to maximise the training benefits by reducing fatigue (Calder, 2005:4) and allows athletes to cope more effectively with high-intensity training loads (Barnett, 2006:782). Furthermore, adequate recovery increases athletes' capacity to deal with higher training volumes so that their overall fitness (aerobic capacity, strength and power), technique and training efficiency can be improved (Calder, 2005:4; Kellmann, 2010:95). In view of the above-mentioned benefits of recovery, it is crucial to implement recovery techniques as part of rugby players' training regimes (Higgins *et al.*, 2011:1050).

Recovery techniques include massage therapy, stretching, active recovery or low-intensity exercise (Suzuki *et al.*, 2004:436; Weinberg & Gould, 2011:510), passive recovery (PAR) (no

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physical activity, passive rest, sufficient sleep) (Suzuki *et al.*, 2004:436; Weinberg & Gould, 2011:510), cold water immersion (CWI), contrast water therapy (CWT), compression garments, nutrition and non-steroidal anti-inflammatory drugs (Barnett, 2006:783; Bompa & Haff, 2009:107; Higgins *et al.*, 2011:1046; Lambert & Van Wyk, 2009:5; Stacey *et al.*, 2010:656). However, CWI and CWT have become increasingly popular post-exercise recovery techniques for many team sports (Higgins *et al.*, 2011:1046; Ingram *et al.*, 2009:418).

Despite numerous research findings with regard to the efficiency of CWI and CWT on the physiological recovery of athletes post-exercise (De Nardi *et al.*, 2011; Higgins *et al.*, 2013; Ingram *et al.*, 2009; Webb *et al.*, 2013; Wilcock *et al.*, 2006), a limited number of researchers have examined the possible benefits of CWI and CWT on the psychological recovery of athletes, specifically relating to the mood states of athletes following exercise. Similarly, the efficiency of PAR for athletes' physiological recovery post-exercise has been extensively examined (Brophy-Williams *et al.*, 2011; De Nardi *et al.*, 2011; Pointon & Duffield, 2012; Stacey *et al.*, 2010), but limited evidence exists regarding the possible benefits of PAR on post-exercise psychological recovery. Therefore, more research that investigates the beneficial effects of different recovery techniques on the psychological states of athletes is needed (Tessitore *et al.*, 2007:749). The need for this type of research is highlighted by the fact that physiological and psychological responses to recovery techniques are interrelated (Stacey *et al.*, 2010:656). In this regard Tessitore *et al.* (2007:749) conclude, for example, that a reduced perception of muscle soreness may positively affect athletes' work attitude during subsequent training sessions. Furthermore, De Nardi *et al.* (2011:613) state that reduced perceived fatigue may improve training efficiency and competition performance.

It is against this background that the subsequent literature review was compiled. The first aim of the literature review was to discuss the physical, physiological and psychological demands of rugby union and the importance of recovery in the prevention of overtraining and subsequent burnout in rugby union players. The second aim was to discuss the following psychometric measuring instruments: the Profile of Mood States (POMS), Stellenbosch Mood Scale (STEMS) and the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport), which can be used to assess the markers that are linked to psychological recovery. The third aim was to review the literature findings with regard to the effect of different recovery techniques such as CWI, CWT and PAR

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on several psychological components of athletes, and to discuss the different CWI, CWT and PAR protocols that researchers use to measure psychological recovery.

Searches for the identification of literature relevant to this review were narrowed down to include only articles from the past 15 years (1999–2014), with the exception of six articles (Brislin, 1986; Kenttä & Hassmén, 1998; Kreider *et al.*, 1998; McNair *et al.*, 1971; Morgan *et al.*, 1987; Raedeke, 1997). Two of the last-mentioned articles (Kreider *et al.*, 1998; Raedeke, 1997) were included due to certain definitions that were used in this literature review. In addition, two of the last-mentioned articles (Kenttä & Hassmén, 1998; Morgan *et al.*, 1987) were included due to the limited research that has investigated the importance of psychological markers in monitoring recovery. The remaining two articles (Brislin, 1986; McNair *et al.*, 1971) were from authors who had developed certain psychometric measuring instruments. Furthermore, searches focused on research that included male or female subjects who were 14 years of age and older and were either active individuals, recreational or professional athletes. The literature search furthermore focused on the psychological effects of CWI, CWT and/or PAR recovery techniques.

Most literature uses the terms overtraining (Halson & Jeukendrup, 2004; Halson *et al.*, 2003; Hartwig, 2009; Kellmann, 2010; Kreider *et al.*, 1998; Lambert & Van Wyk, 2009) and staleness (Kenttä & Hassmén, 1998; Kenttä *et al.*, 2006; Morgan *et al.*, 1987) interchangeably to refer to an imbalance between training and non-training stressors and recovery in athletes (Halson *et al.*, 2003:854). However, for the remainder of this review overtraining will be used to refer to this phenomenon.

## **2.2 The physical, physiological and psychological demands of rugby union**

### **2.2.1 Physical and physiological demands of rugby union**

Rugby union can be described as an intermittently high-intensity team sport that involves aerobic and anaerobic exercise and includes regular physical collisions and tackles between opponents during training and matches (Gill *et al.*, 2006:260; Pointon & Duffield, 2012:206; Smart & Gill, 2011:7). Furthermore, rugby players need to perform a wide variety of activities during a match such as walking, jogging, sprinting, tackling, kicking, passing, sidestepping, catching and jumping (Du Plessis & Krüger, 2007:14; Pook, 2012:4). In this regard, Pook (2012:1) states that

during an 80-minute match, players might complete as much as 6 to 8 kilometres at different running speeds. These distances are covered in more than 200 intervals of varying lengths (Pook, 2012:1). Physical and motor abilities required to perform the above-mentioned activities are strength, power, joint stability, endurance, flexibility, speed and agility (Du Plessis & Krüger, 2007:37; Duthie *et al.*, 2003:983; Pook, 2012:11).

The physiological stress from high-intensity exercise as experienced during a rugby match and training is associated with energy substrate depletion, hyperthermia, mechanical muscle damage, oxidative stress, inflammation and nervous system fatigue, which may ultimately lead to a decline in performance (Leeder *et al.*, 2012:233). According to Ingram *et al.* (2009:417) and Reilly and Ekblom (2005:620) a demanding training and competition regime can exhaust the musculoskeletal, nervous and metabolic systems, which may result in delayed-onset muscle soreness (DOMS). The demands of rugby union are further emphasised by the match analysis results of university-level rugby union players, which indicate that players spend most of the total match time (43.6%) in the high-intensity heart rate zone, with an average match heart rate of 165.0 bpm and an average maximum heart rate of 192.2 bpm (Sparks & Coetzee, 2013:511). The researchers of the last-mentioned study also conclude that the anaerobic glycolytic energy system was primarily used during match play, whereas the aerobic system played a major role during recovery between match play activities (Sparks & Coetzee, 2013:512).

The physiological demands of rugby union match-play are also highlighted by the fact that players experience a significant decrease in lower-body peak power output (as measured by the countermovement jump test) ( $p = 0.001$ ) and testosterone concentrations ( $p = 0.023$ ) below baseline levels at 12 hours ( $p = 0.001$ ) and 36 hours ( $p = 0.016$ ) post-match before returning to baseline levels at 60 hours post-match (West *et al.*, 2013:197). Researchers also found a significantly lower average testosterone to cortisol ratio (an indication of the metabolic stress, muscle damage, negative energy balance and depleted glycogen stores) below the baseline level and significantly higher cortisol concentrations above baseline levels at 12 hours ( $p = 0.001$ ,  $p = 0.004$ ) and 36 hours ( $p = 0.027$ ,  $p = 0.027$ ) post-match respectively before returning to baseline levels at 60 hours post-match (West *et al.*, 2013:197,198). In addition, Gill *et al.* (2006:261) reported that the average creatine kinase (CK) concentration in elite rugby players increased significantly ( $p < 0.01$ ) during match-play and argued that muscle damage caused by

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direct impact between opposing players was the main cause of higher CK concentrations (Gill *et al.*, 2006:260).

From the above-mentioned discussion it is clear that the physical and physiological demands of rugby union impose various stressors on players which could ultimately lead to a decline in performance. However, as was mentioned before, players not only have to deal with the various physical and physiological demands of rugby union, but they also have to cope with various psychological demands during training and matches (Suzuki *et al.*, 2004:436; Venter *et al.*, 2010:133). A brief discussion of the psychological demands of rugby union follows.

### 2.2.2 Psychological demands of rugby union

Factors that may lead to an increase in the psychological demands of rugby union as well as the probability of experiencing psychological stress include competitive transitions between the end of one competition and the start of the next; demanding competition and training loads; concerns about possible injury; the competitive rugby environment; inadequate rest and pressure to perform from coaches, supporters as well as the media (Cresswell & Eklund, 2006a:229). Within one year, elite rugby players may compete in as many as four different teams under different coaches, each with its own competitive league and training schedules (Cresswell & Eklund, 2006a:228). This transition from one competition to the next can leave players feeling mentally, physically and emotionally drained due to very little recovery time between competitions, and could ultimately lead to a decrease in performance and an increased risk of injuries (Cresswell & Eklund, 2006a:228; Reilly & Ekblom, 2005:626).

In this regard, Cresswell and Eklund (2005a:1964) indicate that players with more national-league experience who reported more injuries and won more matches experienced higher levels of physical and emotional exhaustion. In addition, factors such as travel and time away from home may cause players of more successful teams who are required to play more high-level rugby to experience more psychological stress (Cresswell & Eklund, 2005a:1964). Furthermore, additional responsibilities within a team such as leadership and tactical decision-making roles may also increase the perceived imbalance between psychological demands and resources (Cresswell & Eklund, 2005a:1965). Suzuki *et al.* (2004:439) further argue that apart from the

match intensity, players' satisfaction or dissatisfaction with their personal match performances may also influence psychological stress levels.

Nicholls *et al.* (2009:126) observed that elite rugby players experienced more sport and non-sport stressors on training days compared to rest or match days, while many stressors were experienced as "worse than normal" on post-match days compared to match and pre-match days. They attributed this trend in stress perception to psychological factors such as feeling less bored and irritated on match days compared to training days, when players reported having more arguments and less interest and being more irritable (Nicholls *et al.*, 2009:126). West *et al.* (2013:198) also found a significant increase in mood disturbances above baseline levels at 12 hours ( $p = 0.031$ ) post-match in professional rugby players before returning to baseline levels at 36 hours and 60 hours post-match.

All of the last-mentioned stressors and mood disturbances, together with relentless training and match responsibilities as well as unrealistic expectations, may negatively influence rugby players' ability to maintain a high level of training and performance (Cresswell & Eklund, 2006a:226,234). Therefore, over time an imbalance between the stress of training demands and recovery could lead to a decline in performance and subsequent overtraining (Barnett, 2006:782; Lambert & Van Wyk, 2009:1). This notion was also substantiated by various researchers (Bompa & Haff, 2009:99; Faude *et al.*, 2009:433; Hartwig, 2009:51; Kellmann, 2002a:16) who concluded that prolonged high-volume or high-intensity training with inadequate recovery can lead to overtraining.

### **2.3 Overtraining and burnout in rugby union**

Overtraining is "an accumulation of training and non-training stress resulting in a long-term decrement in performance capacity with or without related physiological and psychological signs and symptoms of overtraining in which restoration of performance capacity may take several weeks or months" (Kreider *et al.*, 1998:viii). In addition, Halson *et al.* (2003:854) argued that overtraining may be best described as an imbalance between training and non-training stressors and recovery. The physiological markers of overtraining include the following: cardiovascular changes (e.g., an increase in resting heart rate and blood pressure as well as a decrease in maximum heart rate); glycogen depletion (e.g., a decrease in muscle and liver glycogen stores);

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immune system changes (e.g., frequent illnesses such as upper respiratory tract infection); hormonal changes (e.g., a decrease in catecholamine production or changes in the ratio of serum free testosterone to cortisol levels) and biological changes (e.g., an increase in CK and uric acid concentrations, a decrease in ammonia concentrations and a decrease in maximal and sub-maximal blood lactate levels) (Halson & Jeukendrup, 2004:972; Hartwig, 2009:53; Mackinnon & Hooper, 2000:487). In addition, persistent fatigue, a decrease in performance despite continuous training and a decreased work rate at the lactate threshold intensity level have all been identified as physical markers of overtraining (Halson & Jeukendrup, 2004:972; Hartwig, 2009:53; Mackinnon & Hooper, 2000:487).

In addition to the various physiological markers of overtraining, psychological markers are also linked to overtraining and include increased negative mood state changes (e.g., increased tension, depression, anger, fatigue and confusion and a decline in vigour) as indicated by the POMS, emotional instability, apathy, lack of motivation, loss of appetite, sleep disturbances, high self-reported stress levels, irritability and depression (Hartwig, 2009:53; Kellmann, 2010:96; Mackinnon & Hooper 2000:487). The psychological markers of overtraining such as negative mood state changes can also be linked directly to cardiovascular, enzymatic, endocrine, hormonal and hypothalamic markers of overtraining (Morgan *et al.*, 1987:113). Morgan and co-workers (1987:113) also stated that negative mood state changes are directly linked to a reduced aerobic capacity ( $\dot{V}O_{2\max}$ ), which inevitably leads to a decrease in optimal performance and training ability. Over the long term, overtrained athletes reach a chronic performance plateau or a decline in performance that cannot be alleviated by brief periods of rest and recovery (Kellmann, 2010:96; Stone *et al.*, 2007:204). As a result, continued overtraining without adequate rest and recovery may lead to a phenomenon known as burnout (Weinberg & Gould, 2011:49).

Burnout is defined as “a physical, emotional and social withdrawal from a formerly enjoyable sporting activity” (Gould & Whitley, 2009:18). In addition, Raedeke (1997:398) describes burnout as a psychological syndrome of emotional and physical exhaustion due to a reduced sense of accomplishments and sport devaluation. In this context emotional and physical exhaustion refer to feelings of being over stretched and exhausted due to sport participation and involvement (Cresswell & Eklund, 2005a:1957), as well as a loss of energy and interest in sport

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(Weinberg & Gould, 2011:496). Feelings of a reduced sense of accomplishment reflect a perceived lack of achievement (Cresswell & Eklund, 2005a:1957), low self-esteem, failure and depression (Weinberg & Gould, 2011:496), while sport devaluation refers to a decline in the perceived benefits gained from involvement in sport (Cresswell & Eklund, 2005a:1957). In this regard, it has been reported that elite rugby players associate feelings of reduced accomplishment with events such as non-selection, injury and frustration with personal performance (Cresswell & Eklund, 2006a:232).

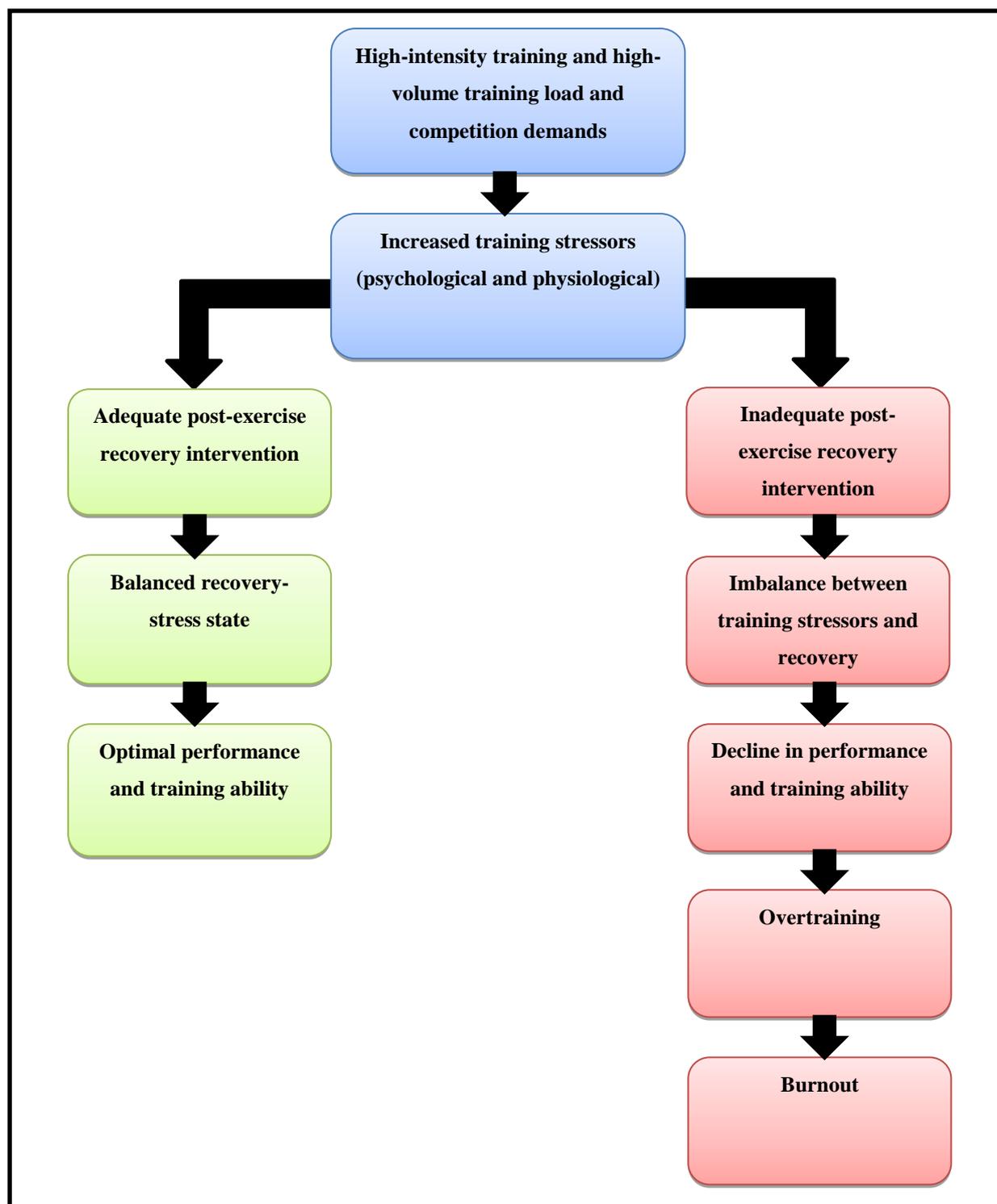
Burnout occurs as a result of chronic stress and a change in motivational orientation, where chronic stress is caused by a perceived or actual imbalance between what is physically, psychologically and socially expected of an athlete and their capability to respond to these expectations (Gould & Whitley, 2009:18). Regarding motivational orientations, various researchers found that amotivation (i.e. motivation low in self-determination) and extrinsic motivation (i.e. financial rewards and scholarships) are positively associated with burnout, while intrinsic motivation (i.e. motivation high in self-determination) is negatively associated with burnout (Cresswell & Eklund, 2005a:1963; Cresswell & Eklund, 2005b:374; Goodger *et al.*, 2007:138).

In a study conducted by Cresswell and Eklund (2006a:225, 226), elite rugby players reported feeling physically run down, moody and lethargic entering the last third of the year, with one player stating: “Mentally it was a tough time. I was completely knackered”; and another player commenting: “Normally I love playing rugby but it wasn’t enjoyable anymore.” They also found that experienced national-level rugby players perceived high levels of exhaustion, possibly due to higher associated physical and psychosocial demands (Cresswell & Eklund, 2006b:133). In this regard, Cresswell and Eklund (2005a:1963) revealed that amotivation, win/loss ratio, injury, playing position, playing experience and team membership are also factors that are associated with burnout. In addition, Goodger *et al.* (2007:143) list the following as typical characteristics of burnout in athletes: loss of motivation; a lack of enjoyment; poor coping skills; high perceptions of stress and anxiety; inadequate recovery; mood disturbances due to training and non-training stressors and perceptions of low social support of significant others. Elite rugby players experience key characteristics of burnout as a result of an imbalance between rugby

demands and the response capability of individual players as well as inadequate recovery (Cresswell & Eklund, 2006a:234).

Adequate recovery and an optimal balance between training stress and subsequent recovery may help athletes to avoid overtraining and burnout. Figure 2.1 is a schematic representation of the process that follows training or competition participation in cases where adequate recovery *versus* inadequate recovery occurs (Kellmann, 2010:96).

Ultimately, overtraining and burnout are two of the most profound negative consequences of inadequate recovery and may in the long-term cause athletes to cease sport participation. It is, therefore, of the utmost importance that sport-related professionals and scientists implement post-exercise and -match recovery techniques in the training regimens of athletes so that overtraining and burnout can be prevented. However, before the implementation of recovery techniques, it is important that the recovery process is clearly understood.



**Figure 2.1:** A schematic representation of the process that follows training or competition participation in cases where adequate recovery *versus* inadequate recovery occurs (adapted from Kellmann, 2010)

## 2.4 Recovery

Recovery refers to a deliberate, self-initiated and goal-orientated activity or a period of physiological and psychological restoration aimed at regaining an athlete's level of training ability back to baseline level (Hanin, 2002:201). Kellmann and Kallus (2001:22) also describe recovery as an inter- and intra-individual multilevel (psychological, physiological and social) process to restore the performance abilities of athletes. Post-exercise recovery occurs after exercise and is associated with the removal of metabolic by-products, the renewal of energy stores and the initiation of tissue repair (Ivy & Portman, 2004:54). Recovery techniques assist in accelerating recovery from fatigue, maintaining optimal performance during subsequent training and sporting events and reducing the risk of injury in athletes (Brophy-Williams *et al.*, 2011:665; Burgess & Lambert, 2010:259; Calder, 2005:4; Gill *et al.*, 2006:260). Barnett (2006:782) and Calder (2005:4) furthermore stated that the advantages of recovery techniques are that they allow athletes to tolerate high-intensity training loads so that the effects of a given training load can be increased in order to improve overall fitness (aerobic capacity, strength and power), technique and efficiency (Kellmann, 2010:95).

Total recovery will therefore enable players to train without limitations due to sore muscles or increased risk for injuries (Burgess & Lambert, 2010:259; Lambert & Van Wyk, 2009:5). Coaches should aim to establish an optimal balance between training and recovery to ensure the complete physiological and psychological recovery of players (Kellmann, 2010:95; Reilly & Ekblom, 2005:626; Suzuki *et al.*, 2004:436). According to Kellmann (2010:96), recovery demands refer to the quality and/or quantity of recovery activities needed to balance the recovery-stress state. The recovery-stress state is determined by the extent to which athletes are physically and/or psychologically stressed (Kellmann, 2002b:42). Therefore, athletes who experience medium stress levels will need a smaller amount of recovery to achieve optimal performance, whereas higher stress levels will require additional recovery activities to meet the recovery demands (Kellmann, 2010:96). Leeder *et al.* (2012:233) as well as Kaczmarek *et al.* (2013:35) concur in this regard that recovery time varies for different exercise stressors and should increase as training intensity increases to maintain a high level of performance. The rate of recovery is also influenced by various lifestyle and habitual factors such as sleeping patterns, nutritional strategies and alcohol intake (Lambert & Van Wyk, 2009:2; Reilly & Ekblom, 2005:626).

However, athletes' state of recovery should be continuously monitored as such monitoring allows coaches and sports scientists to determine if the consequences of heavy training were adaptive or maladaptive (Kenttä *et al.*, 2006:252). Furthermore, frequent monitoring and measuring of parameters such as mood states and perceived exertion during high-intensity training may assist in the prevention of overtraining (Kenttä *et al.*, 2006:252; Morgan *et al.*, 1987:108). In addition, Kellmann (2002a:17) suggest that the psychological markers of overtraining seem to be more reliable and consistent compared to physiological markers. Kellmann (2002b:38) further argues that psychometric instruments provide quick availability of information (sometimes within minutes) when compared to physiological measurements such as blood analyses, which may take days or even weeks. Therefore, sports and exercise psychologists rely upon valid psychological measuring instruments to determine the psychological state of athletes (Terry *et al.*, 2003b:231).

#### 2.4.1 Psychometric instruments used in the assessment of recovery

Kenttä and co-workers (2006:251) suggest that the monitoring of mood states by means of the POMS (McNair *et al.*, 1971) and the subsequent regulation of the training load according to the recorded scores may lead to an optimisation of an individual's training load and assist in detecting symptoms of under-recovery and subsequent overtraining. Similarly, Faude *et al.* (2009:439) conclude that negative mood states are often regarded as early markers of overtraining. In this regard, mood can be defined as “a set of feelings, ephemeral in nature, varying in intensity and duration, and usually involves more than one emotion” (Lane & Terry, 2000:16).

Until recently one of the shortcomings of the POMS was that it could only be administered to an English-speaking population. However, Terry and co-workers (2003b:232) found the POMS to be suitable for translation from one language to another due to its simple format of single or dual-word mood descriptors. The STEMS, a dual-language (Afrikaans and English) version of the Profile of Mood States – Adolescents (POMS-A) (Terry *et al.*, 2003a), was therefore developed (Terry *et al.*, 2003b:233). The RESTQ-Sport (Kellmann & Kallus, 2001) is another popular measuring instrument designed to measure the recovery-stress state of athletes (Kellmann, 2002b:42). The POMS, STEMS and RESTQ-Sport can, therefore, be used as

relevant instruments for monitoring athletes' psychological recovery post-exercise or -matches and will be briefly discussed.

#### *2.4.1.1 The Profile of Mood States (POMS)*

The POMS was initially designed by McNair *et al.* (1971) to observe various mood states in psychiatric patients. However, William Morgan, an American sports psychologist, was the first person to administer the POMS to evaluate the mood states of American athletes (Rohlf's *et al.*, 2004:118). The POMS is a self-assessment instrument for determining mood and affective states (Kellmann, 2002b:41) and provides a measure of total mood disturbances in six mood states, namely anger, confusion, depression, fatigue, tension, and vigour (Rohlf's *et al.*, 2004:118; Kellmann, 2002b:41).

The POMS is a 65-item Likert-format instrument with values ranging on a scale from 0 ("not at all") to 4 ("extremely") (Kellmann, 2002b:41). A total mood disturbance score can be derived by deducting the vigour score from the sum of the five negative scores (anger, confusion, depression, fatigue and tension) (Kellmann, 2002b:41). The POMS has also been used effectively to measure the distress associated with overtraining in athletes, which includes athletes' perceptions of physical (fatigue, exhaustion) and psychological markers (mood changes, depression and anxiety) (Rohlf's *et al.*, 2004:118). These researchers also found that a raised fatigue subscale compared to a raised depression subscale score could serve as an indicator of overtraining (Rohlf's *et al.*, 2004:118). In addition, Kenttä *et al.* (2006:246) suggest that the ratio of the POMS vigour to fatigue scores (expressed as the energy index) tend to show more noticeable changes in response to exhaustive training compared to the other POMS subscales.

#### *2.4.1.2 The Stellenbosch Mood Scale (STEMS)*

In the STEMS, each of the six dimensions of mood (anger, confusion, depression, fatigue, tension and vigour) is represented by four items (Terry *et al.*, 2003b:234). Furthermore, the STEMS includes the mood descriptor of each item in English (i.e. anxious) and Afrikaans (i.e. *angstig*) (Terry *et al.*, 2003b:234) by making use of the back-translation method (Brislin, 1986). The STEMS has a five-point response scale ranging from 0 ("not at all/*glad nie*") to 4 ("extremely/*uiters*") while participants rate "how you feel right now/*hoe jy op hierdie oomblik*

voel” for each mood descriptor (Terry *et al.*, 2003b:234). Terry *et al.* (2003b:241) furthermore stated that the STEMS has shown acceptable psychometric characteristics, is suitable for Afrikaans and English speakers and due to the brevity of the STEMS, it is suitable to assess mood states when limited time is available for data collection (i.e., before a match). Terry *et al.* (2003b:237) found acceptable internal consistency for all six mood scales of the STEMS, with alpha coefficient values of 0.7 and higher. Grobbelaar *et al.* (2011:655) found acceptable Cronbach alpha coefficients ranging from 0.65 to 0.87 in a group of university-level rugby players with a mean age of  $22.26 \pm 1.39$  years.

#### 2.4.1.3 The Recovery-Stress Questionnaire for Athletes (RESTQ-Sport)

The RESTQ-Sport indicates the frequency of stressors and recovery activities in athletes and this recovery-stress state indicates the extent to which athletes are physically and/or mentally stressed (Grobbelaar *et al.*, 2010:43). The RESTQ-Sport measures the regularity of appraised events, states and activities together with the stress and recovery processes in a systematic way (Kellmann 2002b:43). The RESTQ-Sport indicates to coaches and athletes how daily activities contribute to the perceived stress/recovery that athletes experience and the possible effect of these activities on athletic performance by offering a complete screening tool (Kellmann, 2002b:47). The questionnaire consists of 12 general stress and recovery scales (i.e. general stress, emotional stress, social stress, conflicts/pressure, fatigue, lack of energy, physical complaints, success, social recovery, physical recovery, general well-being and sleep quality) and seven sport-specific stress and recovery scales (i.e. disturbed breaks, burnout/emotional exhaustion, fitness/injury, fitness/being in shape, burnout/personal accomplishment, self-efficacy, and self-regulation) (Kellmann, 2002b:43). A Likert-type scale ranging from 0 (“never”) to 6 (“always”) is used to specify how frequently the respondent participated in different activities over the past three days/nights (Kellmann, 2002b:43). According to Goodger *et al.* (2007:141) the burnout dimensions of emotional exhaustion and reduced accomplishment form two subscales of this instrument, whilst devaluation is not included.

The POMS, STEMS and RESTQ-Sport are, therefore, all regarded as valid psychological measuring instruments with a dose-response relationship between observed scores and training loads (Kenttä *et al.*, 2006:246). All of these instruments allow researchers to evaluate and determine disturbances in mood states, which can reflect an imbalance between training stress

and recovery and may, therefore, be effectively used to assess the efficiency of various recovery techniques in sports settings (Barnett, 2006:786).

#### 2.4.2 Recovery techniques applied in sport

Recovery techniques that are most frequently applied by coaches and athletes include massage therapy, stretching, active recovery (e.g., low-intensity exercise) (Suzuki *et al.*, 2004:436; Weinberg & Gould, 2011:510), passive recovery (PAR) (e.g., no physical activity, passive rest or sufficient sleep) (Suzuki *et al.*, 2004:436; Weinberg & Gould, 2011:510), cold water immersion (CWI), contrast water therapy (CWT), compression garments, nutrition, and non-steroidal anti-inflammatory drugs (Barnett, 2006:783; Bompa & Haff, 2009:107; Higgins *et al.*, 2011:1046; Lambert & Van Wyk, 2009:5; Stacey *et al.*, 2010:656). Venter *et al.* (2010:134) grouped different recovery techniques into the following four groups: natural strategies (e.g., active recovery and sleep), physical strategies (e.g., CWI, CWT and massage), psychological strategies (e.g., imagery, music and prayer), and complementary/alternative medicine (e.g., reflexology, acupuncture and herbal therapy).

Vaile and Gill (2008:15) suggest that post-exercise recovery techniques should be time efficient and practical and should acknowledge individual responses to different recovery techniques, especially in team sports where playing position, game time, body mass and physiological status will vary between players. Recovery techniques should be applied immediately after exercise or matches to prevent players from losing their form and confidence and consequently their ability to maintain a high performance level throughout the season (Lambert & Van Wyk, 2009:2). In this regard, West *et al.* (2013:199) state that in rugby union, post-match recovery should take place within 30 to 60 hours to facilitate optimal physiological and mood state restoration.

Over the past decade water immersion-related recovery techniques have gained a lot of attention among athletes to aid in recovery from exercise (Wilcock *et al.*, 2006:748). During water immersion, water applies hydrostatic pressure to the body, which causes the movement of body fluids from the athlete's extremities towards the central cavity (Wilcock *et al.*, 2006:750). This movement of fluids can increase the displacement of substrates from the muscles, increase cardiac output, reduce peripheral resistance and increase the ability of the body to transport substrates (Wilcock *et al.*, 2006:750). An increase in cardiac output increases the blood flow

through the body, which can assist in the metabolism of waste products that accumulated during exercise by reducing the transport time of these products (Wilcock *et al.*, 2006:761). Furthermore, the effect of antigravity as a result of buoyancy may lead to a decline in perceived fatigue and assist in energy conservation (Wilcock *et al.*, 2006:750).

Wilcock *et al.* (2006:748) divide water immersion-related recovery techniques into four different techniques, namely CWI (also known as cryotherapy), CWT, thermotherapy, and water immersion *per se*. Due to the aim of this study; this review will focus only on CWI, CWT as well as PAR.

#### 2.4.2.1 Cold water immersion (CWI)

CWI is the immersion of the athlete's whole body or parts of the body in cold water with temperatures that are 15 °C or lower (Koekemoer & Terblanche, 2010:9; Wilcock *et al.*, 2006:748). Despite limited evidence of the potential benefits of CWI on the perceptual recovery of athletes (Pointon & Duffield, 2012:207), CWI has become an increasingly popular post-exercise recovery technique in many team sports (Leeder *et al.*, 2012:233; Rowsell *et al.*, 2011:1; Vaile *et al.*, 2008:539). CWI is widely applied in the treatment of traumatic injuries and may, therefore, be an appropriate recovery technique for team and contact sports (Barnett, 2006:788; Ingram *et al.*, 2009:421). CWI is often applied in the form of ice baths or activities in a cold swimming pool (Venter *et al.*, 2010:138).

Table 2.1 provides a summary of various CWI protocols that researchers use to examine the psychological recovery of athletes post-exercise.

**Table 2.1: Summary of CWI protocols used by researchers to examine the psychological recovery of athletes post-exercise**

Authors	CWI temperature (°C)	Application time	Repeats	Level of immersion
Ascensão <i>et al.</i> (2011:219)	10	10 min	1	Iliac crest

**Table 2.1 (cont.): Summary of CWI protocols used by researchers to examine the psychological recovery of athletes post-exercise**

<b>Authors</b>	<b>CWI temperature (°C)</b>	<b>Application time</b>	<b>Repeats</b>	<b>Level of immersion</b>
Brophy-Williams <i>et al.</i> (2011:666)	15	15 min	1	Mid-sternum
De Nardi <i>et al.</i> (2011:610)	15	8 min	1	Iliac spine
Elias <i>et al.</i> (2012:359)	12	14 min	1	Xiphoid process
Higgins <i>et al.</i> (2013:2855)	10-12	5 min cold; 2.5 min seated at room temperature	2	Superior iliac spine
Pointon and Duffield (2012:208)	9.2	9 min cold; 1 min seated at room temperature (38 °C)	2	Iliac crest
Rowell <i>et al.</i> (2011:2)	10	1 min cold; 1 min seated in ambient air (~24 °C)	5	Mesosternale level
Stacey <i>et al.</i> (2010:659)	10	10 min	1	Up to neck
Vaile <i>et al.</i> (2008:541)	15	14 min	1	Up to neck
Webb <i>et al.</i> (2013:2450)	10-12	5 min	1	Anterior superior iliac spine

From Table 2.1 it is clear that the majority of researchers use temperatures of between 10 and 15 °C (Ascensão *et al.*, 2011; Brophy-Williams *et al.*, 2011; De Nardi *et al.*, 2011; Elias *et al.*, 2012; Higgins *et al.*, 2013; Rowell *et al.*, 2011; Stacey *et al.*, 2010; Vaile *et al.*, 2008; Webb *et al.*, 2013) in the examination of the psychological recovery benefits of CWI. Pointon and Duffield (2012) are the only researchers to apply a water temperature of 9.2 °C. Application

times vary between 5 and 14 minutes (Ascensão *et al.*, 2011; Brophy-Williams *et al.*, De Nardi *et al.*, 2011; Elias *et al.*, 2012; Stacey *et al.*, 2010; Vaile *et al.*, 2008; Webb *et al.*, 2013), with the majority of researchers applying 10 to 14 minutes of CWI (Ascensão *et al.*, 2011; Brophy-Williams *et al.*, 2011; Elias *et al.*, 2012; Stacey *et al.*, 2010; Vaile *et al.*, 2008).

However, some researchers follow protocols where CWI is alternated by PAR (during which athletes remain seated at room temperature) for several repeats, with a total recovery time of 10 minutes up to 33 minutes. In this regard, protocols vary as follows: 1 minute CWI, alternated by 1 minute PAR, repeated five times (Rowell *et al.*, 2011); 9 minutes CWI, alternated by 1 minute PAR, repeated twice (Pointon & Duffield, 2012); 5 minutes CWI, alternated by 2.5 minutes PAR, repeated twice (Higgins *et al.*, 2013). Immersion levels also vary from the anterior superior iliac spine (De Nardi *et al.*, 2011; Higgins *et al.*, 2013; Webb *et al.*, 2013) up to the neck (Stacey *et al.*, 2010; Vaile *et al.*, 2008).

From the above-mentioned discussion it is clear that protocols for CWI vary considerably between studies. Overall researchers are more interested in the most effective protocols for post-exercise psychological recovery. Results with regard to the effectiveness of the above-mentioned protocols to bring about psychological recovery among participants are discussed in the following section.

CWI seems to serve as an effective analgesic for up to 96 hours post-exercise by reducing perceived muscle soreness on average by 16%, with a significantly more effective analgesic effect at 24 hours ( $p = 0.001$ ) and 48 hours ( $p = 0.000$ ) respectively following high intensity exercise in male and female athletes of different athletic training status (Leeder *et al.*, 2012:238). In this regard, Ascensão *et al.* (2011:221) also found that CWI resulted in significantly reduced perceived muscle soreness in the quadriceps ( $p < 0.05$ ) and calf muscles ( $p < 0.05$ ) of soccer players at 24 hours and for hip adductor muscles ( $p < 0.05$ ) at 30 minutes after exercise.

Leeder and co-workers (2012:236) suggest that CWI causes a cold-induced decrease in muscle blood flow and tissue temperature, which triggers a decline in inflammation and causes a reduced sensation of pain, which may serve as one explanation for CWI's analgesic characteristics. These researchers also claim that CWI has become such a popular and frequently

used recovery technique due to athletes' belief that CWI will have a positive outcome (Leeder *et al.*, 2012:238). This notion is confirmed by Broatch *et al.* (2014:2143), who suggests that a strong belief in CWI may enhance its value in recuperating vigour and perceptual recovery from exercise. In cases where athletes were provided with information sheets on the efficacy of CWI before the application of CWI, a prior belief in the benefits of CWI as well as the cold stimulus itself resulted in significantly higher ratings of physical and mental readiness for exercise ( $p < 0.05$ ) as well as vigour ( $p < 0.05$ ) following CWI, when compared to thermo-neutral immersion (Broatch *et al.*, 2014:2141).

De Nardi and co-workers (2011:613) investigated the effects of CWI on performance in young soccer players and observed that perceived fatigue post-exercise was significantly reduced ( $p = 0.02$ ). Rowsell *et al.* (2011:4) found similar results, with CWI being significantly ( $p = 0.04$ ) more effective in minimising perceived leg soreness and in reducing general fatigue associated with playing consecutive soccer matches when compared to hot water immersion. In addition, Elias *et al.* (2012:361) found that CWI was effective in reducing post-exercise perceived fatigue values in Australian football players at 1 and 24 hours, and restored perceived fatigue back to baseline line levels at 48 hours post-exercise.

According to De Nardi *et al.* (2011:613) the reduction in perceived fatigue that athletes experience due to CWI plays an important role in improving training compliance and match performances. Brophy-Williams *et al.* (2011:668,669) examined the effects of CWI after high-intensity exercise and recorded significantly higher scores in perceived recovery [as defined by the Totally Quality Recovery Perception (TQRP) questionnaire scores of Kenttä and Hassmén (1998)] immediately ( $p = 0.02$ ) and 3 hours ( $p = 0.04$ ) post-exercise, and suggest that this phenomenon can be attributed to a reduced inflammatory response. However, no significant reduction in the sensation of muscle soreness was observed (Brophy-Williams *et al.*, 2011:669).

In contrast, Stacey *et al.* (2010:660) reported a significant increase ( $p \leq 0.05$ ) in quadriceps pain levels (as measured by participants' visual analogue scale (VAS) scores) after CWI in male athletes. However, participants in this study reported that their lower extremities generally felt significantly better following CWI ( $p \leq 0.05$ ) when compared to PAR. In view of the fact that physiological recovery was not improved even though athletes perceived that they felt better,

Stacey and co-workers (2010:663) postulated that CWI may provide athletes with a false sense of well-being. Moreover, Vaile *et al.* (2008:542) found no significant changes in the perception of exertion (RPE) in endurance cyclists where CWI was applied following high-intensity exercise. However, Vaile *et al.* (2008:543) argued that RPE measures may not serve as accurate indicators of psychological responses to the recovery technique applied during maximal effort exercise.

With regard to rugby union, Venter *et al.* (2010:141) found that CWI was the most popular post-exercise recovery technique among rugby union players due to the belief that CWI would reverse the negative effects of match-related collisions and tackles. Compared to CWT, CWI also resulted in significantly lower levels of perceived muscle soreness ( $p = 0.02$ ) 48 hours after collision-based exercise in rugby players (Higgins *et al.*, 2013:2857). However, complete recovery had still not occurred at 48 hours post-exercise, since muscle pain measures remained below baseline levels at this time point (Higgins *et al.*, 2013:2858). Pointon and Duffield (2012:212) reported that CWI resulted in significantly lower ( $p = 0.04$ ) perceived muscle soreness 2 hours after a high-intensity intermittent sprint and tackling exercise in rugby players. Similarly, Webb *et al.* (2013:2452) found that CWI resulted in a significant reduction of perceived muscle soreness in rugby players at 18 to 42 hours after a match.

The variation in CWI protocols makes it difficult to compare the results of the above-mentioned CWI-related studies and to determine the most effective protocol for the acute psychological recovery of athletes, especially rugby players. However, it is evident that CWI protocols that were more successful in obtaining significant results with regard to psychological recovery, specifically with respect to the perceived muscle soreness of athletes, adhered to the following guidelines: water temperature ranged between 9.2 °C and 12 °C, application time ranged from 5 minutes up to 20 minutes, while the immersion level ranged between the anterior, superior iliac spine and the mesosternale level (Ascensão *et al.*, 2011:219; Higgins *et al.*, 2013; Pointon & Duffield, 2012:208; Rowsell *et al.*, 2011:2; Webb *et al.*, 2013:2450). In addition, CWI protocols that were more successful in obtaining significant results with regard to the recovery of the perceived fatigue of athletes adhered to the following guidelines: water temperature ranged between 12 °C and 15 °C, application time ranged from 8 minutes up to 15 minutes, while the immersion level ranged between the iliac spine and the mid-sternum (De Nardi *et al.*, 2011:610;

Elias *et al.*, 2012:359; Rowsell *et al.*, 2011:2). Furthermore, CWI protocols that obtained significant results with regard to athletes' perceptions of recovery adhered to the following guidelines: water temperatures ranged between 10 °C and 15 °C, application time between 10 and 15 minutes, while the immersion level ranged between the mid-sternum and the neck (Brophy-Williams *et al.*, 2011:666; Stacey *et al.*, 2010:659). Despite these findings, more research is required to establish the best CWI protocol for the acute psychological recovery of athletes, especially rugby players, specifically with respect to possible mood state changes.

From the above-mentioned discussion it is clear that despite the popularity of CWI, results with regard to the effectiveness of CWI for the psychological recovery of athletes post-exercise are contradictory. More research is therefore needed to verify the use of CWI for the acute psychological recovery of athletes, especially rugby players, specifically with respect to possible mood state changes.

#### 2.4.2.2 Contrast water therapy (CWT)

CWT is a low-cost, practical recovery technique that can easily be adopted as part of an athlete's training regime (Vaile *et al.*, 2007:701). Another key advantage of CWT is that no additional energy expenditure occurs during the recovery process when compared to active recovery (low-intensity exercise) that results in an increased heart rate and systolic blood pressure during the recovery process (Sayers *et al.*, 2011:300). CWT can, therefore, be beneficial and may be a preferred method of recovery when energy conservation is vital over a prolonged competition period (i.e. during heats, semi-finals) (Sayers *et al.*, 2011:300). In addition, CWT increases blood flow to the working muscles and accelerates the removal of lactic acid (Calder, 2005:15). During CWT, athletes alternate intermittently between cold and hot water immersion for 30 to 300 seconds at a time for a total duration of 4 to 30 minutes directly after exercise (Barnett, 2006:789; Vaile *et al.*, 2007:697; Versey *et al.*, 2012:130; Wilcock *et al.*, 2006:749).

Table 2.2 provides a summary of various CWT protocols that were implemented by researchers to investigate the psychological recovery of athletes post-exercise.

**Table 2.2: Summary of CWT protocols used by researchers to examine the psychological recovery of athletes post-exercise**

Authors	CWT temperature (°C)		Application time	Repeats	Order (start/end)
	Hot	Cold			
De Nardi <i>et al.</i> (2011:610)	28	15	2 min cold; 2 min hot	2	Cold, hot
Elias <i>et al.</i> (2012:359)	38	12	1 min hot; 1 min cold	7	Hot, cold
Higgins <i>et al.</i> (2013:2855)	38–40	10–12	1 min cold; 1 min hot	5	Cold, hot
Kinugasa & Kilding (2009:1404)	38	12	1min cold; 2 min hot	3	Cold, hot
Sayers <i>et al.</i> (2011:296)	38	15	3.5 min hot; 30 sec cold	3	Hot, cold
Vaile <i>et al.</i> (2008:541)	38	15	1 min cold; 1 min hot	7	Cold, hot
Vaile <i>et al.</i> (2007:698)	40-42	8-10	1 min cold; 2 min hot	5	Cold, hot
Versey <i>et al.</i> (2012:132)	38.4	14.6	1 min hot; 1 min cold	3 (6 min) OR 6 (12 min) OR 9 (18 min)	Hot, cold
Webb <i>et al.</i> (2013:2450)	40–42	8–10	1 min cold; 2 min hot	3	Cold, hot

From Table 2.2 it is clear that the majority of researchers used temperatures between 8 and 15 °C (De Nardi *et al.*, 2011; Elias *et al.*, 2012; Higgins *et al.*, 2013; Kingasa & Kilding, 2009; Sayers *et al.*, 2011; Vaile *et al.*, 2008; Vaile *et al.*, 2007; Webb *et al.*, 2013) for the CWI part of CWT, whereas the majority of researchers used 38 °C (Elias *et al.*, 2012; Higgins *et al.*, 2013; Kingasa

& Kilding, 2009; Sayers *et al.*, 2011; Vaile *et al.*, 2008; Versey *et al.*, 2012) as the water temperature for hot water immersion. Only two groups of researchers used hotter water temperatures (40–42 °C) (Vaile *et al.*, 2007; Webb *et al.*, 2013), and one group of researchers a lower water temperature at 28 °C (De Nardi *et al.*, 2011) when CWT was applied.

Application times varied from a total recovery time of 6 up to 15 minutes, consisting of two to nine repeats of 1 (Higgins *et al.*, 2013; Vaile *et al.*, 2008) or 2 minutes (Kingasa & Kilding, 2009; Vaile *et al.*, 2007; Versey *et al.*, 2012; Webb *et al.*, 2013) to 2 minutes for both cold and hot water immersion. However, the order of application varied, with some researchers first applying hot-water immersion (Elias *et al.*, 2012; Versey *et al.*, 2012), while other researchers first applied cold water immersion (De Nardi *et al.*, 2011; Higgins *et al.*, 2013; Kingasa & Kilding, 2009; Vaile *et al.*, 2007; Vaile *et al.*, 2008; Webb *et al.*, 2013). Similar to CWI, the above-mentioned literature shows that protocols for CWT vary considerably between studies and more clarity is needed concerning the most effective protocol design in bringing about acute psychological recovery in athletes, especially rugby players.

Kinugasa and Kilding (2009:1405) found that CWT resulted in an increased perceived recovery (as measured by the TQRP scale) in soccer players. However, they recorded only a small practical significant difference between CWT and PAR (ES = 0.41) TQRP scores, but observed that players' legs felt lighter (ES = 0.62) following match-play due to CWT when compared to PAR (Kinugasa & Kilding, 2009:1405). CWT also resulted in a significant reduction of perceived fatigue ( $p < 0.001$ ) in state-level hockey players, and the authors of this study concluded that perceived fatigue may be particularly important for increased psychological recovery and increased psychological well-being (Sayers *et al.*, 2011:301). Elias *et al.* (2012:360,361) concur in this regard by indicating that a single exposure to post-exercise CWT for 14 minutes in Australian football players effectively reduced perceived fatigue at 1 hour, 24 and 48 hours post-exercise. Webb *et al.* (2013:2452) found that CWT resulted in meaningfully (79%–95% chance of being likely beneficial) reduced perceptions of muscle soreness at 18 to 42 hours post-match in rugby union players.

In contrast, De Nardi *et al.* (2011:613) found no significant reduction in perceived fatigue due to CWT in young soccer players over a 4-day period when compared to PAR. Similarly, Vaile *et al.*

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(2008:543) report no significant decrease in the RPE of elite cyclists following CWT, whereas they did observe slightly lower levels of perceived muscle soreness following CWT after eccentric exercise (Vaile *et al.*, 2007:700). In contrast, Versey *et al.* (2012:134) report substantially lower RPE scores were reported in trained male runners post-exercise, following a 6 minute (75% chance of being likely beneficial) and 8 minute (88% chance of being very likely beneficial) CWT session, although 12 minutes of CWT led to only a small practically significant (66% chance of being possibly/possibly not beneficial) better RPE recovery effect compared to PAR. However, whole body fatigue was not affected by post-exercise CWT (Versey *et al.*, 2012:134).

Similar to CWI, the variation in CWT protocols makes it difficult to compare the results of the above-mentioned CWT-related studies and to determine the most effective protocol for the acute psychological recovery of athletes, especially rugby players. However, it is evident that CWT protocols, which were more successful in obtaining significant results with regard to psychological recovery, specifically where it relates to the RPE of athletes, adhered to the following guidelines: cold water temperature was 14.6 °C and hot water temperature was 38.4 °C, application time ranged from 1 minute in hot water, alternated by 1 minute in cold water, repeated three to nine times for a total recovery time of 6 to 18 minutes, and the level of immersion was up to the neck (Versey *et al.*, 2012:132).

In this regard, CWT protocols that were successful in providing significant results relating to perceived muscle soreness adhered to the following guidelines: cold water temperature was 8 °C to 10 °C and hot water temperature was 40 °C to 42 °C, application time ranged from 1 minute in cold water, alternated by 2 minutes in hot water, repeated three times for a total recovery time of 9 minutes, and the level of immersion was up to the anterior superior iliac spine (Webb *et al.*, 2013:2450). In addition, where CWT protocols were more successful in obtaining significant results relating to the perceived fatigue of athletes, the following guidelines were adhered to: cold water temperature ranged between 12 °C and 15 °C and hot water temperature was 38 °C, application time and level of immersion ranged from 3.5 minutes in hot water, alternated by 30 seconds in cold water up to the jugular notch, and repeated three times for a total recovery time of 12 minutes (Sayers *et al.*, 2011:296), to 1 minute hot water alternated by 1 minute cold water up to the xiphoid process, repeated seven times for a total recovery time of 14 minutes (Elias *et*

*al.*, 2012:359). CWT protocols that obtained significant results with regard to athletes' perceptions of recovery adhered to the following guidelines: cold water temperature was 12 °C and hot water temperature 38 °C, application time was 1 minute in cold water, alternated by 2 minutes in hot water, repeated three times for a total recovery time of 9 minutes, and the level of immersion was up to the mesosternale level (Kinugasa & Kilding, 2009:1404).

Similar to CWI, from the above-mentioned discussion it is clear that CWT protocols used by researchers who examined the acute psychological recovery of athletes varied considerably. In addition, it is evident from the above-mentioned discussion that contrasting results exist with regard to the effectiveness of CWT for the psychological recovery of athletes post-exercise. More research is, therefore, needed to verify the most effective CWT and the use of CWT for the acute psychological recovery of athletes, especially rugby players, specifically in relation to mood states.

#### 2.4.2.3 Passive recovery (PAR)

Another post-match or -exercise recovery technique that is used by athletes is PAR, where athletes are encouraged to rest and not to engage in additional exercise during the rest period (Suzuki *et al.*, 2004:436). A period of no physical activity and sleep are forms of PAR (Weinberg & Gould, 2011:510). Table 2.3 presents PAR protocols that were implemented by researchers to investigate the psychological recovery of athletes post-exercise.

**Table 2.3: Summary of PAR protocols used by researchers to examine the psychological recovery of athletes post-exercise**

Authors	Protocol	Application time
Brophy-Williams <i>et al.</i> (2011:666)	Participants remained seated in a laboratory	15 min
De Nardi <i>et al.</i> (2011:610)	Participants rested in the shade	8 min
Elias <i>et al.</i> (2012:359)	Participants remained seated	14 min
Hauswirth <i>et al.</i> (2011:3)	Participants remained seated in an arm chair	30 min

**Table 2.3 (cont.): Summary of PAR protocols used by researchers to examine the psychological recovery of athletes post-exercise**

<b>Authors</b>	<b>Protocol</b>	<b>Application time</b>
Higgins <i>et al.</i> (2013:2855)	Participants remained seated in a thermoneutral environment	10 min
Kenttä <i>et al.</i> (2006:248)	Short-term PAR - rest for one night Long-term PAR - one complete day off training	8 hours rest – short-term PAR 24 hours rest – long-term PAR
Kinugasa and Kilding (2009:1404)	Participants performed static stretching for 7 min followed by lying down with legs raised above heart level for 2 min	9 min
Pointon and Duffield (2012:208)	Participants remained seated in a laboratory	20 min
Suzuki <i>et al.</i> (2004:436)	Participants completed no additional exercise or activities post-match	Complete rest post-match
Vaile <i>et al.</i> (2008:541)	Participants remained seated	14 min
Vaile <i>et al.</i> (2007:698)	Participants remained seated	15 min
Versey <i>et al.</i> (2012:132)	Participants remained seated	20 min

From Table 2.3 it is clear that in the majority of studies where PAR was applied athletes remained seated for the duration of the recovery time (Brophy-Williams *et al.*, 2011; De Nardi *et al.*, 2011; Elias *et al.*, 2012; Hausswirth *et al.*, 2011; Higgins *et al.*, 2013; Pointon & Duffield, 2012; Suzuki *et al.*, 2004; Vaile *et al.*, 2007; Vaile *et al.*, 2008; Versey *et al.*, 2012), lay in a supine position on a bed (Stacey *et al.*, 2010), or performed static stretches for 7 minutes, after which they lied down with legs raised above heart level for 2 minutes (Kinugasa & Kilding, 2009).

In one study athletes performed no additional recovery activities after exercise and rested for one night (short-term PAR), or were given a complete day off training (long-term PAR) (Kenttä *et al.*, 2006). One researcher also allowed rugby players to rest after a rugby match by doing no additional exercise or post-match activities (Suzuki *et al.*, 2004). Application time of PAR varied

between less than 10 minutes (De Nardi *et al.*, 2011; Kingasa & Kilding, 2009), 10 to 12 minutes (Higgins *et al.*, 2013; Sayers *et al.*, 2011; Stacey *et al.*, 2010) or 14 to 15 minutes (Brophy-Williams *et al.*, 2011; Elias *et al.*, 2012; Vaile *et al.*, 2008; Vaile *et al.*, 2007). However, a few researchers applied PAR for 20 minutes (Pointon & Duffield, 2012; Versey *et al.*, 2012) or 30 minutes (Hauswirth *et al.*, 2011), while some researchers (Kenttä *et al.*, 2006; Suzuki *et al.*, 2004) allowed athletes to rest for 8 to 24 hours after exercise.

According to Bompa and Haff (2009:108), sleep plays a key role in promoting recovery and adaptations to training and aid in optimal performance during competition and training. Despite rest being the most popular factor mentioned in improving recovery, rest as a recovery intervention is often ignored by athletes due to their natural instinct to train harder when performance decreases (Kenttä & Hassmén, 1998:2, 9). However, Kenttä *et al.* (2006:249) shows that a daily training load of three training sessions per day for three consecutive weeks caused a consistent decline in the POMS energy index (ratio of vigour to fatigue) of elite kayakers, whereas both short- (rest for one night) and long-term PAR (rest for two nights and one day) in one week led to an increase in the energy index close to fully restored levels. They also found that as fatigue progressively accumulated throughout the three weeks, the energy index gradually and significantly declined ( $p = 0.02$ ) below baseline levels during the second and third week, and that neither short- nor long-term PAR was successful in restoring the energy index scores back to baseline levels (Kenttä *et al.*, 2006:249). These results were attributed to the possibility that the kayakers could not cope with the excessive training demands or did not have sufficient time to recover (Kenttä *et al.*, 2006:251).

Hauswirth *et al.* (2011:4) indicate that neither perceived muscle soreness nor perceived fatigue was improved by PAR during 48 hours post strenuous running exercise, whereas athletes' well-being remained lower than pre-exercise levels at 1 hour, 24 and 48 hours post-exercise. PAR was also not successful in causing significant changes in post-match anger and vigour subscale scores immediately, 1 day or 2 days post-PAR (Suzuki *et al.*, 2004:438). However, two days after the match, the tension subscale was significantly lower ( $p < 0.05$ ) for players who applied active rest compared to players who used PAR as a recovery technique (Suzuki *et al.*, 2004:438). PAR was also ineffective to improve perceived recovery post-exercise compared to CWI (Brophy-

Williams *et al.*, 2011:668) and CWT in athletes and soccer players respectively (Kinugasa & Kilding, 2009:1405).

Compared to CWI, PAR was also not sufficient in reducing perceived fatigue in team sport athletes following high-intensity exercise (De Nardi *et al.*, 2011:613; Elias *et al.*, 2012:361). In addition, perceived fatigue post-exercise in state-level hockey players could not be recuperated by means of PAR when compared to CWT (Sayers *et al.*, 2011:300). Although some researchers report that perceived muscle soreness in rugby players following collision-based exercise could not be sufficiently reduced *via* PAR compared to CWI (Pointon & Duffield, 2012:208), others indicate that perceived muscle soreness in rugby players could be significantly reduced ( $p = 0.05$ ) *via* PAR compared to CWT (Higgins *et al.*, 2013:2857). PAR had no effect on the RPE of elite cyclists after high-intensity exercise (Vaile *et al.*, 2008:542) or on the RPE of athletes after eccentric exercises (Vaile *et al.*, 2007:700).

Unlike CWI and CWT, PAR protocols used in the above-mentioned studies did not vary considerably. In this regard, existing research suggests that the PAR protocol that was more successful in obtaining significant results with regard to acute psychological recovery, specifically with regard to perceived muscle soreness of athletes, required participants to remain seated in a thermoneutral room for 10 minutes (Higgins *et al.*, 2013:2855).

From the above-mentioned discussion it is clear that PAR was found to be less effective in the psychological recovery of athletes post-exercise when compared to other recovery techniques, with the exception of one study where PAR was found to be more beneficial when compared to CWT in helping to reduced perceived muscle soreness. However, more research is required to fully establish the effect of PAR on the acute psychological recovery of athletes, especially rugby players, specifically with respect to mood states.

## **2.5 Conclusion**

The importance of both physiological and psychological recovery in preventing overtraining and subsequent burnout as well as assisting in the attainment of optimal sport performances has prompted the author of this review to achieve the following aims by means of this review: Firstly, to discuss the physiological and psychological demands of rugby union and the

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importance of recovery in the prevention of overtraining and subsequent burnout in rugby union players. Secondly, to discuss the following psychometric measuring instruments: the POMS, STEMS and the RESTQ-Sport, which can be used to assess the markers that are linked to psychological recovery. Thirdly, to review the literature findings with regard to the effect of different recovery techniques such as CWI, CWT and PAR on several psychological factors in athletes and to discuss the different CWI, CWT and PAR protocols that researchers use to achieve psychological recovery.

Research evidence suggests that the physical demands of rugby training and match-play during which players can complete between 6 to 8 kilometres at different running speeds (i.e. walking, jogging, sprinting, tackling, kicking, passing, sidestepping, catching and jumping) produce physiological stress in players. This stress, combined with insufficient recovery, can lead to a decline in performance. Physiological stress as experienced during rugby training and match-play is associated with energy substrate depletion, hyperthermia, mechanical muscle damage, oxidative stress, inflammation and nervous system fatigue.

However, apart from the physiological stress due to the nature of the rugby union training and matches, players also experience psychological stress due to inadequate rest; concerns about possible injuries; pressure to perform from coaches, supporters and the media; travel and time spent away from home; additional pressure on those in leadership and tactical decision-making roles; relentless training and competition demands and competitive transitions between the end of one competition and the start of the next competition. In this regard, evidence suggests that insufficient recovery as a result of relentless training and competition demands can cause rugby players to feel mentally, physically and emotionally exhausted and may cause a decline in players' training and performance ability. Moreover, it is clear that an imbalance between training stress and recovery over time can lead to overtraining and subsequent burnout, which is characterised by players who withdraw themselves on a physical, social and emotional level from the sporting activity they formerly enjoyed.

From the literature it is evident that post-exercise recovery techniques form a vital part of training regimens in order to assist in athletes' physiological and psychological recovery. These recovery techniques should be aimed at reducing fatigue and the risk of injuries as well as

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improving athletes' ability to cope with high training and competition demands. The frequent monitoring of recovery may lead to an optimisation of the individual training load and assist in detecting symptoms of under-recovery and subsequent overtraining.

Research evidence suggests that psychometric measuring instruments may serve as an effective and reliable method to assess athletes' psychological recovery, as it allows researchers to quickly make information with regard to athletes' psychological states available. In this regard, the POMS, STEMS and RESTQ-Sport are all considered to be valid psychometric measuring instruments to measure psychological markers such as changes in mood states, which may reflect an imbalance between training stress and recovery in athletes. These measuring instruments may therefore allow researchers to assess the efficiency of various post-match and -training recovery techniques.

While research evidence shows that CWI significantly reduced perceived muscle soreness after collision-based exercise in rugby players, perceived muscle soreness was not completely recovered following CWI. Furthermore, it would seem that the capacity of CWI to influence athletes' psychological recovery has been more extensively examined in soccer players, runners, and Australian football players than in any other type of athlete. Findings in this regard indicate that CWI significantly reduced perceived muscle soreness and perceived fatigue in soccer players, athletes and Australian football players, and that CWI may serve as an effective analgesic. In contrast, some researchers found CWI to be inefficient in reducing perceived muscle soreness or RPE following high-intensity exercise. However, researchers argue that CWI may provide athletes with a false sense of well-being, since they perceive that CWI makes them feel better while physiological recovery is not improved.

Overall CWI protocols make use of immersion depths that ranged from the anterior superior iliac spine up to the level of an athlete's neck. Water temperatures range between 9.2 °C and 15 °C, while CWI duration varies between one set of 8 to 15 minutes, and several sets of 1 minute to 9 minutes at a time interspersed with rests periods of between 1 minute and 2.5 minutes, during which participants remain seated at room temperature.

The variation in CWI protocols makes it difficult to compare the results of CWI-related studies and to determine the most effective protocol for the acute psychological recovery of athletes. However, existing research suggests that CWI protocols that were more successful in obtaining significant results with regard to psychological recovery, specifically relating to perceived muscle soreness and fatigue as well as perceptions of recovery of athletes, adhered to the following guidelines: water temperatures ranged between 9.2 °C and 15 °C, application time between 5 and 20 minutes, and immersion levels ranged between the anterior, superior iliac spine and the mesosternale level. Despite these findings, more research is required to establish the best CWI protocol for the acute psychological (mood states) recovery of rugby players, since only a small number of studies made use of rugby players as participants.

Findings with regard to the acute effect of CWT on the psychological recovery of various athletes are very conflicting, with some suggesting that CWT can be effective in reducing perceived muscle soreness in rugby players following match-play or collision-based exercises, whereas others found CWT to be the least effective when compared to other recovery techniques. In this regard, CWT seems to be effective in reducing perceived fatigue, perceived muscle soreness and RPE post-match or -exercise in a wide range of athletes. However, other researchers report no significant improvement in perceived fatigue, perceived muscle soreness or RPE following match-play or exercise.

Similar to what was found with regard to CWI protocols, CWT protocols also varied considerably from one study to the next. For example, application time varied from 6 to 18 minutes, with cold water immersion that lasted from 1 to 2 minutes and hot water immersion that lasted 2 minutes. Water temperatures for immersions in cold water varied from 8 °C to 15 °C and for hot water from 28 °C to 42 °C. Generally protocols made use of CWT depths that ranged from the anterior superior iliac spine up to the level of the athlete's neck.

However, existing research suggests that CWT protocols that are more successful in obtaining significant results with regard to psychological recovery, specifically relating to perceived fatigue and RPE of athletes, adhere to the following guidelines: cold water temperatures range from 12 °C to 15 °C and hot water temperatures range between 38 °C to 38.4 °C. Application time ranges from 1 minute to 3.5 minutes in hot water, alternated by 30 seconds up to 1 minute

in cold water, repeated three to nine times for a total recovery time of 6 to 12 minutes. Immersion levels range between the jugular notch and the neck.

CWT protocols that obtained significant results with regard to athletes' perceptions of recovery adhered to the following guidelines: cold water temperature was 12 °C and hot water temperature 38 °C, but the application time was 1 minute first in cold water, alternated by 2 minutes in hot water, repeated three times for a total recovery time of 9 minutes, with the level of immersion up to the mesosternale level. In addition, where CWT obtained significant results with regard to perceived muscle soreness, the following guidelines were adhered to: cold water temperature was 8 °C to 10 °C and hot water temperature was 40 °C to 42 °C, application time ranged from 1 minute in cold water, alternated by 2 minutes in hot water, repeated three times for a total recovery time of 9 minutes, and the level of immersion was up to the anterior superior iliac spine.

Most of the research findings indicate that PAR was insufficient in recuperating the mood states of rugby players after match-play, and that active recovery seems to be significantly more effective in causing acute, post-match, psychological recovery in team sport athletes. Furthermore, neither short- nor long-term PAR was regarded to be effective in causing recovery in athletes who participated in consecutive training sessions over a prolonged period of time.

Overall, compared to various other recovery techniques, PAR was less effective in uplifting perceived fatigue, perceived muscle soreness and RPE scores in athletes after high-intensity exercise. In general, researchers made use of PAR protocols that required participants to either lie supine on a bed or to lie down with legs raised above heart level after a period of static stretching. Most PAR protocols expected participants to stay seated for periods of between 8 and 30 minutes. However, existing research suggests that the PAR protocol that was more successful in obtaining significant results with regard to psychological recovery, specifically relating to the perceived muscle soreness of athletes, expected participants to remain seated in a thermoneutral room for 10 minutes.

In conclusion, researchers agree that psychological and physiological recovery cannot be separated and are linked in some way. Despite this notion, the majority of current research still

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focuses only on the recovery of physiological markers where CWI, CWT or PAR is applied. Furthermore, researchers who have examined the effectiveness of CWI, CWT or PAR for the psychological recovery of athletes report conflicting results with regard to the effectiveness of these techniques. In addition, only a small number of publications use mood states as measure of psychological recovery and focus on team sport athletes such as rugby union players as study participants. Existing research also does not provide direction or guidelines in terms of the most effective CWI, CWT or PAR protocols for the psychological recovery of athletes. All these research gaps need to be filled by conducting studies that focus more on the effectiveness of different types of recovery protocols to cause acute recovery of different psychological measures.

Lastly, the benefits of research that provides more answers concerning the use of CWI, CWT and PAR for the psychological recovery of athletes must not be overlooked, as these answers will allow coaches, players, sports scientists and sports psychologists to alleviate acute and accumulated psychological fatigue. Especially in the long run, this can be detrimental to athletes' well-being and health.

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## **Chapter 3**

# **The difference between the acute effects of cold water immersion and passive recovery on the mood states of university- level rugby players**

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### **3. The difference between the acute effects of cold water immersion and passive recovery on the mood states of university-level rugby players**

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This article will be submitted for publication in the *International Journal of Sport and Exercise Psychology*. This article is hereby included according to the specific prescriptions of the journal. Although not in accordance with the guidelines of the journal, tables and figures were included in the text to make the article easier to read and understand. Furthermore, the line spacing of the article was set at one-and-a-half lines and the first line of a paragraph is not indented to conform to the rest of the dissertations' layout. The instructions for authors are included as Appendix E: Guidelines for authors: International Journal of Sport and Exercise Psychology.

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## THE DIFFERENCE BETWEEN THE ACUTE EFFECTS OF COLD WATER IMMERSION AND PASSIVE RECOVERY ON THE MOOD STATES OF UNIVERSITY-LEVEL RUGBY PLAYERS

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### **Abstract**

The aim of this study was to determine the difference between the acute effects of cold water immersion (CWI) and passive recovery (PAR) on the mood states and the energy index of university-level rugby players post-exercise. The Stellenbosch Mood Scale (STEMS) was completed four times by u/21 players of a South African university club (n = 23): the morning before breakfast (baseline); before completion of an anaerobic exercise bout (pre-anaerobic); after completion of an anaerobic exercise bout (post-anaerobic) and after completion of a 20-minute recovery session (post-recovery). The experimental group completed 20 minutes of CWI, while the control group recovered passively (PAR) for 20 minutes. PAR caused statistically significant and medium practical significant decreases for confusion, depression and tension, while anger, fatigue, vigour and the energy index remained unchanged from pre-anaerobic to post-recovery. Except for confusion, which showed a medium practically significant decrease in the CWI group, no statistically significant differences from pre-anaerobic to post-recovery were observed for any of the other STEMS subscale scores or the energy index. However, a comparison of acute mood state changes between groups by means of an ANCOVA revealed no statistical or practically significant differences in pre-anaerobic and post-recovery changes for all mood states except for vigour, which showed a higher practically significant change for the CWI compared to the PAR group. Therefore, although research suggests that CWI may have the potential to optimally recuperate the psychological state of athletes after exhaustive exercise, this study indicates that CWI did not have a significantly more beneficial effect on mood states compared to PAR directly after an intense anaerobic exercise bout, except for vigour.

**Keywords:** cold water immersion; passive recovery; psychological recovery; mood states; rugby union

### **Introduction**

The emergence of rugby union as a professional sport placed additional pressure on players to become bigger, stronger and faster (Smart & Gill, 2011) to avoid non-selection and the risk of injury (Cresswell & Eklund, 2006). Furthermore, elite players may compete in as many as four different teams, each with its own competitive league and training schedules and under different coaches (Cresswell & Eklund, 2006). This transition from one competition to the next may leave players feeling mentally, physically and emotionally drained due to very little recovery time (Cresswell & Eklund, 2006). This can ultimately lead to a decline in performance and an increased risk of injuries (Cresswell & Eklund, 2006; Reilly & Ekblom, 2005). Structured recovery sessions are often applied in athletes' training regimes (Barnett, 2006) to ensure complete physiological and psychological recovery (Reilly & Ekblom, 2005). Two recovery techniques that have gained much attention among athletes over the past decade are cold water immersion (CWI) and passive recovery (PAR) (Barnett, 2006; Wilcock, Cronin, & Hing, 2006). However, despite numerous research findings on the efficiency of CWI and PAR for the physiological recovery of athletes post-exercise (De Nardi, La Torre, Barassi, Ricci, & Banfi, 2011; Higgins, Cameron, & Climstein, 2013; Ingram, Dawson, Goodman, Wallman, & Beilby, 2009), a limited number of researchers have examined the possible benefits of these recovery techniques for the psychological recovery of athletes (Barnett 2006; Pointon & Duffield, 2012), specifically with respect to the mood states and energy index of athletes.

Athletes who do not recover sufficiently may be unable to maintain the required intensity and training loads, and can also become prone to injuries due to higher fatigue levels (Barnett, 2006). Insufficient recovery may also lead to maladaptation, with negative training outcomes, and cause overtraining over a long period of time (Hartwig, 2009; Kellmann, 2010). Symptoms of overtraining include a depressed mood, general apathy, decreased self-esteem, emotional instability, disturbed sleep, irritability and restlessness (Kellmann, 2010). Research, therefore, suggests that measurable changes in psychological states from baseline values are often identified during periods of intense training and/or overtraining (Hartwig, 2009). In this regard the monitoring of mood states by means of the Profile of Mood States (POMS) and the

subsequent regulation of the training load according to the recorded scores may lead to an optimisation of the individual training load and assist in detecting symptoms of under-recovery and subsequent overtraining (Kenttä, Hassmén, & Raglin, 2006). Mood can be defined as “a set of feelings, ephemeral in nature, varying in intensity and duration, and usually involve more than one emotion” (Lane & Terry, 2000, p. 16). Morgan, Brown, Raglin, O’Connor, and Ellickson (1987), for example, showed that competitive swimmers who had positive mood states prior to overtraining developed mood disturbances as a result of overtraining. A significant increase in mood disturbances above baseline levels at 12 hours ( $p = .031$ ) post-match also occurred in professional rugby union players before these values returned to baseline levels at 36 hours and 60 hours post-match (West et al., 2013).

It is, therefore, not surprising that researchers regard psychological states, especially mood states, to be reliable for early detection of overtraining and that these psychological parameters may even allow researchers to evaluate the psychological responses of athletes post-recovery (Halson & Jeukendrup, 2004; Hartwig, 2009). Furthermore, psychological markers of overtraining seem to be more reliable and consistent when compared to physiological markers (Kellmann, 2002).

The risk for and the possible disadvantages of overtraining have led to the design and use of structured post-exercise and -match recovery techniques that enhance the recovery process and shift the stress-recovery balance away from the stresses induced by training and match-play (Barnett, 2006). As was previously mentioned, the primary recovery techniques currently used by athletes include CWI and PAR (Barnett, 2006). However, a large number of researchers have investigated the physiological responses of these recovery techniques (De Nardi et al., 2011; Higgins et al., 2013; Ingram et al., 2009; Webb, Harris, Cronn, & Walker, 2013), while only a limited number of researchers have investigated the exact influence of these recovery techniques on the mental (psychological) recuperation of athletes.

PAR is a post-exercise recovery technique where athletes rest passively for a certain length of time and do not do more than their everyday routine during the rest period (Suzuki et al., 2004). Suzuki and co-workers (2004) observed that the post-match fatigue subscale scores of the POMS increased significantly ( $p = .05$ ) when PAR was applied directly after a rugby match. Moreover,

no significant changes in post-match POMS anger and vigour subscale scores were evident immediately, one day or two days following PAR (Suzuki et al., 2004). PAR also had no significant effect on the rating of the perceived exertion (RPE) of elite cyclists after high-intensity exercise and on athletes who completed eccentric exercises respectively (Vaile, Gill, & Blazeovich, 2007; Vaile, Halson, Gill, & Dawson, 2008). A daily training load of three training sessions per day for three consecutive weeks caused a consistent decline in the energy index (ratio of POMS vigour to fatigue) of elite kayakers, while both short- (rest for one night) and long-term (rest for two nights and one day) PAR resulted in an increase in the energy index very close to fully restored levels during the first week (Kenttä et al., 2006). However, as fatigue progressively accumulated throughout the three weeks, the energy index gradually declined below baseline levels ( $p = .02$ ) during the second and third week, and neither short- nor long-term PAR was successful in restoring the POMS energy index back to baseline levels (Kenttä et al., 2006).

CWI has also become a frequently applied post-exercise recovery technique in rugby, possibly due to players' belief that CWI addresses the effects of collisions and tackles that form an integral part of the game (Venter, Potgieter, & Barnard, 2010). CWI is the immersion of an athlete's whole body or parts of the body in cold water with water temperatures of 15 °C or lower (Vaile et al., 2008; Wilcock et al., 2006). CWI serves as an effective analgesic post-exercise, reducing perceived muscle soreness and fatigue following high-intensity exercise or matches (Leeder, Gissane, Van Someren, Gregson, & Howatson, 2012; Webb et al., 2013). In cases where participants were provided with information sheets on the efficacy of CWI, a prior belief in the benefits of CWI as well as the cold stimulus itself resulted in significantly higher ratings of physical and mental readiness for exercise ( $p < .05$ ), as well as a significantly higher rating of vigour ( $p < .05$ ) (Broatch, Petersen, & Bishop, 2014).

A comparison between the effects of CWI and PAR revealed that CWI resulted in a significantly greater ( $p = .04$ ) decrease in perceived muscle soreness 2 hours post-exercise in rugby players (Pointon & Duffield, 2012) and CWI restored perceived fatigue back to baseline line values 48 hours post-exercise among Australian football players, compared to PAR (Elias et al., 2012). PAR was also insufficient to aid perceived recovery post-exercise [as defined by the Total Quality Recovery Perception questionnaire (TQRP) scores] when compared to CWI in athletes

(Brophy-Williams, Landers, & Wallman, 2011). Despite these benefits of CWI, a lack of evidence exists with regard to the possible effect of CWI on perceptual recovery following rugby-specific exercises (Barnett 2006; Pointon & Duffield, 2012). This point is emphasised by the fact that psychological factors such as a reduced perception of muscle soreness and fatigue have the potential to positively affect players' work attitude, training compliance and competition performances (De Nardi et al., 2011; Tessitore, Meeusen, Cortis, & Capranica, 2007). More research is, therefore, required to determine the beneficial effects of recovery techniques on the psychological state of athletes (Tessitore et al., 2007).

Therefore, in view of the above-mentioned need, the aim of this study was to determine the difference between the acute effects of CWI and PAR on the mood states and the energy index of university-level rugby players post-exercise. Findings from this study may provide practitioners in the field of sports science with clarity concerning the efficiency of CWI or PAR to aid in the psychological recovery, and specifically the recovery of rugby players' mood states. Results may also reveal the usefulness of mood states and the POMS to evaluate the recovery of players in a time-efficient manner.

## **Method**

### ***Study design***

The design of the study was a pre-post research test design, with convenience sampling. An ethical application for approval by the Health Research Ethics Committee of the Faculty of Health Sciences of the institution where the research was conducted was submitted and a project number of NWU-00201-14-S1 was allocated to the project. The study was conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council.

### ***Participants***

A group of 23 u/21 university-level rugby players (mean age 20.1, SD = 0.41 years) of a South African university club voluntarily participated in the study. Participants were randomly assigned to either an experimental (n = 12) or control group (n = 11). Only players who were totally injury free at the time of testing were eligible to participate in the study. The study design, purpose and possible risks of the study were explained to the participants and written informed

consent was obtained from the participants before the investigation. The competitive rugby-playing experience of these players varied between 4 and 15 years, with an average of 10.20, SD = 2.80 years. Regarding position, the group consisted of 12 backline players and 11 forwards.

Each participant was instructed to sleep at least 8 hours during the evening and morning prior to the testing session. For at least 48 hours before the scheduled tests they also had to refrain from ingesting any drugs (e.g., alcohol, medicine) or participating in strenuous physical activity that could influence the physical, physiological or psychological responses of the body. Participants had to maintain their usual diet during the week of testing.

The participants arrived at the testing sessions in a rested and fully hydrated state. The players were tested during the in-season phase of their periodisation cycle. During the in-season phase the players spent an average of 1.8, SD = 0.70 hours a day on weight training for 3.50, SD = 0.90 days per week. They also spent an average of 2.4, SD = 1.20 hours a day on field training sessions for 3.9, SD = 0.70 days per week. During the time of testing they had already completed three months of a combined rugby conditioning programme, which consisted of field training sessions five times a week and gym resistance training sessions four times a week. The field training sessions were focused on rugby-specific drills, skills and activities aimed at improving the players' fitness levels and rugby skills. The gym resistance training sessions focused on improving players' functional muscle strength and explosive power.

### ***Procedure***

The research project was conducted over three consecutive days for three consecutive weeks. For the purpose of this study, only the data of the first day of the first week was used. On the first day of testing the players reported to the laboratory at 06:00 for baseline values to be taken. The baseline testing took place in a fasting state just after the players had woken up. The players completed the demographic and general information questionnaire as well as the Stellenbosch Mood Scale (STEMS) (Terry, Potgieter, & Fogarty, 2003b) during baseline testing.

After baseline measurements had been taken, the players were allowed to eat breakfast. At 11:00 they again reported to the laboratory in groups of four players each so that all the above-mentioned measurements could be repeated (pre-anaerobic). After completion of the STEMS,

the players were subjected to a high-intensity anaerobic training session of 15 minutes. Exactly 3 minutes after the anaerobic session (post-anaerobic), venous blood samples were collected and the players again completed the STEMS. Blood lactate was measured to ensure that the anaerobic session taxed the anaerobic glycolytic energy system totally and caused acute exhaustion. The blood samples were used to analyse the blood lactate concentration levels of the players. This was followed by a 20-minute PAR for the control group and 20 minutes of CWI for the experimental group. Three minutes after completion of the different recovery techniques the players again completed the STEMS (post-recovery).

### **Measuring instruments**

#### ***Demographic and general information questionnaire***

The rugby players' demographic and personal information was collected by means of the above-mentioned questionnaire. The rugby players' ages, exercising habits, injury incidence, competing levels and best performance were also obtained by means of this questionnaire.

#### ***Mood states***

The Stellenbosch Mood Scale (STEMS) of Terry and co-workers (2003b) is a dual-language (English and Afrikaans) questionnaire that is a derivative of the Profile of Mood States (POMS) of McNair, Lorr, and Droppleman (1971). The STEMS measures six subscales, i.e. tension, depression, anger, vigour, fatigue and confusion, with four items contributing to each subscale. Participants were requested to indicate "How are you feeling right now?" in terms of the 24 mood descriptors on a five-point Likert scale, anchored by descriptors ranging from "Not at all" [0], to "Extremely" [4]. Terry et al. (2003b) showed that all six mood scale items of the STEMS had acceptable internal consistency with alpha coefficient values that meet or exceed the .70 threshold of acceptability. A study in which the STEMS was used to measure the mood states of 56 male university rugby players (mean age: 22.26, SD = 1.39 years) also reported acceptable internal consistencies for the data of these players, with Cronbach alpha values ranging between .65 and .87 (Grobbelaar, Malan, Steyn, & Ellis, 2011). The criterion validity of the POMS-A (on which the STEMS is based) is supported due to relationships (0.67-0.90,  $p < .05$ ) with previously validated inventories such as Positive and Negative Affect Schedule (PANAS), the State-Trait Anger-expression Inventory (STAXI) and the original Profile of Mood States inventory (POMS) (Terry, Lane, & Fogarty, 2003a).

The STEMS was completed by the players at 4 time points, namely during baseline, the pre-anaerobic, post-anaerobic and post-recovery periods. In order to avoid the carryover effect due to memory, the order of questions in the STEMS was changed for each of the time periods that players filled in the questionnaire.

### ***Anaerobic session***

Players completed a 15-minute, high-intensity anaerobic session on the rugby field while wearing rugby boots under the supervision of a qualified Sport Scientist. The anaerobic session consisted of a 3-minute warm-up, followed by shuttle runs at different intensities and various distances for the remaining 12 minutes. Capillary blood from the hyperaemic fingertip was drawn from the fingertip by a test strip which has a siphoning action that draws the blood in exactly three minutes after completion of the anaerobic session. Capillary blood samples were used to analyse blood lactate by means of a Simplified Blood Lactate Test Meter Lactate Pro LT-1710 (Arkray Factory Inc., KDK Corporation, Shiga, Japan). The Lactate Pro Lactate Test Meter is a valid ( $r = 0.975 - 0.993$ ) and reliable instrument for measuring blood lactate (Medbø, Mamen, Olsen, & Evertsen, 2000). The lactate test meter was calibrated according to the manufacturer's specifications at the beginning of the test day. A numeric result was displayed *via* an easy to read, large LCD screen within 60 seconds after the blood sample had been drawn. The blood lactate analysis revealed an average value of 5.2,  $SD = 2.7$  ummol/L blood for players 3 minutes after the anaerobic session.

### ***Recovery sessions***

#### ***Passive recovery (PAR)***

The control group was subjected to passive recovery during which they had to be seated for the whole 20 minute period in a laboratory, of which the temperature was regulated at 24 °C.

#### ***Cold water immersion (CWI)***

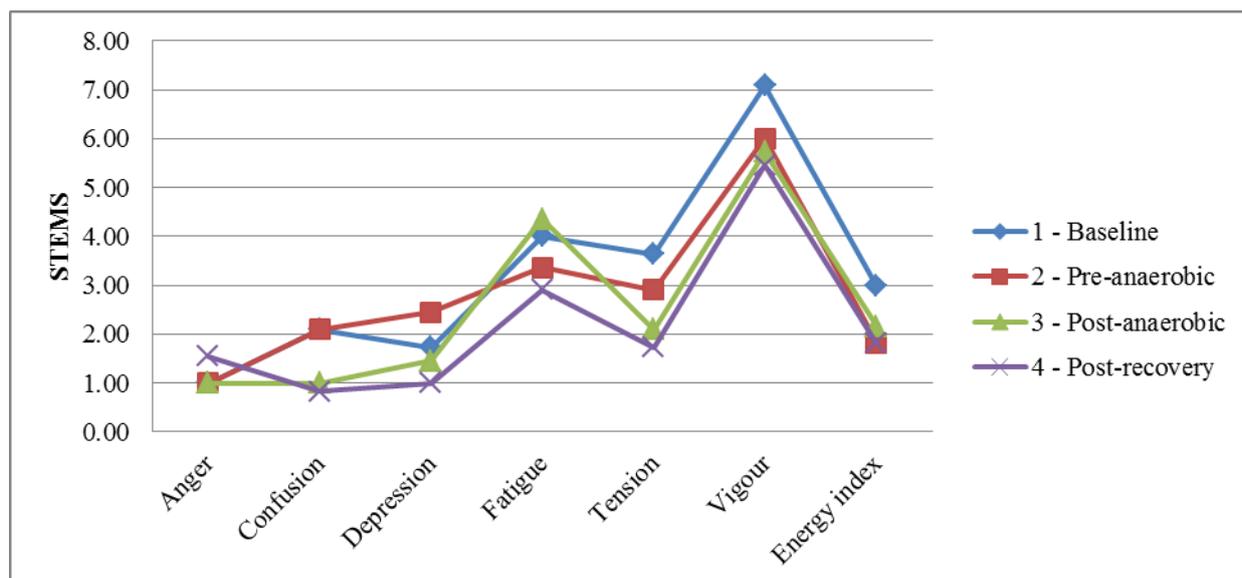
Players submerged themselves in a cryotherapy bath up to their umbilicus for a period of 20 minutes while standing still. The cryotherapy bath was regulated at a temperature of 8,  $SD = 1$  °C. Participants had to keep their hands and arms folded on their chests away from the water at all times. The reason why researchers decided to use 20 minutes as the period for CWI is that the majority of CWI-related studies used CWI for at least 20 minutes (Pritchard & Saliba, 2014).

### **Statistical analysis**

Firstly, the energy index scores were calculated for each of the players by dividing the vigour scores by the fatigue scores (Kenttä et al., 2006) for each data collection point and for each participant. Next, descriptive statistics (mean values (m) and standard deviations (SD)) were calculated for all variables. A dependent t-test was applied to determine if a significant difference existed between the baseline and pre-anaerobic STEMS subscale and energy index values for each of the groups. The results of the last-mentioned analysis were used to determine if the intake of food had any influence on the last-mentioned values. This was followed by a dependant t-test to determine the significant differences in the STEMS subscale and energy index values from pre-anaerobic to post-recovery within each of the groups. Next, a one-way between-groups analysis of covariance (ANCOVA) (with adjustment for the pre-anaerobic values) was performed to identify significant differences in the STEMS subscale values between groups. The level of significance was set at  $p \leq .05$ . The practical significance of differences between the two groups was determined by means of Cohen's effect sizes (ES) (small: ES ~ 0.2; medium: ES ~ 0.5; large: ES ~ 0.8) (Thomas, Nelson, & Silverman, 2011).

### **Results**

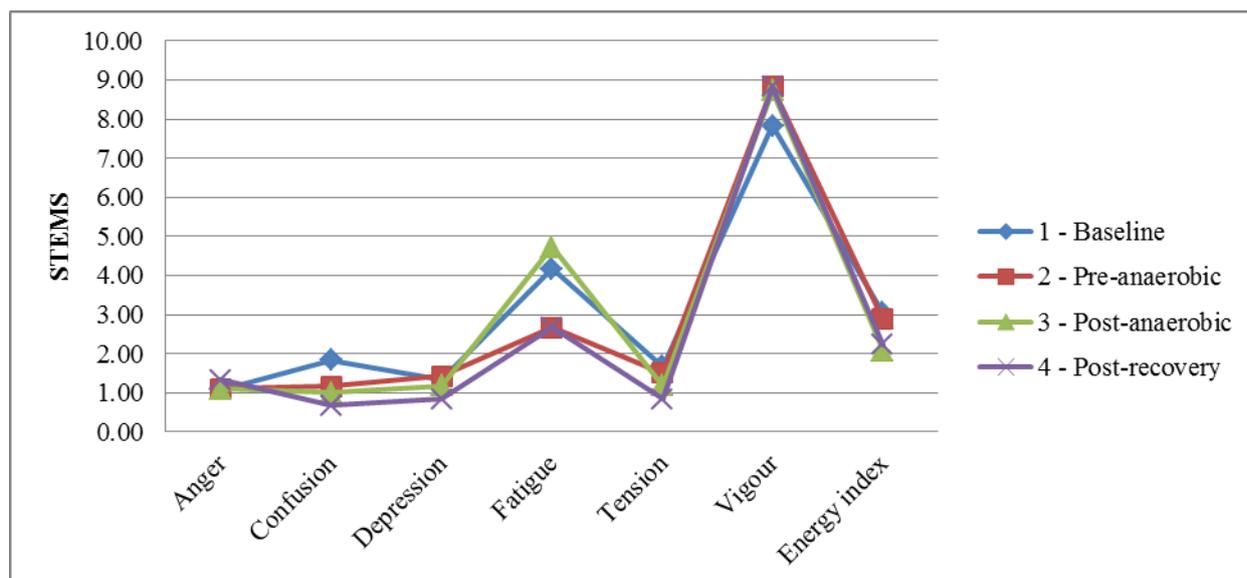
Figures 3.1 and 3.2 graphically display the mean values (m) for each of the STEMS subscales and energy index (vigour to fatigue ratio) of the control and experimental groups respectively for the different time periods of testing.



**Figure 3.1: Average STEMS subscale and energy index values of the control group for the different time periods of testing (baseline, pre-anaerobic, post-anaerobic and post-recovery)**

From the results as displayed in Figure 3.1 it is clear that the average anger STEMS subscale value remained unchanged (m: 1.00) from the baseline to post-anaerobic time periods, while the post-recovery value for anger increased (m: 1.55). The average value for the confusion subscale remained unchanged (m: 2.09) from the baseline to the pre-anaerobic time period, but showed a steady decrease from the pre-anaerobic (m: 1.00) to both the post-anaerobic and -recovery time periods (m: 0.82). For the depression subscale, the average baseline value (m: 1.73) increased during the pre-anaerobic time period (m: 2.45), while both the post-anaerobic (m: 1.45) and post-recovery value (m: 1.00) decreased below baseline values.

No fixed pattern was observed for changes in the fatigue subscale over time: baseline (m: 4.00), pre-anaerobic (m: 3.36), post-anaerobic (m: 4.36) and post-recovery (m: 2.91). In contrast, tension showed a steady decrease from the baseline to the post-recovery time periods: baseline (m: 3.64), pre-anaerobic (m: 2.91), post-anaerobic (m: 2.09) and post-recovery (m: 1.73). The average vigour value showed a similar trend by steadily declining over time: baseline (m: 7.09), pre-anaerobic (m: 6.00), post-anaerobic (m: 5.73), and post-recovery (m: 5.45). However, no fixed pattern of change was observed for the energy index: baseline (m: 2.98), pre-anaerobic (m: 1.82), post-anaerobic (m: 2.16) and post-recovery (m: 1.80).



**Figure 3.2: Average STEMS subscale and energy index values of the experimental group for the different time periods of testing (baseline, pre-anaerobic, post-anaerobic and post-recovery)**

The results in Figure 3.2 indicate that the average anger STEMS subscale value increased from the baseline (m: 1.08) to pre-anaerobic time period (m: 1.09), but remained unchanged for the post-anaerobic time period (m: 1.09), before increasing during the post-recovery time period (m: 1.33). A steady decrease was observed for the confusion subscale over all time periods: baseline (m: 1.83), pre-anaerobic (m: 1.17), post-anaerobic (m: 1.00) and post-recovery (m: 0.67). Depression increased from the baseline (m: 1.33) to the pre-anaerobic time period (m: 1.42), but decreased again to the post-anaerobic period (m: 1.18), after which it decreased drastically to below the baseline value in the post-recovery period (m: 0.83).

Fatigue showed no fixed pattern for changes over the different time periods: baseline (m: 4.17), pre-anaerobic (m: 2.67), post-anaerobic (m: 4.73) and post-recovery (m: 2.67). In contrast, the tension subscale showed a steady decrease over the different time periods: baseline (m: 1.67), pre-anaerobic (m: 1.50), post-anaerobic (m: 1.18) and post-recovery (m: 0.83). For vigour, the average value increased from the baseline (m: 7.83) to the pre-anaerobic time period (m: 8.83), after which a small decrease to post-anaerobic (m: 8.73), and a small increase to post-recovery (m: 8.83) were noted. Similar to the trend of the tension subscale, energy index values decreased steadily from the baseline (m: 3.05), pre-anaerobic (m: 2.88) to post-anaerobic (m: 2.08) time period, after which it increased again to the post-recovery time period (m: 2.23).

No significant difference was found for the STEMS subscale and energy index values between the baseline and pre-anaerobic values for either of the groups. Due to these results the researchers only made use of the pre-anaerobic time period's values for further analyses as food intake did not have a significant influence on the STEMS subscale and energy index values for any of the groups.

Descriptive statistics of both the control and experimental groups as well as the significance of differences between the pre-anaerobic and post-recovery STEMS subscale values and energy index values are presented in Tables 3.1 and 3.2 respectively.

**Table 3.1: Descriptive statistics of the control group (n = 11), as well as the dependent t-test and ES results of the STEMS subscale and energy index values for the pre-anaerobic and post-recovery time periods**

Subscale	Control group				P-value	ES
	Pre-anaerobic		Post-recovery (PAR)			
	Mean	SD	Mean	SD		
Anger	1.00	1.95	1.55	3.59	.38	0.28
Confusion	2.09	2.47	0.82	1.08	.02 <sup>#</sup>	0.52**
Depression	2.45	2.98	1.00	1.84	.02 <sup>#</sup>	0.49**
Fatigue	3.36	3.59	2.91	2.70	.41	0.13
Tension	2.91	2.81	1.73	2.28	.01 <sup>#</sup>	0.42*
Vigour	6.00	2.41	5.45	3.53	.64	0.23
Energy index	1.82	2.40	1.80	3.45	.98	0.01

SD = standard deviation; ES = effect size; \*\*\* = Large ES, \*\* = Medium ES, \* = Small ES; # =  $p \leq .05$

Results from Table 3.1 show that statistically significant and medium practical significant decreases were observed for confusion ( $p = .02$ ; ES = 0.52), depression ( $p = .02$ ; ES = 0.49) while a statistical significant and small practical significant decrease for tension ( $p = .01$ ; ES = 0.42) was observed from the pre-anaerobic to the post-recovery time periods. Anger, fatigue, vigour and the energy index showed no statistical nor practical significant differences between the pre-anaerobic and post-recovery values.

**Table 3.2: Descriptive statistics of the experimental group (n = 12) as well as the dependent t-test and ES results of the STEMS subscale and energy index values for the pre-anaerobic and post-recovery time periods**

Subscale	Experimental group				P-value	ES
	Pre-anaerobic		Post-recovery (CWI)			
	Mean	SD	Mean	SD		
Anger	1.09	1.71	1.33	2.57	.61	0.20
Confusion	1.17	0.94	0.67	1.61	.24	0.53**
Depression	1.42	2.43	0.83	1.53	.48	0.24
Fatigue	2.67	2.81	2.67	2.23	1.00	0.00
Tension	1.50	1.62	0.83	1.75	.09	0.41
Vigour	8.83	3.71	8.83	3.97	1.00	0.00
Energy index	2.88	3.62	2.23	2.04	.62	0.18

SD = standard deviation; ES = effect size; \*\*\* = Large ES, \*\* = Medium ES, \* = Small ES; # =  $p \leq .05$

From Table 3.2 it is evident that no statistically significant differences from the pre-anaerobic to post-recovery time periods were observed for any of the STEMS subscale scores or the energy index. However, confusion showed a medium practical significant (ES = 0.53) decrease from the pre-anaerobic to the post-recovery time period.

Table 3.3 presents the results of differences in the acute effects of the recovery interventions between the experimental and the control group.

**Table 3.3: Results of the ANCOVA (adjusted for pre-anaerobic time point differences) for the STEMS subscale and energy index changes between the experimental and the control group**

Subscale	Adjusted means		MSE	P-value	ES
	Experimental	Control			
Anger	1.33	1.55	4.28	.81	0.10
Confusion	0.88	0.59	1.20	.55	0.27
Depression	0.10	0.82	2.14	.78	0.12
Fatigue	2.86	2.70	2.81	.82	0.10
Tension	1.34	1.18	1.27	.75	0.14
Vigour	8.37	5.96	13.70	.17	0.65**
Energy index	2.16	1.88	8.01	.82	0.10

MSE = mean square error; ES = effect size; \*\*\* = Large ES, \*\* = Medium ES, \* = Small ES; # =  $p \leq .05$

From Table 3.3 it is clear that no statistically or practical significant differences in the post-recovery values for the anger, confusion, depression, fatigue, and tension subscales or the energy index were observed between the experimental and the control group after adjusting for differences in the pre-anaerobic values (Table 3.3). Although not statistically significantly different, the vigour subscale revealed a higher practically significant value (ES = 0.65) for the experimental compared to the control group.

### Discussion

Although the PAR group showed more statistically and practical significant changes from the pre-anaerobic to the post-recovery time period for the STEMS mood subscales compared to the CWI group, vigour was the only mood subscale for which the CWI group obtained higher practical significant (ES = 0.65) values compared to the PAR group. However, the reader must realise that in cases where PAR or CWI had the desired recovery effect on the mood state subscales of players, the post-recovery values would be similar to the pre-anaerobic values and would, therefore, not provide statistically or practical significant differences. This would mean that players' mood states returned to levels that were observed before the execution of the exhausting anaerobic session. On the other hand it is also possible that the different recovery techniques had a positive effect on the players' negative mood state subscales (such as anger,

confusion, depression, fatigue and tension) with values that significantly decreased from the pre-anaerobic to the post-recovery time period. *Vice versa*, recovery techniques may also lead to a significant increase in a positive mood subscale such as vigour and the energy index (vigour to fatigue ratio) from the one time period to the next.

In view of the last-mentioned explanation, it is clear that PAR resulted in acute psychological recovery for all the STEMS subscales. Negative mood states such as confusion, depression and tension even showed statistically ( $p < .05$ ) and practical significant ( $ES = 0.4 - 0.5$ ) decreases from the pre-anaerobic to the post-recovery time period. The anger and vigour subscales as well as the energy index showed a non-significant increase, decrease and decrease respectively from the pre-anaerobic to the post-recovery time period, which is an indication that psychological recovery occurred.

Overall, these results are in contrast to the results of studies that have thus far investigated the effects of PAR on the psychological recovery of sports participants. For example, neither perceived muscle soreness nor perceptions of fatigue were improved by PAR post-exercise in well-trained runners (Hauswirth et al., 2011). Moreover, Suzuki et al. (2004) found that the fatigue POMS subscale values increased significantly ( $p = .05$ ) where PAR was applied directly after a rugby match. In addition, the same group of researchers also recorded no significant changes in the tension subscale value immediately after the match, but observed decreases in the tension value two days after the match (Suzuki et al., 2004). However, tension was significantly decreased only after the application of active recovery compared to PAR. In line with findings from this study, the same researchers also recorded no significant changes in post-match POMS anger and vigour subscale values immediately, one day or two days following PAR in a group of rugby players (Suzuki et al., 2004). Furthermore, although short-term PAR did not bring elite kayakers' POMS energy index values back to baseline values during the second and third week of a three-week training camp (Kenttä et al., 2006), short-term PAR was efficient in restoring the kayakers' energy index closely back to baseline. PAR also did not have any significant effect on the RPE of elite cyclists after high-intensity exercise or on the RPE of athletes after eccentric exercises in studies by Vaile et al. (2007; 2008). One study even showed that cyclists' legs felt heavy and stiff after PAR in between cycling trials (Lane & Wenger, 2004).

One probable reason for the differences in the outcome of PAR on the psychological recovery of participants in our study compared to participants of other studies is methodological differences. For example, Suzuki et al. (2004) examined the effects of PAR after the conclusion of an 80-minute rugby match which was interrupted by 10 minutes of rest at half time, compared to our study, which made use of a 15 minute anaerobic session. Furthermore, in our study the extent of physical exertion and fatigue was evaluated by determining the post-exercise blood lactate levels, which were observed to be 5.2, SD = 2.7 ummol/L blood on average. This indicates that the anaerobic session taxed the anaerobic glycolysis energy system and caused fatigue.

Suzuki and co-workers (2004) did not evaluate the extent of fatigue or give any indication of the demands that were placed on the body during match-play. Furthermore, Suzuki et al. (2004) interpreted results by only focusing on statistically significant differences in the POMS subscale values between time periods as an indication of psychological recovery. As was previously discussed, we regarded non-significant changes from pre-anaerobic to post-recovery time periods to be an indication of acute psychological recovery. Also, despite previous findings which showed an exhausting anaerobic exercise session will have a detrimental acute effect on the mood states of athletes (Kenttä et al., 2006), findings of this study suggest that the exercise session had a beneficial effect on the negative mood states (confusion, depression and tension) of rugby players. The recovery of these post-recovery mood states was therefore not only caused by PAR but also by the exercise session itself.

Similar to the outcome of PAR, CWI also resulted in acute psychological recovery for all the STEMS subscales. However, in contrast to the effects of PAR, confusion was the only negative mood state that displayed a practical significant decline (ES = 0.53) from the pre-anaerobic to the post-recovery time period. All the remaining mood states and the energy index showed non-significant differences between the last-mentioned time periods. Studies that have thus far examined the possible acute psychological recovery capabilities of CWI reported significantly reduced ( $p = .02$ ) perceived fatigue post-exercise in young soccer (De Nardi et al., 2011) and Australian football players (Elias et al., 2012), although perceived fatigue was only restored back to baseline line levels at 48 hours post-exercise in the Australian football players. In addition, Brophy-Williams et al. (2011) examined the effects of CWI after high-intensity exercise and recorded significantly higher scores in perceived recovery (as defined by TQRP questionnaire

scores) immediately ( $p = .02$ ) and at 3 hours ( $p = .04$ ) post-exercise. With regard to vigour, researchers have suggested that vigour plays an important role in reflecting athletes' subjective measurements of being alive and vigorous or having energy and can be influenced by recovery experiences (Sonnetag & Niessen, 2008).

Although the design of this study did not allow the researchers to determine the reasons underlying the psychological recovery that participants experienced due to CWI, several possible reasons may be provided. Firstly, various researchers have alluded to the fact that the popularity of CWI as a recovery technique as well as the frequency of use may influence the effectiveness of CWI due to athletes' prior belief that CWI will have a positive outcome (Leeder et al., 2012; Stacey, Gibala, Martin Ginis, & Timmons, 2010). This notion was confirmed by Broatch et al. (2014), who found that a prior belief in the benefits of CWI as well as the cold stimulus itself resulted in significantly higher ratings of physical and mental readiness for exercise ( $p < .05$ ) as well as the rating of vigour ( $p < .05$ ) following CWI compared to thermo-neutral immersion. Therefore it is possible that the perception of participants in the present study might have been influenced by the athletes' belief and expectation that CWI would positively benefit their recovery. In addition, Wilcock et al. (2006) state that buoyancy during water immersion will lead to a reduction in the gravitational forces that act on the musculoskeletal system, which will ultimately cause increased relaxation of muscles and a subsequent a reduction in perceived fatigue. The same researchers also argue that the weightlessness that is experienced during water immersion decreases the perceptions of fatigue due to a reduction in neuromuscular signal magnitudes and energy conservation (Wilcock et al., 2006).

From the above discussion it is clear that both PAR and CWI had beneficial effects on the acute recovery of rugby players' mood states directly after the execution of a high-intensity exercise session. However, in order to obtain an answer with regard to the significance of PAR compared to CWI on the acute recovery of the different STEMS mood state subscales, an ANCOVA was performed. The results of this analysis revealed neither statistically nor practically significant differences in pre-anaerobic and post-recovery changes for anger, confusion, depression, fatigue, tension and the energy index between CWI and PAR. Vigour was the only subscale for which a higher practically significant change ( $ES = 0.65$ ) was observed for the experimental (CWI)

compared to the control group (PAR). Therefore, CWI can be regarded as a more effective recovery technique for the post-exercise acute recovery of vigour, compared to PAR.

To the researchers' knowledge, until now researchers have not compared the efficacy of CWI and PAR on the acute recovery of rugby players' mood states. However, studies that have compared CWI to PAR in athlete populations reported CWI to be significantly more beneficial, especially in reducing perceptions of fatigue (Brophy-Williams et al., 2011; De Nardi et al., 2011; Elias et al., 2012), and perceived muscle soreness (Higgins et al., 2013; Ingram et al., 2009; Leeder et al., 2012; Pointon & Duffield, 2012) post-exercise.

Stacey et al. (2010) raised the possibility that CWI may provide athletes with heightened perceptions of well-being and a reduced sensation of pain due to the finding that athletes indicated that their lower extremities generally felt better following CWI when compared to PAR. These athletes felt better despite of increased quadriceps pain levels (as measured by VAS scores) and RPE during successive cycling bouts (Stacey et al., 2010). CWI may therefore be effective in creating a feel-good perception, which may explain why vigour was more significantly influenced by CWI compared to PAR. According to Venter et al. (2010), the belief of rugby players in particular that CWI would reverse the possible negative effects of collisions and tackles may also play a role in the perceived effectiveness of CWI post-exercise. As was also mentioned before, vigour is sensitive to participants' recovery experiences (Sonnetag & Niessen, 2008), which may also partly explain the vigour results.

From the results in Figures 3.1 and 3.2 it is clear the anaerobic session positively benefited three of the six STEMS mood subscales, namely confusion, depression and tension, which decreased from the baseline to the post-anaerobic time period. Only fatigue and vigour subscales and the energy index (vigour to fatigue ratio) were negatively influenced by the anaerobic session with an increased value for fatigue and decreased values for vigour and the energy index from the baseline to the post-anaerobic time period. The average anger subscale values remained unchanged for these time periods. Therefore, although the anaerobic exercise session led to physiological exhaustion, as indicated by the high post-exercise blood lactate levels, the mood state-related results show that the anaerobic exercise did not have a similar effect on the psychological state of players. In fact, the anaerobic exercise session had the opposite effect by

causing a decrease in the negative mood states (confusion, depression and tension) of players. As was mentioned before, these results are quite surprising in view of previous research, which showed that exhausting anaerobic exercise had a detrimental acute effect on the mood states of athletes (Kenttä et al., 2006). In contrast, a positive mood state such as vigour was negatively influenced by the anaerobic session, which is more in line with the findings of previous research.

These findings place a question mark on the use of mood states, especially negative mood states (such as confusion, depression and tension), as indicators of psychological recovery. They also contradict the notion that a strong link or relationship exists between physiological and psychological fatigue (Stacey et al., 2010). Therefore, for most of the negative mood state subscales both the exercise session and the recovery techniques ultimately had a beneficial effect. Negative mood state subscale values decreased just after execution of the exercises session, but decreased even further after completion of the recovery techniques. Fatigue, vigour and energy index were the only mood state-related variables that showed a different trend, with the values in most cases being more positively influenced by PAR or CWI compared to anaerobic exercise.

Overall, the findings from the present study suggest that more research is needed to verify the theory that mood state changes may be effectively used to assess the efficiency of various recovery techniques and the negative impact of high intensity exercise (Barnett, 2006). Some researchers even state that athletes may in certain cases experience a false sense of well-being and increased perceptions of recovery even though psychological recovery did not occur (Stacey et al., 2010). This false sense of well-being and recovery may even increase players' risk of injuries and overtraining.

## **Conclusion**

As far as the researchers know, this is the first study to compare the efficacy of CWI and PAR with respect to the acute recovery of sport participants' STEMS derived mood states after a strenuous exercise session. Previous studies mostly focused on perceived fatigue, muscle soreness and POMS mood states when investigating psychological recovery in athletes. However, despite the uniqueness of this study, results show that when compared to PAR, CWI did not aid more in the acute psychological recovery of university-level rugby players' mood

states. Vigour was the only mood state subscale for which the CWI group showed a medium practical significant difference ( $ES = 0.65$ ) compared to the PAR group.

Therefore, CWI compared to PAR may not be sufficient or successful in causing the complete acute psychological recovery of rugby players. However, more research is needed to fully understand the role of both CWI and PAR in causing acute psychological recovery, specifically as it relates to the mood state recovery of athletes. Practitioners and players are, therefore, advised to examine and apply other recovery techniques in conjunction with CWI and PAR to ensure complete acute psychological recovery after training and matches. It is also important to educate athletes on the benefits of recovery techniques and to strengthen their belief in the use of these techniques.

Furthermore, it would be of value to establish the link between psychological and physiological responses to exercise and recovery as the amount of physical and physiological fatigue post-exercise as indicated by the high average blood lactate value did not correspond to a compatible increase in psychological fatigue as measured by the changes in STEMS subscales and energy index. This finding is also in direct contrast to the fundamental premise of this study that an anaerobic exercise session will have an acute detrimental effect on the mood states of players, as the anaerobic exercise had the opposite effect by benefitting especially the negative mood states. These results influenced the total study outcome and made the interpretation of the study's findings very difficult.

Several shortcomings of this study should, however, be considered when interpreting the data. Even though an attempt was made to prevent a carryover effect of the STEMS questionnaire's answers from one testing period to the next, the possibility exists that carryover still occurred. The use of other measuring instruments (e.g., interviews) that do not use the questionnaire format to evaluate acute recovery and fatigue indicators is, therefore, recommended. Furthermore, due to the possibility that individual differences in the psychological response to anaerobic exercise and the recovery techniques may have influenced the results, it would be advisable to rather make use of a cross-over design for future studies. This design will reduce the possible influence of a confounding covariate such as individual differences in the reaction to exercise and acute recovery sessions and also make the study more efficient when rather small

sample sizes are used. Furthermore, as fatigue, vigour and energy index were the only mood state-related variables that were more positively influenced by PAR or CWI compared to exercise, it would be advisable to rather make use of other psychological recovery indicators than mood states which are better linked to physiological recovery. Lastly, a rugby match or full training session would serve as a better and more sport-specific intervention to bring about physiological and psychological fatigue to test the acute response to different recovery techniques compared to a 15-minute anaerobic session.

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## **Chapter 4**

# **The difference between the acute effects of contrast water therapy and passive recovery on the mood states of university- level rugby players**

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## **4. The difference between the acute effects of contrast water therapy and passive recovery on the mood states of university-level rugby players**

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This article will be submitted for publication in the *Journal of Applied Sport Psychology*. This article is hereby included according to the specific prescriptions of the journal. Although not in accordance with the guidelines of the journal, tables and figures were included in the text to make the article easier to read and understand. Furthermore, the line spacing of the article was set at one-and-a-half lines and the first line of a paragraph is not indented to conform to the rest of the layout of the dissertation. The instructions for authors are included as Appendix F: Guidelines for authors: Journal of Applied Sport Psychology.

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## THE DIFFERENCE BETWEEN THE ACUTE EFFECTS OF CONTRAST WATER THERAPY AND PASSIVE RECOVERY ON THE MOOD STATES OF UNIVERSITY-LEVEL RUGBY PLAYERS

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### Abstract

We compared the acute effects of contrast water therapy (CWT) and passive recovery (PAR) on the mood states of university-level rugby players after an anaerobic exercise bout. The Stellenbosch Mood Scale (STEMS) was completed over four time periods by twenty-three under 21 university-level rugby players who either completed CWT (n = 11) or PAR (n = 10) for 20 minutes. Neither the experimental nor the control group experienced significant pre-anaerobic and post-recovery changes for any of the STEMS subscale or energy index values. CWT compared to PAR did have a statistically and practically significant more beneficial effect on vigour ( $p = .05$ ;  $ES = 0.92$ ), with a large practical significant decrease in fatigue ( $ES = 0.88$ ) after the anaerobic exercise bout.

**Keywords:** contrast water therapy; passive recovery; psychological recovery; mood states; rugby union

### Introduction

Recovery techniques after training or competitions have become an integral part of elite athletes' training regimes (Barnett, 2006). The purposes of these recovery techniques are to accelerate recovery, optimise subsequent training sessions, increase the effect of a given training load and maintain optimal performance (Elias et al., 2012; Ingram, Dawson, Goodman, Wallman, & Beilby, 2009; Versey, Halson, & Dawson, 2012). An imbalance between the stress of training demands and recovery over time could lead to a decline in performance and subsequent overtraining (Barnett, 2006; Lambert & Van Wyk, 2009). Coaches should, therefore, establish an

optimal balance between training and recovery to ensure the complete physiological and psychological recovery of athletes (Kellmann, 2010; Reilly & Ekblom, 2005; Suzuki et al., 2004). Rugby is an example of a sport where the physiological stress due to training and competition demands may lead to fatigue and cellular disturbances, which in turn may reduce performance (Leeder, Gissane, Van Someren, Gregson, & Howatson, 2012). However, apart from the physiological stress caused by rugby, players also have to deal with psychological, emotional, social and behavioural stressors (Venter, Potgieter, & Barnard, 2010; Suzuki et al., 2004). Contrast water therapy (CWT) and passive recovery (PAR) are among the most common recovery techniques that rugby players apply to achieve recovery (Barnett, 2006; Lambert & Van Wyk, 2009). However, despite numerous research findings on the efficiency of CWT and PAR for the physiological recovery of athletes post-exercise (De Nardi, La Torre, Barassi, Ricci, & Banfi, 2011; Higgins, Cameron, & Climstein, 2013), research with regard to the possible benefits of these recovery techniques on the psychological recovery of athletes is scarce and contradictory (Elias et al., 2012; Sayers, Calder, & Sanders, 2011).

Rugby union is characterised by frequent high-intensity bouts of sprinting and involves regular collisions and physical contact between opponents (Gill, Beaven, & Cook, 2006; Poynton & Duffield, 2012; Smart & Gill, 2011). The physiological stress from high-intensity exercise as experienced during a rugby match and training is associated with energy substrate depletion, hyperthermia, mechanical muscle damage, oxidative stress, inflammation and nervous system fatigue, which may ultimately lead to a decline in performance (Leeder et al., 2012:233). However, apart from the physiological stress due to the nature of the rugby union training and matches, players also experience psychological stress due to inadequate rest; concerns about possible injuries; pressure to perform from coaches; supporters and the media; travel and time spent away from home; additional pressure on those in leadership and tactical decision-making roles; relentless training and competition demands and competitive transitions between the end of one competition and the start of the next competition (Cresswell & Eklund, 2006).

Mood states, as measured by the Profile of Mood States (POMS) of (McNair, Lorr, and Droppleman, 1971) are one of the indicators of psychological stress due to the fact that disturbances in mood states may reflect an imbalance between training stress and recovery (Barnett, 2006). Mood as defined by Lane and Terry (2000) is “a set of feelings, ephemeral in

nature, varying in intensity and duration, and usually involve more than one emotion” (p. 16). West et al. (2013) found a significant increase in the mood disturbances of professional rugby union players at 12 hours ( $p = .031$ ) post-match before returning to baseline levels at 36 hours ( $p = .220$ ) and 60 hours ( $p = .954$ ) post-match. Morgan, Brown, Raglin, O’Connor, and Ellickson (1987) also argued that these mood state changes can be viewed in the light of reduced functional capacity such as reduced aerobic capacity ( $\dot{V}O_{2\max}$ ) in athletes, which may negatively affect optimal performance and training ability. However, the frequent application of recovery techniques during training and match-play periods may assist athletes in alleviating the negative effects of training and match demands (Barnett, 2006).

PAR is a recovery technique where the body is allowed to recover without any intervention (Lambert & Van Wyk, 2009). Athletes are, therefore, encouraged to rest and not to engage in any additional exercises during the rest period (Suzuki et al., 2004). Regarding mood states, Suzuki et al. (2004) found that PAR did not significantly improve the anger and vigour subscale scores of the POMS in rugby players after a match. Furthermore, Suzuki and co-workers (2004) found that directly after match-play, the fatigue subscale value of the POMS increased significantly following PAR, while the tension subscale score did not significantly decrease after two days following PAR when compared to active recovery. From the last-mentioned research findings, it is clear that PAR was ineffective in recuperating rugby players’ mood states after match-play. A daily training load of three training sessions per day for three consecutive weeks caused a consistent decline in the energy index (ratio of POMS vigour to fatigue) of elite kayakers, while both short- (rest for one night) and long-term (rest for two nights and one day) PAR resulted in an increase in the energy index very close to fully restored levels during the first week (Kenttä, Hassmén & Raglin, 2006). However, as fatigue progressively accumulated throughout the three weeks, the energy index gradually declined below baseline levels ( $p = .02$ ) during the second and third week, and neither short- nor long-term PAR was successful in restoring the POMS energy index back to baseline levels (Kenttä et al., 2006).

Another recovery technique that has become popular in recent times is CWT (Versey et al., 2012). During CWT athletes alternate between cold and hot water immersion (Barnett, 2006; Ingram et al., 2009; Vaile, Gill, & Blazevich, 2007; Versey et al., 2012) for 30 to 300 seconds per temperature for a total duration of 4 to 30 minutes (Wilcock, Cronin, & Hing, 2006). A key

advantage of CWT is that no additional energy is used during the recovery process, especially if the conservation of energy is vital over an extended period of team work (e.g., heats, semi-finals) (Sayers et al., 2011). According to Calder (2005), as well as Sayers and co-workers (2011), benefits in applying CWT as a recovery technique include reduced perceived fatigue and sensations of delayed-onset muscle soreness (DOMS). Sayers et al. (2011) also concluded that recovery from perceived fatigue may possibly lead to better psychological well-being, which is a sign of psychological recovery. With regard to rugby union players, Webb, Harris, Cronin, and Walker (2013) found that CWT resulted in meaningfully reduced perceptions of muscle soreness (79%–95% chance of likely being beneficial) 18 to 42 hours post-match. In contrast, CWT caused significantly higher levels of perceived muscle soreness at 1 hour following collision-based exercises among rugby players when compared to PAR in a study by Higgins et al. (2013). These researchers also noted that 48 hours post-exercise, CWT resulted in the least recovery of perceived muscle soreness when compared to PAR (Higgins et al., 2013). Therefore, despite the potential of CWT to benefit post-exercise recovery, contradicting evidence exists with regard to CWT's efficiency in causing psychological recuperation or recovery.

From the abovementioned literature it is clear that limited and contradicting research exists with regard to the possible effects of CWT and PAR on the post-exercise mood states (psychological recovery) of rugby union players. More research is, therefore, required to investigate the potential of different recovery techniques to cause psychological recovery in athletes (Sayers et al., 2011). The outcome of this type of research may possibly allow athletes to address psychological fatigue post-exercise effectively, which ultimately may lead to the execution of higher-quality training sessions and, in the long term, better sport performances (Tessitore, Meeusen, Cortis, & Capranica, 2007). Consequently, the aim of this study was to determine the difference in the acute effects of CWT and PAR on the mood states of university-level rugby players.

## **Method**

### ***Study design***

The design of the study was a pre-post research test design, with convenience sampling. An ethical application for approval by the Health Research Ethics Committee of the Faculty of Health Sciences of the institution where the research was conducted was submitted and a project

number of NWU-00201-14-S1 was allocated to the project. The study was conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council.

### ***Participants***

A group of 23 under 21 university-level rugby players (mean age 20.1, SD = 0.41 years) of a South African club institute voluntarily participated in the study. Only 21 participants completed all the questionnaires, which meant that two participants were excluded from the study. Participants were randomly assigned to either an experimental (n = 11) or control group (n = 10). Only players who were totally injury free at the time of testing were eligible to participate in the study. The study design, purpose and possible risks of the study were explained to the participants and written informed consent was obtained from the participants before the investigation. The competitive rugby-playing experience of these players varied between 4 and 15 years, with an average of 10.20, SD = 2.80 years. Regarding position, the group consisted of 11 backline players and 10 forwards.

Each participant was instructed to sleep at least 8 hours during the evening and morning prior to the testing session. They also had to refrain from ingesting any drugs (e.g., alcohol, medicine) or participating in strenuous physical activity that may influence the physical, physiological or psychological responses of the body for at least 48 hours before the scheduled tests. Participants had to maintain the same diet during the week of testing. The participants arrived at the testing sessions in a rested and fully hydrated state. The players were tested during the in-season phase of their periodization cycle. During the in-season phase the players spend an average of 1.8, SD = 0.70 hours a day on weight training for 3.50, SD = 0.90 days per week. They also spend an average of 2.4, SD = 1.20 hours a day on field training sessions for 3.9, SD = 0.70 days per week. During the time of testing they had already completed three months of a combined rugby conditioning programme, which consisted of field training sessions five times a week and gym resistance training sessions four times a week. The field training sessions were focused on rugby-specific drills, skills and activities aimed at improving the players' fitness levels and rugby skills. The gym resistance training sessions focused on improving players' functional muscle strength and explosive power.

### ***Procedure***

The research project was conducted over three consecutive days for three consecutive weeks. For the purpose of this study, only the data of the first day of the first week was used. During the first day of testing the players reported to the laboratory at 06:00 in the morning for baseline values to be taken. The baseline testing took place in a fasting state just after the players had woken up. The players completed the demographic and general information questionnaire as well as the Stellenbosch Mood Scale (STEMS) (Terry, Potgieter, & Fogarty, 2003b) during baseline testing.

After baseline measurements had been taken, players were allowed to eat breakfast. At 11:00 they again reported to the laboratory in groups of four players each so that all the above-mentioned measurements could be repeated (pre-anaerobic). After completion of the STEMS, players were subjected to a high-intensity anaerobic training session of 15 minutes. Exactly three minutes after the anaerobic session (post-anaerobic), venous blood samples were collected and the players again completed the STEMS. Blood lactate was measured to ensure that the anaerobic session taxed the anaerobic glycolytic energy system totally and caused acute exhaustion. The blood samples were used to analyse the blood lactate concentration levels of the players. This was followed by a 20-minute PAR for the control group and 20 minutes of CWT for the experimental group. Three minutes after completion of the different recovery techniques the players again completed the STEMS (post-recovery).

### **Measuring instruments**

#### ***Demographic and general information questionnaire***

The rugby players' demographic and personal information was collected by means of the above-mentioned questionnaire. The rugby players' ages, exercising habits, injury incidence, competing levels and best performance were also obtained by means of this questionnaire.

#### ***Mood states***

The Stellenbosch Mood Scale (STEMS) of Terry and co-workers (2003b) is a dual language (English and Afrikaans) questionnaire that is a derivative of the Profile of Mood States (POMS) of McNair et al. (1971). The STEMS measures six subscales, i.e. tension, depression, anger, vigour, fatigue and confusion, with four items contributing to each subscale. Participants were requested to indicate "How are you feeling right now?" in terms of the 24 mood descriptors on a

five-point Likert scale, anchored by descriptors ranging from “Not at all” [0], to “Extremely” [4]. Terry et al. (2003b) showed that all six mood scale items of the STEMS showed acceptable internal consistency for all groups with alpha-coefficient values that met or exceeded the 0.7 threshold of acceptability. A study in which the STEMS was used to measure the mood states of 56 male university rugby players (mean age: 22.26, SD = 1.39) also reported acceptable internal consistencies for the data of these players, with Cronbach alpha values ranging between .65 and .87 (Grobbelaar, Malan, Steyn, & Ellis, 2011). The criterion validity of the POMS-A (on which the STEMS is based) is supported due to relationships (0.67 – 0.90,  $p < .05$ ) with previously validated inventories such as Positive and Negative Affect Schedule (PANAS), the State-Trait Anger-expression Inventory (STAXI) and the original Profile of Mood States inventory (POMS) (Terry, Lane, & Fogarty, 2003a).

The STEMS was completed by the players over 4 time periods, namely during baseline, the pre-anaerobic, post-anaerobic and post-recovery periods. In order to avoid the carryover effect due to memory, the order of questions in the STEMS was changed for each of the time periods that players filled in the questionnaire.

### ***Anaerobic session***

Players completed a 15-minute, high-intensity anaerobic session on the rugby field while wearing rugby boots under the supervision of a qualified sport scientist. The anaerobic session consisted of a 3-minute warm-up, followed by shuttle runs at different intensities and various distances for the remaining 12 minutes. Capillary blood from the hyperaemic fingertip was drawn by a test strip which has a siphoning action that draws the blood in exactly three minutes after completion of the anaerobic session. Capillary blood samples were used to analyse blood lactate by means of a Simplified Blood Lactate Test Meter Lactate Pro LT-1710 (Arkray Factory Inc., KDK Corporation, Shiga, Japan). The Lactate Pro Lactate Test Meter is a valid ( $r = 0.975-0.993$ ) and reliable instrument for measuring blood lactate (Medbø, Mamen, Olsen, & Evertsen, 2000). The lactate test meter was calibrated according to the manufacturer’s specifications at the beginning of the test day. A numeric result was displayed via an easy-to-read, large LCD screen within 60 seconds after the blood sample had been drawn. The blood lactate analysis revealed an average value of 5.2, SD = 2.7 ummol/L blood for players 3 minutes after the anaerobic session.

### ***Recovery sessions***

#### *Passive recovery (PAR)*

The control group was subjected to passive recovery during which they had to be seated for the whole 20-minute period in a laboratory of which the temperature was regulated at 24 °C.

#### *Contrast water therapy (CWT)*

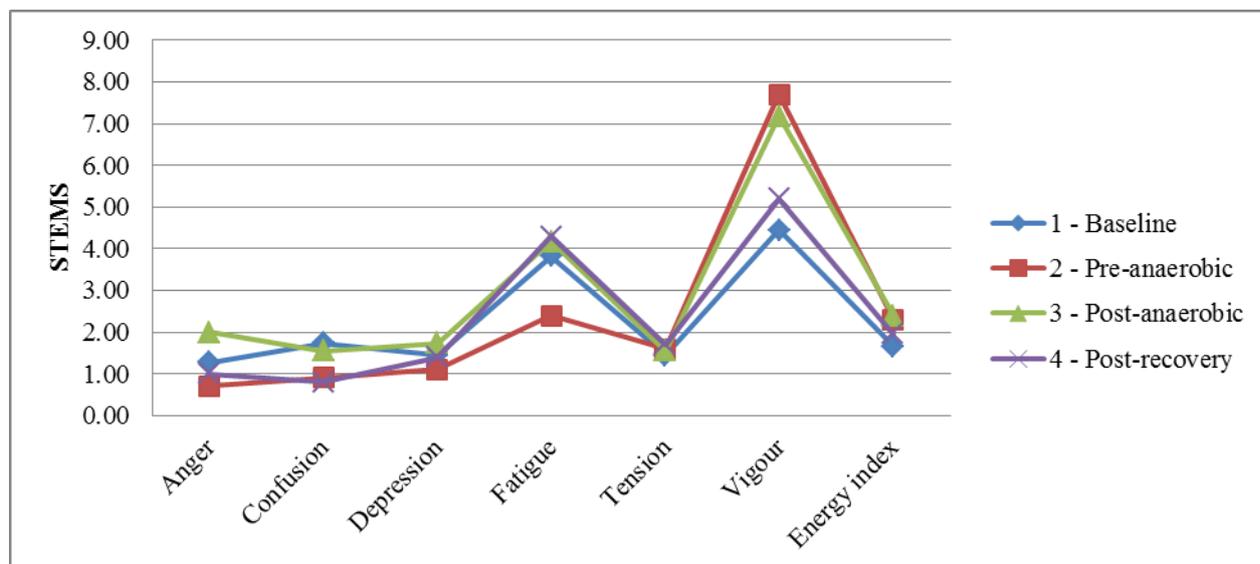
During this recovery technique participants were required to submerge themselves in a warm water pool, which was regulated at a temperature of 38, SD = 1 °C up to their umbilicus for a period of 3 minutes while standing still, followed by a quick transfer within 10 seconds to an adjacent cryotherapy bath (8, SD = 1 °C), where they had to submerge themselves up to their umbilicus for 1 minute. This 4-minute regimen was completed five times so that the duration of the total recovery period was 20 minutes. Researchers have deemed the ratios of 3:1 to 4:1 for the duration of warm and cold water immersions to be effective for acute recovery of participants (Wilcock et al., 2006).

### **Statistical analysis**

Firstly, the energy index scores were calculated for each of the players by dividing the vigour by each of the fatigue scores (Kenttä et al., 2006) for each time point of data collection. Next, descriptive statistics (mean values and standard deviations (SD)) were calculated for all variables. A dependent t-test was applied to determine if a significant difference existed between the baseline and pre-anaerobic STEMS subscale and energy index values for each of the groups. The results of the last-mentioned analysis were used to determine if the intake of food had any influence on the last-mentioned values. This was followed by a dependant t-test, which was performed to determine the significant differences in the STEMS subscale values from pre-anaerobic to post-recovery within each of the groups. Next, a one-way between-groups analysis of covariance (ANCOVA) (with adjustment for differences in the pre-anaerobic values) was performed to identify significant differences in the STEMS subscale values between groups. The level of significance was set at  $p \leq 0.05$ . The practical significance of differences between the two groups was determined by means of Cohen's effect sizes (ES) (small: ES ~ 0.2; medium: ES ~ 0.5; large: ES ~ 0.8) (Thomas, Nelson, & Silverman, 2011).

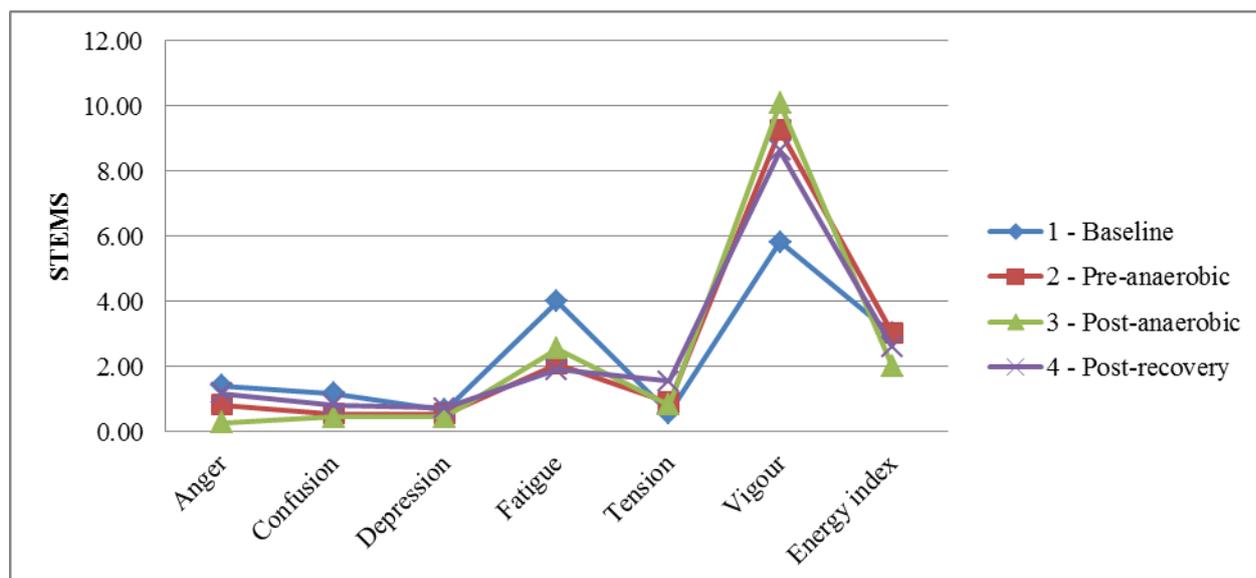
## Results

Figures 4.1 and 4.2 graphically display the mean values (m) for each of the STEMS subscales and energy index (vigour to fatigue ratio) of the control and experimental groups respectively for the different time periods of testing.



**Figure 4.1: Average STEMS subscale and energy index values of the control group for the different time periods of testing (baseline, pre-anaerobic, post-anaerobic and post-recovery)**

Results (Figure 4.1) show that no fixed pattern was observed for changes in the average anger STEMS subscale over time: baseline (m: 1.27), pre-anaerobic (m: 0.70), post-anaerobic (mean: 2.00) and post-recovery (m: 1.00). The average confusion, depression, fatigue and tension values showed a similar trend with no fixed pattern for changes over time: baseline (m: 1.73; 1.45; 3.82 and 1.45), pre-anaerobic (m: 0.90; 1.10; 2.40 and 1.60), post-anaerobic (m: 1.55; 1.73; 4.18 and 1.55) and post-recovery (m: 0.80; 1.40; 4.30 and 1.70). In contrast, for the vigour subscale, the average baseline value (m: 4.45) increased during the pre-anaerobic time period (m: 7.70), whereas both the post-anaerobic (m: 7.18) and -recovery values (m: 5.20) decreased, but not below baseline values. However, no fixed pattern of change was observed for energy index: baseline (m: 1.66), pre-anaerobic (m: 2.30), post-anaerobic (m: 2.40) and post-recovery (m: 1.95).



**Figure 4.2: Average STEMS subscale and energy index values of the experimental group for the different time periods of testing (baseline, pre-anaerobic, post-anaerobic and post-recovery)**

Results (Figure 4.2) indicate that a steady decrease was observed for the average anger STEMS subscale from the baseline (m: 1.42) to pre-anaerobic (m: 0.82) time period, after which it decreased drastically below the baseline value at the post-anaerobic (m: 0.27) time period, before increasing again at post-recovery (m: 1.18). Similar to the trend of the anger subscale, the average confusion and depression values steadily decreased from baseline (m: 1.17 and 0.67), pre-anaerobic (m: 0.55 and 0.55) to post-anaerobic (m: 0.45 and 0.45) time periods, before showing an increase at post-recovery (m: 0.82 and 0.73). Fatigue and tension showed no fixed pattern for changes over the different time periods: baseline (m: 4.00 and 0.58), pre-anaerobic (m: 2.09 and 0.91), post-anaerobic (m: 2.55 and 0.82) and post-recovery (m: 1.91 and 1.55). However, for vigour, the average value drastically increased from baseline (m: 5.83) to pre-anaerobic (m: 9.27) and post-anaerobic (m: 10.09) time periods, but then decreased again at the post-recovery (m: 8.64) time period. The energy index value increased from baseline (m: 3.02) to the pre-anaerobic time period (m: 3.04) but then decreased below baseline at the post-anaerobic period (m: 2.03) before showing an increase again at the post-recovery (m: 2.62) time period.

No significant differences were found for any of the STEMS subscales or the energy index values between the baseline and pre-anaerobic values for each of the groups. Due to these results

the researchers only made use of the pre-anaerobic time period's values for further analyses as food intake did not have a significant influence on the STEMS subscale and energy index values for any of the groups.

Descriptive statistics of both the control and experimental groups as well as the significance of differences between the pre-anaerobic and post-recovery STEMS subscale and energy index values are presented in Table 4.1 and 4.2 respectively.

**Table 4.1: Descriptive statistics of the control group (n = 10) as well as the dependent t-test and ES results of the STEMS subscale and energy index values for the pre-anaerobic and post-recovery time periods**

Subscale	Control group				P-value	ES
	Pre-anaerobic Mean	Pre-anaerobic SD	Post-recovery (PAR) Mean	Post-recovery (PAR) SD		
Anger	0.70	1.64	1.00	1.89	.70	0.18
Confusion	0.90	1.20	0.80	1.32	.85	0.08
Depression	1.10	1.52	1.40	3.27	.74	0.20
Fatigue	2.40	2.27	4.30	3.30	.06	0.84***
Tension	1.60	1.90	1.70	2.83	.92	0.05
Vigour	7.70	4.88	5.20	3.49	.83	0.51**
Energy index	2.30	3.30	1.95	2.71	.33	0.73***

SD = standard deviation; ES = effect size; \*\*\* = Large ES, \*\* = Medium ES, \* = Small ES; # =  $p \leq .05$

No statistically significant differences between the pre-anaerobic and post-recovery values were observed for any of the six STEMS subscales or the energy index in the control group. Furthermore, no practical significant differences were recorded between the pre-anaerobic and the post-recovery values for the anger, confusion, depression and tension STEMS subscales. However, fatigue revealed a large practical significant increase (ES = 0.84) while vigour and the energy index revealed a medium and large practical significant decrease respectively (ES = 0.51; 0.73) from the pre-anaerobic to the post-recovery time period.

**Table 4.2: Descriptive statistics of the experimental group (n = 11) as well as the dependent t-test and ES results of the STEMS subscale and energy index values for the pre-anaerobic and post-recovery time periods**

Subscale	Experimental group				P-value	ES
	Pre-anaerobic		Post-recovery (CWT)			
	Mean	SD	Mean	SD		
Anger	0.82	1.33	1.18	2.99	.56	0.27*
Confusion	0.55	0.93	0.82	1.83	.39	0.29*
Depression	0.55	0.93	0.73	2.10	.77	0.19
Fatigue	2.09	1.70	1.91	2.02	.80	0.11
Tension	0.91	1.22	1.55	3.86	.57	0.52**
Vigour	9.27	4.05	8.64	3.64	.51	0.16
Energy index	3.04	3.96	2.62	3.00	.80	0.11

SD = standard deviation; ES = effect size; \*\*\* = Large ES, \*\* = Medium ES, \* = Small ES; # =  $p \leq .05$

For the experimental group, the results in Table 4.2 indicate that no statistically significant differences existed between the pre-anaerobic and post-recovery time periods for any of the six STEMS subscales or the energy index values. However, for the tension subscale a medium practical significant increase (ES = 0.52) occurred from the pre-anaerobic to the post-recovery time period.

Table 4.3 presents the results of differences in the acute effects of the recovery interventions between the experimental and control groups.

**Table 4.3: Results of the ANCOVA (adjusted for pre-anaerobic time point differences) for the STEMS subscale and energy index changes between the experimental and control group**

Subscale	Adjusted means		MSE	P-value	ES
	Experimental	Control			
Anger	1.13	1.05	5.00	.94	0.04
Confusion	0.97	0.64	1.82	.59	0.24
Depression	1.00	1.10	6.10	.92	0.04
Fatigue	2.00	4.20	6.24	.59	0.88***
Tension	1.73	1.50	11.45	.88	0.07
Vigour	8.27	5.61	8.28	.05 <sup>#</sup>	0.92***
Energy index	2.73	1.66	7.78	.42	0.39

MSE = mean square error; ES = effect size; \*\*\* = Large ES, \*\* = Medium ES, \* = Small ES; # =  $p \leq .05$

After adjustments for differences in the pre-anaerobic values of the two groups, the results in Table 4.3 show no statistically or practical significant differences between the post-recovery values for the anger, confusion, depression and tension STEMS subscales or the energy index for the experimental and control groups. Although the difference is not statistically significant, when compared to the control group, the experimental group revealed a practical significantly lower value for the fatigue subscale (ES = 0.88). Furthermore, compared to the control group, the experimental group revealed a statistically and practical significantly higher value for the vigour subscale ( $p = .05$ , ES = 0.92).

## Discussion

Although the PAR group showed more practical significant changes for the STEMS mood state subscales and the energy index values from the pre-anaerobic to post-recovery time periods than the CWT group, fatigue and vigour were the only mood state subscales that obtained practical or statistically significantly lower and higher values respectively, for the CWT compared to the PAR group. However, the reader must realise that in cases where PAR or CWT had the desired recovery effect on the mood state subscales of players, the post-recovery values would be similar to those of the pre-anaerobic values and would, therefore, not obtain statistically or practical significant differences. This would mean that players' mood states returned to levels that were

observed before performing the exhausting anaerobic session. On the other hand, it is also possible that the different recovery techniques had a positive effect on the players' negative mood state subscales (such as anger, confusion, depression, fatigue and tension), with values that significantly decreased from the pre-anaerobic to the post-recovery time period. *Vice versa*, recovery techniques may also lead to a significant increase in a positive mood subscale such as vigour and the energy index (vigour to fatigue ratio) from the one time period to the next.

In view of the last-mentioned explanation, it is clear that PAR resulted in acute psychological recovery for four of the six STEMS mood subscales. Negative mood subscales such as confusion showed a non-significant decrease, while anger, depression and tension all showed non-significant increases from the pre-anaerobic to the post-recovery time period. These results would, therefore, suggest that acute psychological recovery did occur. In contrast, PAR had a practical significant increasing and decreasing effect respectively on the fatigue (ES = 0.84) and vigour (ES = 0.51) subscale values from the pre-anaerobic to the post-recovery time period. In addition, a large practical significant decrease in the energy index value (ES = 0.73) occurred, which indicates that the participants' level of vigour relative to their fatigue level was lower and, therefore, caused their energy index to be negatively influenced. In view of the last-mentioned findings, PAR was insufficient in the acute psychological recovery of fatigue, vigour and the energy index (vigour to fatigue ratio) immediately after an anaerobic exercise bout.

Overall, these results are in contrast to the results of previous studies, which have also investigated the effects of PAR on the psychological recovery of athletes. For example, short-term PAR did not bring elite kayakers' POMS energy index values back to baseline values during the second and third week of a three-week training camp, although values recovered back to baseline values during the first week of training in kayakers (Kenttä et al., 2006). Kenttä et al. (2006) argued that a decline in the energy index values during the second and third week of the training camp could be a result of athletes' difficulty to cope with the excessive training demands or insufficient time for recovery. However, in line with the findings of this study, neither perceived muscle soreness nor perceived fatigue was improved by PAR in well-trained runners (Hauswirth et al., 2011). Similarly, Suzuki et al. (2004) also reported a significant increase ( $p = .05$ ) in the POMS fatigue subscale immediately after a rugby match when PAR was applied. However, in contrast to our findings, the vigour subscale in these players showed no significant

changes immediately after a rugby match when PAR was applied (Suzuki et al., 2004). In addition, the same researchers recorded no significant changes in anger and tension POMS values immediately one or two days following PAR in a group of rugby players (Suzuki et al., 2004). However, tension was only significantly decreased ( $p < .05$ ) two days after the match, with the application of active recovery compared to PAR (Suzuki et al., 2004).

One possible reason for the negative acute effect of PAR on the perceived fatigue and vigour of players post-exercise is that players may perceive PAR to be ineffective due to the fact that they were not actively doing anything to alleviate the fatigue due to exercise. This notion is supported by Lane and Wenger (2004), who reported that cyclists' legs felt fatigued and stiff between cycling trials where PAR was used as a recovery technique and ascribed this negative perception to the psychological effect of doing nothing to facilitate recovery post-exercise. In this regard an examination of a combination of recovery techniques led Lambert and Van Wyk (2009) to conclude that "something is better than nothing" with "nothing" referring to PAR. These arguments would suggest that participants' prior belief regarding the effectiveness or ineffectiveness of a specific recovery technique may influence the psychological benefits that are derived from the technique concerned (Stacey, Gibala, Martin Ginis, & Timmons, 2010).

The players who were subjected to CWT experienced non-significant decreases in fatigue, vigour and the energy index and non-significant increases in anger, confusion and depression from pre-anaerobic to post-recovery time periods. In view of these changes it is clear that CWT led to acute psychological recovery of five of the six STEMS mood state subscales as well as the energy index. However, CWT led to a medium practical significant increase ( $ES = 0.52$ ) on one of the negative mood state subscales, namely tension. Studies that have thus far examined the possible acute psychological recovery capabilities of CWT reported a significant reduction in perceived fatigue ( $p < .001$ ) among state-level hockey players after high-intensity exercise (Sayers et al., 2011). Similarly, Elias et al. (2012) found that CWT effectively reduced perceived fatigue at 1 hour, 24 hours and 48 hours post-exercise in Australian football players. Other researchers also observed a practically significant increase in perceived recovery (as measured by the Total Quality Recovery Perception (TQRP) scale) ( $ES = 0.69$ ) and a practical significantly lighter feeling of the legs ( $ES = 0.62$ ) in soccer players following match-play where CWT was applied (Kinugasa & Kilding, 2009). In contrast, De Nardi et al. (2011) found that CWT did not

result in a significant reduction in perceived fatigue in young soccer players after exercise over a 4-day training period. Despite the fact that whole body fatigue was not affected by post-exercise CWT in trained male runners, substantially lower levels of rating of perceived exertion (RPE) were recorded, following a 6 and 8-minute CWT session respectively (Versey et al., 2012). In contrast however, Vaile, Halson, Gill, and Dawson (2008) reported no significant decrease in the RPE among elite cyclists following CWT, but argued that this may have been due to the maximum effort required from participants, while after submaximal exercise results might have been different.

Although the design of this study did not allow the researchers to determine the reasons underlying the psychological recovery that participants experienced due to CWT, several possible reasons may be provided: Firstly, research suggests that CWT may enhance recovery by increasing blood flow, circulation, lactate removal and range of motion, whereas a decrease in the inflammatory response, perceptions of pain and stiffness may also occur (Wilcock et al., 2006). In this regard, Higgins et al. (2013) stated that most researchers have until now mainly focused on the acceleration of waste product removal through the muscle pump function as a physiological mechanism to explain the recovery effect due to CWT. However, researchers (Higgins et al., 2013; Wilcock et al., 2006) suggest that immersion times during CWT are insufficient to reduce deep muscle temperature sufficiently in order to increase vasoconstriction and vasodilation, which aid in causing the muscle pump function. Moreover, Wilcock et al. (2006) argued that a sudden immersion in cold water from hot water may not result in vasoconstriction but in vasodilation due to a shock response. Instead, Wilcock and co-workers (2006) propose that hydrostatic pressure from water immersion causing an inward and upward displacement of fluids would seem to be the physiological mechanism responsible for enhanced recovery. A displacement of body fluids would lead to a higher cardiac output, which will cause an increase in blood flow and subsequent increase in vasodilation in response to a higher arterial pressure (Wilcock et al., 2006). A higher blood flow will then aid in the metabolism of waste products post-exercise (Wilcock et al., 2006).

However limited research has investigated the psychological mechanisms that underlie the possible post-exercise recovery benefits of CWT. Some researchers postulate that the weightlessness of water immersion will reduce neuromuscular signal magnitudes and energy

conservation, which may lead to a decrease in the perception of fatigue (Wilcock et al., 2006). Furthermore, a reduction in the gravitational forces that act on the musculoskeletal system will cause muscle relaxation, which may also lead to an alleviation of perceived fatigue (Wilcock et al., 2006). Muscle relaxation due to CWT may also benefit participants' anger, confusion and depression STEMS subscale values. In addition, Versey et al. (2012) suggest that a placebo effect in CWT must be acknowledged, since athletes' existing beliefs are likely to influence their recovery responses. Even though these explanations would suggest that all of the mood state subscales would benefit from CWT, tension showed a practically significant increase from pre-anaerobic to post-recovery time periods. As was mentioned before, Wilcock et al. (2006) proposed that a sudden immersion in cold water from hot water might result in a shock response, which may cause discomfort and distress to participants. In view of the fact that participants ended the CWT with 1 minute of cold water immersion, it is possible that the discomfort and distress that are related to immersion in water at a low temperature ( $8 \pm 1$  °C), may have caused the participants to feel more tense.

From the above discussion it is clear that both PAR and CWT had beneficial effects on the acute recovery of the majority of rugby players' mood states directly after performing an anaerobic exercise session. However, in order to evaluate the differences in the significance of these acute beneficial effects between PAR and CWT, an ANCOVA was performed. The results of this analysis revealed no statistically or practical significant differences in changes from the pre-anaerobic to post-recovery time periods for anger, confusion, depression, tension and energy index between CWT and PAR. Fatigue and vigour were the only two subscales for which the experimental (CWT) group obtained significantly lower and higher changes respectively compared to the control (PAR) group. These results would suggest that CWT is more beneficial for the acute recovery of mood states than PAR immediately after a high-intensity exercise session. Similarly, other studies that have also compared CWT to PAR in athlete populations reported CWT to be significantly more beneficial, especially in reducing perceptions of fatigue (Elias et al., 2012; Sayers et al., 2011) and RPE (Versey et al., 2012), as well as in improving perceived recovery (Kinugasa & Kilding, 2009) post-exercise.

From the previous discussion it is clear that CWT will have a more pronounced effect on muscle relaxation, energy conservation and waste-product removal as well as a reduction in

neuromuscular signal magnitudes due to the increased hydrostatic pressure and weightlessness of water immersion, compared to PAR. This may explain the differences in perceived fatigue changes between the two recovery techniques.

With regard to vigour, researchers are of the opinion that vigour can be positively influenced by participants' recovery experiences (Sonnetag & Niessen, 2008). Vigour is described as a participant's subjective experiences of being alive and vigorous or having energy (Sonnetag & Niessen, 2008). The researchers would therefore expect participants' vigour scores to increase as their fatigue scores decrease. To test this hypothesis, the correlation coefficients between the changes in the different pre-anaerobic and post-recovery results were determined and showed that a non-significant, inverse correlation of  $r = -0.29$  ( $p = .72$ ) existed between changes in vigour and fatigue values over time. This inverse relationship between vigour and fatigue was also noted by Torres, Nowson, and Silverman (2008), who also linked higher levels of vigour and lower levels of fatigue to a normally functionally hypothalamic pituitary adrenal axis and improved mood.

However, although we expected CWT to benefit the acute recovery of mood states post-exercise more compared to PAR, only two of the measured STEMS mood state subscales showed significant improvements in the CWT compared to the PAR group. Therefore, CWT was not more beneficial in the acute recovery of the majority of mood state subscales when compared to PAR. One of the premises of this study was that an exhausting anaerobic exercise session will have a detrimental acute effect on the mood states of athletes (Kenttä et al., 2006). In our study, the extent of physical exertion and fatigue was evaluated by determining the post-exercise blood lactate levels, which were observed to be  $5.2$ ,  $SD = 2.7$   $\mu\text{mol/L}$  blood on average. This indicates that the anaerobic session taxed the anaerobic glycolysis energy system and caused fatigue.

However, several findings of this study suggest that the exercise session had a beneficial effect on especially the negative mood states of the experimental group (anger, confusion, depression and tension). In this last-mentioned group, vigour was also increased due to the anaerobic session, which was totally unexpected. Nevertheless, for this group the recovery technique (CWT) had a detrimental effect on all the negative mood states, which is totally unexpected. In

contrast, the control group experienced negative changes in the majority of positive and negative mood state subscales due to the anaerobic exercise session but the recovery technique did alleviate most (except for tension) of these negative changes. The only mood state that showed a different trend was tension, which decreased due to the exercise session. All the last-mentioned results would suggest that individual differences between athletes may lead to different mood state responses due to exhaustive exercise, and that these differences may ultimately determine the post-recovery response. These findings also place a question mark behind the use of mood states, especially negative mood states (such as confusion, depression and tension), as indicators of psychological recovery. It also contradicts the notion that a strong link or relationship exists between physiological and psychological fatigue (Stacey et al., 2010).

Overall, findings from the present study suggest that more research is needed to verify the theory that mood state changes may be effectively used to assess the efficiency of various recovery techniques as well as the fatiguing effect of exercise (Barnett, 2006). Some researchers even stated that athletes may in certain cases experience a false sense of well-being and increased perceptions of recovery, even though psychological recovery did not occur (Stacey et al., 2010). This false sense of well-being and recovery may even increase players' risk of injury and overtraining.

### **Conclusion**

As far as the researchers could determine, this was the first study to compare the efficacy of CWT and PAR on the recovery of athletes' STEMS-derived mood states. Previous studies mostly emphasised perceived fatigue and RPE when investigating psychological recovery in athletes. However, despite the uniqueness of the study, results showed that when compared to PAR, CWT did not aid more in the acute psychological recovery of university-level rugby players' mood states. Vigour was the only mood state subscale for which the CWT group showed a statistically and practical significantly higher value compared to the PAR group, while fatigue showed a large practical significantly lower value for the CWT compared to the PAR group. Therefore, although the results from this study support the use of CWT to alleviate vigour and fatigue post-exercise when compared to PAR, further research is required to gain a better understanding of the exact mechanisms that are related to the possible benefits of CWT and PAR for the acute psychological recovery of athletes.

However, despite these conclusions it was observed that the amount of physical and physiological fatigue post-exercise as indicated by the high average blood lactate value did not correspond to a compatible increase in psychological fatigue, especially for the experimental group. Similarly, against all expectations CWT had a detrimental effect on the negative mood states of players. These findings are in direct contrast to the fundamental premise of this study that an anaerobic exercise session will have an acute detrimental effect compared to the recovery techniques which will have a beneficial effect on the mood states of athletes. These results influenced the total study outcome and made the interpretation of the study's findings very difficult.

Certain other shortcomings of the study should, however, also be considered when interpreting the results. Even though an attempt was made to prevent a carryover effect of the STEMS questionnaire's answers from one testing period to the next, the possibility exists that carryover still occurred. The use of other measuring instruments (e.g., interviews) that do not use the questionnaire format to evaluate acute recovery and fatigue indicators can therefore be recommended. Furthermore, due to the possibility that individual differences in the psychological response to anaerobic exercise and the recovery techniques may have influenced the results, it would be advisable to rather make use of a cross-over design for future studies. A comparison between the possible recovery benefits of CWT and other hydrotherapy-related techniques such as cold water immersion will also allow researchers to better explain the last-mentioned mechanisms. Researchers may also explore the efficiency of combined recovery techniques to cause complete acute psychological recovery in athletes. Lastly, a rugby match or full training session would serve as a better and more sport-specific intervention to bring about physiological and psychological fatigue to test the acute response to different recovery techniques compared to a 15-minute anaerobic session.

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# **Chapter 5**

## **Summary, conclusions, limitations and recommendations**

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# 5. Summary, conclusions, limitations and recommendations

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## 5.1 Summary

## 5.2 Conclusions

## 5.3 Limitations and recommendations

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### 5.1 Summary

The objectives of this study were firstly to determine the difference between the acute effects of cold water immersion (CWI) and passive recovery (PAR) on the mood states (tension, depression, anger, vigour, fatigue and confusion) and the energy index of university-level rugby players post-exercise. Secondly, the objective was to determine the difference between the acute effects of contrast water therapy (CWT) and PAR on the mood states and the energy index of university-level rugby players post-exercise. Chapter 1 provided the problem statement, the objectives and hypotheses of the study as well as the structure of the dissertation.

Chapter 2 consisted of a literature review titled “The need for recovery and the effects of cold water immersion, contrast water therapy and passive recovery techniques on the psychological well-being of athletes”. The aim of this review was firstly to discuss the physical, physiological and psychological demands of rugby union and the importance of recovery in the prevention of overtraining and subsequent burnout in rugby union players. Secondly, the purpose of the review was to discuss the following psychometric measuring instruments: the Profile of Mood States (POMS), Stellenbosch Mood Scale (STEMS) and the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport), which are used to assess the markers that are linked to psychological recovery. Thirdly, the purpose was to provide a review on the literature findings with regard to the effect of different recovery techniques such as CWI, CWT and PAR on several psychological components of athletes, and to discuss the different CWI, CWT and PAR protocols that researchers use to attain psychological recovery.

From the literature review it was evident that rugby union training and match-play make various physiological and psychological demands on players and that the execution of post-exercise recovery techniques in players' training regimes are necessary to aid in the physiological and psychological restoration of athletes' training and performance abilities. Furthermore, the integration of recovery techniques into the training regimens of athletes will assist in preventing overtraining and subsequent burnout, which results from an imbalance between training stress and recovery. Moreover, frequent monitoring of recovery levels may allow practitioners to optimise individual training loads and to detect symptoms of under-recovery and subsequent overtraining. In this regard, the POMS, STEMS and RESTQ-Sport are all considered to be valid psychometric measuring instruments to measure psychological markers such as changes in mood states, which may be indicators of an imbalance between training stress and recovery in athletes. These measuring instruments may also allow researchers to assess the efficiency of various post-exercise and match recovery techniques.

Although various recovery techniques are applied in sport, CWI, CWT and PAR have gained increased popularity over the past decade. However, findings with regard to the effectiveness of these recovery techniques on the psychological recovery of athletes' post-exercise and post-match are conflicting. For example, some researchers reported that both CWI and CWT were effective in reducing perceived muscle soreness and perceived fatigue post-exercise and post-match. Others also concluded that CWI seemed to serve as an effective analgesic. However, in contrast, various researchers found CWI and CWT to be ineffective in reducing the last-mentioned psychological factors. With regard to PAR, results suggested that PAR is mostly ineffective in reducing psychological factors such as perceived muscle soreness and perceived fatigue post-exercise and after match-play, and suggested that it might be ascribed to the psychological effect of doing nothing to facilitate recovery. These contradicting results may in part be caused by the fact that no set protocols were used when researchers investigate the efficiency of CWI, CWT and PAR on the psychological recovery of athletes. For example for CWI, water temperatures ranged between 9.2 °C and 15 °C, while CWI duration varied between one set of 8 to 15 minutes, several sets of 1 minute to 9 minutes at a time interspersed with rest periods of between 1 minute and 2.5 minutes during which participants remained seated at room temperature. With regard to CWT, the application time varied from 6 up to 18 minutes, with cold water immersion that lasted from 1 to 2 minutes and hot water immersion that lasted 2 minutes.

Water temperatures for immersions in cold water varied from 8 °C to 15 °C and for hot water from 28 °C to 42 °C. Generally protocols made use of CWT depths that ranged from the anterior superior iliac spine up to the level of athletes' neck. However, for PAR, the protocol used by researchers did not vary considerably. In general, researchers made use of PAR protocols that required participants to either remain seated for periods of between 8 and 30 minutes; lie supine on a bed; or to lie down with legs raised above heart level after a period of static stretching.

However, existing research suggests that CWI protocols that were more successful in obtaining significant results with regard to psychological recovery, specifically where it relates to perceived muscle soreness and fatigue as well as perceptions of recovery of athletes, adhered to the following guidelines: water temperatures ranged between 9.2 °C and 15 °C, application times between 5 and 20 minutes, while immersion levels ranged between the anterior, superior iliac spine and the mesosternale level. CWT protocols that were more successful in obtaining significant results with regard to psychological recovery, specifically where it relates to perceived fatigue and rate of perceived exertion (RPE) of athletes, adhered to the following guidelines: cold water temperature ranged from 12 °C to 15 °C and hot water temperature ranged between 38 °C to 38.4 °C. Application time ranged from 1 minute to 3.5 minutes in hot water, alternated by 30 seconds up to 1 minute in cold water, repeated 3 to 9 times for a total recovery time of 6 to 12 minutes, while immersion levels ranged between the jugular notch and the neck.

Furthermore, CWT protocols that obtained significant results with regard to athletes' perceptions of recovery adhered to the following guidelines: cold water temperature was 12 °C and hot water temperature 38 °C, however the application time was 1 minute first in cold water, alternated by 2 minutes in hot water, repeated 3 times for a total recovery time of 9 minutes, with the level of immersion up to the mesosternale level. In addition, where CWT obtained significant results with regard to perceived muscle soreness, the following guidelines were adhered to: cold water temperature was 8 °C to 10 °C and hot water temperature was 40 °C to 42 °C, application time ranged from 1 minute in cold water, alternated by 2 minutes in hot water, repeated 3 times for a total recovery time of 9 minutes and level of immersion that was up to the anterior superior iliac spine. Furthermore, where PAR was more successful in obtaining significant results with regard to psychological recovery, specifically relating to perceived muscle soreness of athletes, participants were expected to remain seated in a thermoneutral room for 10 minutes.

The first article titled: “The difference between the acute effects of cold water immersion and passive recovery on the mood states of university-level rugby players” was presented in Chapter 3. The aim of this study was to determine the difference between the acute effects of CWI and PAR on the mood states and energy index of university-level rugby players post-exercise. A group of 23 under/21 university-level rugby players (age:  $20.1 \pm 0.41$  years) of a South-African university club voluntarily participated in the study and were randomly assigned to either an experimental (CWI) or control group (PAR). Data was obtained by means of questionnaires aimed at gaining demographic and general information as well as information with regard to the mood states of the participants. In this regard, the Stellenbosch Mood Scale (STEMS) was completed over four time periods: during the morning (baseline); before completion of a high-intensity anaerobic training session (pre-anaerobic); after completion of a high-intensity anaerobic training session of 15 minutes (post-anaerobic) and after completion of a 20-minute recovery session (post-recovery).

The experimental group completed 20 minutes of CWI, whereas the control group recovered passively for the same time period. Descriptive statistics (mean, standard deviation, dependent *t*-test and effect size values) were reported for all six STEMS subscales and the energy index of the experimental ( $n = 12$ ) and control group ( $n = 11$ ). A dependent *t*-test and a Cohen’s effect size calculation were performed to determine the statistical ( $p < .05$ ) and practical significance of pre-anaerobic and post-recovery changes in the STEMS and energy index values. An analysis of covariance (ANCOVA) (with adjustment for the pre-anaerobic scores) was used to identify significant differences in the STEMS subscale and energy index values between groups. Although the experimental group (CWI) experienced no significant changes from pre-anaerobic to post-recovery time periods for any of the STEMS subscale values or the energy index except for a medium practical significant decrease ( $ES = 0.53$ ) in the confusion subscale value, the control group’s confusion, depression and tension subscale values decreased significantly ( $p < .05$ ) from pre-anaerobic to post-recovery time periods. However, for the majority of the STEMS subscale values, the ANCOVA revealed no significant differences when the pre-anaerobic and post-recovery changes between groups were compared. Vigour was the only subscale for which the experimental group experienced a medium practical significant increase ( $ES = 0.65$ ) compared to the control group. Therefore, although research suggests that CWI may have the potential to optimally recuperate the psychological state of athletes after exhaustive exercise, this

study indicates that CWI did not have a significantly more beneficial effect on the markers of mood state compared to PAR except for vigour.

Chapter 4 consisted of the second article titled: “The difference between the acute effects of contrast water therapy and passive recovery on the mood states of university-level rugby players”. The aim of this study was to determine the difference between the acute effects of CWT and PAR on the mood states and energy index of university-level rugby players post-exercise. A group of 23 under/21 university-level rugby players (age:  $20.1 \pm 0.41$  years) of a South-African university club voluntarily participated in the study and were randomly assigned to either an experimental (CWT) or control group (PAR). Two participants in the control group did not complete the Stellenbosch Mood Scale (STEMS) and therefore their results had to be omitted from further analysis.

Data was obtained by means of a set of questionnaires aimed at gaining demographic and general information as well as information with regard to the mood states of the participants. In this regard, the Stellenbosch Mood Scale (STEMS) was completed over four time periods: during the morning (baseline); before completion of a high-intensity anaerobic training session (pre-anaerobic); after completion of a high-intensity anaerobic training session of 15 minutes (post-anaerobic) and after completion of a 20-minute recovery session (post-recovery). The experimental group completed 20 minutes of CWT, while the control group recovered passively for the same time period. Descriptive statistics (mean, standard deviation, dependent *t*-test and effect size values) were reported for all six STEMS subscales and energy index for the experimental ( $n = 11$ ) and control group ( $n = 10$ ).

A dependant *t*-test and a Cohen’s effect-size calculation were performed to determine the statistical ( $p < .05$ ) and practical significance of pre-anaerobic and post-recovery changes in the STEMS and energy index values. An ANCOVA (with adjustment for differences in the pre-anaerobic scores) was used to determine significant differences in the STEMS subscale values and energy index between groups. Neither the experimental nor the control group experienced significant changes from pre-anaerobic to post-recovery time periods for any of the STEMS subscale values or the energy index. The ANCOVA revealed a significant difference when the pre-anaerobic and post-recovery changes in the STEMS vigour subscale values between groups

were compared. In this regard, the experimental group showed a statistically significant higher value for vigour ( $p = .05$ ) when compared to the control group. In addition, for vigour, the experimental group recorded a large practical significant higher value ( $ES = 0.92$ ), as well as a large practically significant lower value for fatigue ( $ES = 0.88$ ) compared to the control group. Results therefore indicated that CWT when compared to PAR did have significantly more beneficial effects on vigour and fatigue, both markers of mood states, immediately after an intense anaerobic exercise bout. Therefore, although the results from this study support the use of CWT to alleviate vigour and fatigue post-exercise when compared to PAR, overall CWT did not aid more in the acute psychological recovery of university-level rugby players' mood states.

The article presented in Chapter 3 was compiled in accordance with the guidelines of the *International Journal of Sport and Exercise Psychology* and the article presented in Chapter 4 was compiled in accordance with the guidelines of the *Journal of Applied Sport Psychology*, to which it will be submitted for possible publication. Each article consists of an introduction and the experimental approach of the specific studies. The research methods (participants, procedures and data analyses) were also described, together with the results and discussion of each of the studies, followed by conclusions.

## 5.2 Conclusions

The conclusions drawn from this study are presented in accordance with the set hypotheses:

**Hypothesis 1:** *Compared to PAR, CWI will have statistically and practical significantly more positive acute effects on the mood states (anger, confusion, depression, fatigue, tension and vigour) and energy index of university-level rugby players post-exercise.*

The results show that CWI did not have a statistically significant more beneficial effect on the markers of mood state or energy index compared to PAR directly after an intense anaerobic exercise bout. None of the mood state or energy index differences between CWI and PAR proved to be statistically significant when the control and experimental groups were compared. Vigour was the only mood state for which the experimental group obtained a medium practical significant higher value than the control group. In view of this conclusion, hypothesis 1 is, therefore, rejected.

**Hypothesis 2:** *Compared to PAR, CWT will have statistically and practical significantly more positive acute effects on the mood states (anger, confusion, depression, fatigue, tension and vigour) and energy index of university-level rugby players post-exercise.*

Results indicated that compared to PAR, CWT only had a statistically and practical significant beneficial effect on vigour, whereas fatigue showed a large practical significant decrease after an intense anaerobic exercise bout. Hypothesis 2 is, therefore, rejected in view of the fact that the majority of mood states and the energy index were not statistically and practical significantly improved by CWT compared to PAR.

Overall, the study results, therefore, suggest that when compared to PAR, CWI and CWT do not aid more in the acute psychological recovery of university-level rugby players' mood states and energy index. In this regard, compared to PAR, apart from the medium practical significant increase in vigour following CWI and the statistically significant increase in vigour as well as large practical significant increase in fatigue following CWT, neither CWI nor CWT were more beneficial in the recovery of the majority of mood states and the energy index in rugby players post-exercise compared to PAR. Therefore, despite the increasing popularity of these last-mentioned recovery techniques which could possibly create a false sense of well-being and an expectation in players that recovery will occur following CWI and/or CWT, the researcher suggests that sport scientists, sport psychologists, coaches and players should combine the use of these last-mentioned recovery techniques with other recovery techniques to assist in the holistic approach of players' physiological and psychological recovery. In turn, this combined use of recovery techniques might possibly aid in the prevention of possible injuries, overtraining and subsequent burnout due to insufficient physiological and psychological recovery.

### **5.3 Limitations and recommendations**

Although these results cast a shadow of doubt on the contention that the use of CWI and CWT as acute psychological recovery techniques will be more beneficial than the use of PAR, the following limitations must be considered when interpreting the results of this study:

- At present, the available literature contains insufficient and conflicting data with regard to the efficiency and usefulness of CWI, CWT and PAR on the acute psychological recovery of rugby players. Clear-cut results with regard to this aspect are especially important in view of

the notion that psychological and physiological recovery cannot be separated and are linked in some way. Despite this notion, the majority of current research still focuses only on the recovery of physiological markers where CWI, CWT or PAR is applied. In addition, only a small number of publications used mood states as measure of psychological recovery and focused on team sport athletes such as rugby union players as study participants. Existing research also does not provide direction or guidelines in terms of the most effective CWI, CWT or PAR protocols for the psychological recovery of athletes. All these research gaps need to be filled by conducting studies that focus more on the effectiveness of different types of recovery protocols to cause acute recovery of different psychological measures.

- The effectiveness of different recovery techniques on the psychological recovery of athletes should be tested over a longer time period as more permanent versus ephemeral mood state changes usually occur over the course of a season.
- Furthermore, more research is required to study the beliefs that players have regarding different recovery techniques. The theory of planned behaviour postulates that beliefs will influence the resulting behaviour.
- With regard to the results of the present studies, it is possible that individual differences in the psychological response to the different recovery techniques may have influenced the results, which would make the use of a cross-over design in future studies more useful. This design will reduce the possible influence of a confounding covariate such as individual differences in the reaction to acute recovery sessions and also make the study more statistically efficient when rather small sample sizes are used.
- Furthermore, as fatigue, vigour and energy index were the only mood state-related variables that in most cases were more positively influenced by CWI, CWT and PAR, it would be advisable to rather make use of other psychological recovery indicators than mood states that are better linked to physiological recovery.
- One of the premises of this study was that an exhausting anaerobic exercise session will have a detrimental acute effect on the mood states of rugby players. Ultimately, for especially the experimental groups, the exercise session had a beneficial effect on the majority of mood state subscales. In contrast, for the majority of mood states the control group experienced negative changes due to the anaerobic exercise session, but the recovery techniques did alleviate most of these negative changes. These results influenced the total study outcome and made the interpretation of study findings very difficult.

- All of the last-mentioned results would suggest that individual differences between athletes may lead to different mood state responses due to exhaustive exercise and that these differences may ultimately determine the post-recovery response. Researchers would, therefore, in future need to experiment with other recovery indicators.
- Even though an attempt was made to prevent a carryover effect of the STEMS questionnaire's answers from one testing period to the next, the possibility exists that carryover still occurred. The use of other measuring instruments that do not use the questionnaire format to evaluate acute recovery and fatigue indicators is, therefore, recommended.
- A rugby match or full training session would probably serve as a better and more sport-specific intervention to bring about physiological and psychological fatigue to test the acute response to different recovery techniques compared to a 15-minute anaerobic session.
- Therefore, although the results from this study support the use of CWT and to a certain extent CWI to alleviate vigour and fatigue post-exercise when compared to PAR, further research is required to gain a better understanding of the exact mechanisms that are related to the possible benefits of CWI, CWT and PAR for the acute psychological recovery of rugby players.
- Finally, a comparison between the possible recovery benefits of CWI, CWT and other hydrotherapy-related techniques will allow researchers to better explain the last-mentioned mechanisms. Researchers might also explore the efficiency of combined recovery techniques to cause complete acute psychological recovery in rugby players.

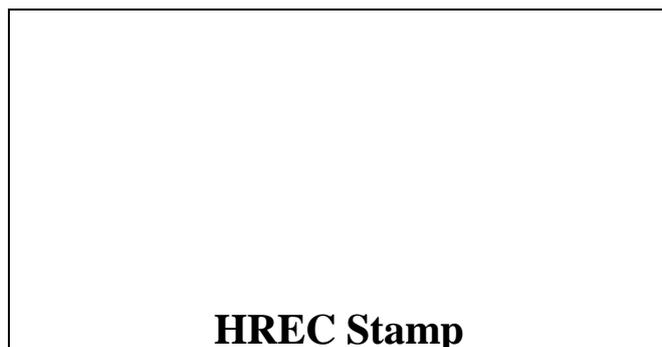
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## Appendices

- Appendix A:** Informed consent
- Appendix B:** Raw data card
- Appendix C:** Questionnaire: Demographic and general information
- Appendix D:** Questionnaire: Stellenbosch Mood Scale (STEMS)
- Appendix E:** Guidelines for authors: International Journal of Sport and Exercise Psychology
- Appendix F:** Guidelines for authors: Journal of Applied Sport Psychology
- Appendix G:** Proof of language editing
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# Appendix A: Informed consent

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## **PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM FOR PARTICIPANTS OF THE RUGBY RECOVERY PROJECT**

### **TITLE OF THE RESEARCH PROJECT:**

**Effects of different recovery techniques on certain physical, motor performance, psychological and haematological components in university level rugby players**

**REFERENCE NUMBERS:** NWU-00201-14-S1

### **PRINCIPAL INVESTIGATOR:**

Prof. Ben Coetzee

### **ADDRESS:**

School for BRS

Building K21

North-West University

Faculty of Health Sciences

Potchefstroom

2522

**CONTACT NUMBER:** 0182991803

You are being invited to take part in a research project that forms part of several post graduate, master degree-studies. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

**This study has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-00201-14-S1) and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee members or relevant authorities to inspect the research records.**

#### **What is this research study all about?**

- *This study will be conducted at the Potchefstroom Campus of the North-West University and will involve blood sampling, heart rate and physical activity monitoring, physical and motor performance tests, the completion of psychological questionnaires as well as a seven-day weighed food record for analyses during several time periods before and after recovery interventions. Experienced sport science researchers trained in human movement, sport science and nutrition will conduct the analyses and tests. Thirty participants will be included in this study.*
- *The objectives of this research are to determine the effects of various recovery techniques (cold water immersion (CWI), contrast water therapy (CWT), self-myofascial release and breathing techniques (SMRDB) and passive recovery (PAR)) on the lower and upper body explosive power output, forearm strength, several haematological analytes, HRV (heart rate variability), as well as certain psychological parameters in a cohort of university-level rugby players. The researchers also want to determine if there are any statistical significant relationships between several indicators of recovery (upper body explosive power output, forearm strength, several haematological analytes, HRV as well as certain psychological parameters) in a cohort of university-level rugby players.*

*Furthermore, another aim is to determine the effect of dietary intake on the HRV in a cohort of university-level rugby players. Moreover, the researchers want to determine the normal dietary practices, supplement use and nutritional knowledge of a cohort of university-level rugby players. The last aim is to determine the significant acute changes in certain haematological, physical, motor performance and psychological parameters after execution of a 15 minute anaerobic rugby specific session in a cohort of university-level rugby players.*

### **Why have you been invited to participate?**

- *You have been invited to participate because you are a male u/21 rugby player from the Potchefstroom Campus of the North-West University.*
- *You have also complied with the following inclusion criteria: You are actively involved and training as a member of the Rugby Institute and are totally injury and illness free at the time of testing. Your manager and coach, and you, yourself provided voluntary consent to participate in the study. In the event that you want to participate in the study but the coach or manager do not want to give permission to you to participate, your wish will be fulfilled.*
- *Moreover, you will only be included in the study if are prepared to attend the familiarization session, do all the motor and physical performance tests, as well as undergo blood sampling during the duration of each of the testing occasions.*
- *Furthermore, you will only be included if you are willing to undergo the different recovery interventions.*
- *Lastly, you will also only be included in the study if you did not participate in strenuous physical activity that may influence the physical or physiological responses of the body for at least 48 hours before the scheduled tests.*
- *You will be excluded if: you do adhere to the above-mentioned inclusion criteria or if you become injured or ill at any time during the testing period or if you voluntary withdraw from the study at any time.*

**What will your responsibilities be?**

- *You will be expected to undergo anthropometric measurements (body mass and stature), provide blood (at least 6 finger pricks x 3 for each week of testing) for blood analyses, complete several questionnaires and a seven-day weighed food record, execute several physical and motor performance tests: the Vertical Jump Test, the Five Repetition Smith Machine Bench Throw Test and the Grip Strength test, perform an anaerobic shuttle run session as well as various recovery techniques. These tests will be performed seven times during an one week period and will be repeated twice over another two weeks. All together all the analyses and tests will take more or less 60 minutes to perform. You will also be expected to wear a Global Positioning System and heart rate monitor during execution of the anaerobic session as well as an Actiheart monitor for 48 hours each week.*

**Will you benefit from taking part in this research?**

- *Among the direct benefits are that you will be able to gain access to your results. Their data will also be used to explain to you and/or your sport scientist orally which recovery techniques are more effective in causing acute physical, physiological and psychological recovery for yourself. You and your sport scientists will also be afforded the opportunity to talk to the researchers about any recovery advice that you may have a need for. Furthermore, HRV data will allow the researchers to evaluate your day to day recovery levels which can assist your coach and yourself to identify weak points and enable you to identify factors that are detrimental to your recovery. As part of the research project you will also be afforded the opportunity to obtain information with regard to your dietary preferences and profile as well as recommendations to improve your diet. Data with regard to mood states, sleeping quality and quantity will also allow researchers to provide you with feedback concerning these aspects.*
- *An indirect benefit of the study is an expansion of existing expert knowledge in the field of Applied Sport Science which can be transferred to the wider sporting community.*

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**Are there risks involved in your taking part in this research?**

- *Risks will be minimised and the researchers will aim to maximise potential benefits that are likely to have a valuable impact on you either directly or indirectly. An experienced sport scientist will perform a warm before the battery of physical and motor performance tests to prepare you physically and physiologically for the test demands and to decrease injury risk. A medical doctor will be on standby during the total duration of the project, should any injuries occur. In case of illness or injury you will immediately be withdrawn from the project and will be allowed to leave at any time if they feel so.*
- *The risk for infection during blood sampling will be minimized by employing the following procedures: Before the finger prick method is employed the fingertip will be cleansed thoroughly by making use of a Webcol, alcohol swap and dried by a sterile gauze pad. The researchers who collect the blood samples will wear powder-free, sterile surgical gloves at all times during blood sampling. Gloves will be replaced each time that another player's blood samples are taken. A sterile, single-use lancing device will be used to swiftly puncture the finger slightly lateral to the ball of the finger. After blood sampling the fingertip will again be cleansed by using a Webcol swap and dried by a sterile gauze pad. A sterile cotton ball will then be placed on the punctured area and closed with a hypoallergenic Band-aid adhesive bandage to stop any bleeding. All used materials (lancets, blood lactate strips, Webcols swaps, gauze pads, surgical gloves, etc.) will immediately be discarded into appropriate medical waste containers so as to minimize the risk for contact with contaminated blood. You may experience a bit of discomfort due to the frequency of the finger prick technique (at least 6 finger pricks for each week of testing) that is used to collect venous blood. You will however be familiarized with this technique during the familiarization day a week before the project starts.*
- *Players, especially the back line players, may find the CWI uncomfortable due to the temperature of the water ( $8 \pm 1^{\circ}\text{C}$ ) and the duration of immersion (20 minutes). Although there is always a risk that you may experience "cold shock" due to the sudden immersion in cold water, the fact that you are familiar with this recovery technique due to the fact that you are subjected to it frequently during training sessions, will decrease the risk of "cold shock".*

- *You may also experience extreme fatigue, muscle discomfort and nausea due to execution of the anaerobic session. A scientifically compiled warm-up will however be performed before execution of the anaerobic session to minimize injury risk and to prepare the body for this session. Furthermore, you will be familiarised with the test during the familiarization session. You are however familiar with these type of interval sessions due to the fact that you regularly perform it during training.*

**What will happen in the unlikely event of some form of discomfort occurring as a direct result of your taking part in this research study?**

- *Should you have the need for further discussions after the execution of the tests or analyses of matches an opportunity will be arranged for you to do so. In case of illness or injury you will immediately be withdrawn from the study and will be allowed to leave at any time if you feel so. During the execution of the physical tests a medical physician will be on standby should any medical attention be needed.*

**Who will have access to the data?**

- *Anonymity will be partial due to the fact that the sport scientist want feedback with regard to the outcome of the different recovery techniques but the researchers will respect the decision of each player in order to protect his anonymity. Data will be coded to ensure that no link can be made to a specific player. Reporting of findings will be anonymous by only authorising the head researcher to have control over the distribution of these findings. Only the head researcher and research assistants will have access to the data and will also sign a confidentiality agreement to protect players. Data will be kept safe and secure by locking hard copies in locked cupboards in the researcher's office and for electronic data it will be password protected. Data will be stored for 7 years.*

Will you be paid to take part in this study and are there any costs involved?

**No, you will not be paid to take part in the study. There will also be no costs involved for you, if you do take part.**

Is there anything else that you should know or do?

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- 
- **You can contact Prof Ben Coetzee at 018 299 1803; ben.coetzee@nwu.ac.za if you have any further queries or encounter any problems.**
  - **You can contact the Health Research Ethics Committee via Mrs Carolien van Zyl at 018 299 2094; carolien.vanzyl@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher.**
  - **You will receive a copy of this information and consent form for your own records.**

How will you know about the findings?

- The findings of the research will be shared with you if you are interested. The main findings of the project will be shared with the head sport scientist of the Rugby Institute (Jacus Coetzee) so that it can be used to your benefit. The researchers will try and share the information three months after conclusion of the project orally with the last-mentioned person. You are welcome to contact us regarding the findings of the research. We will be sharing the findings with you as soon as it is available.

### **Declaration by participant**

By signing below, I ..... agree to take part in a research study entitled: **Effects of different recovery techniques on certain physical, motor performance, psychological and haematological components in university level rugby players.**

### **I declare that:**

- I have read this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions to both the person obtaining consent, as well as the researcher and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

- I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ..... on (*date*) ..... 20....

.....

.....

Signature of participant

Signature of witness

**Declaration by person obtaining consent**

I (*name*) ..... declare that:

- I explained the information in this document to .....
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) ..... on (*date*) ..... 20....

.....

.....

Signature of person obtaining consent

Signature of witness

**Declaration by researcher**

I (*name*) ..... declare that:

- I explained the information in this document to .....
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) ..... on (*date*) ..... 20....

.....

.....

**Signature of researcher**

**Signature of witness**

# Appendix B: Raw data card



**RAW DATA FOR HRV – NAME OF PLAYER AND NUMBER:**

**Recovery group: CWI or PAR (encircle the relevant option)**

Note: The following tests have been completed over four different time periods: baseline, pre-anaerobic, post-anaerobic and post-recovery

TEST COMPONENT	1 <sup>ST</sup> TIME
LACTATE	

## THE STELLENBOSCH MOOD SCALE

Name and Surname:

Date and time:

Below is a list of words that describe feelings people have. Please read each one carefully. Mark [X] the answer that best describes **how you feel right now**. / Hieronder is 'n lys van woorde wat gevoelens beskryf wat mense ervaar. Lees asseblief elkeen noukerig en merk [X] die antwoord wat die beste beskryf hoe jy op hierdie oomblik voel.

AFRIKAANS	<i>Gladnie</i> / Not at all	<i>Effens</i> / A little	<i>Taamlik</i> / Moderately	<i>Bate / Quite</i> a bit	<i>Uiters /</i> Extremely	ENGLISH
Verward	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Confused
Vermoeid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Worn out
Vererg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Annoyed
Verbitterd	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Bitter
Vaak	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Sleepy
Uitgeput	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Exhausted
Senuweeagtig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Nervous
Paniekerig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Panicky
Op en wakker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Alert
Ontwrig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Muddled
Onseker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Uncertain
Ongelukkig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Unhappy
Neerslagtig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Depressed
Moeg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tired
Mismoedig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Downhearted
Lewendig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Lively
Kwaad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Angry
Humeurige	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Bad tempered
Energiek	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Energetic
Ellendig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Miserable
Deurmekaar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mixed up
Bekommerd	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Worried
Angstig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Anxious
Aktief	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Active

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**RAW DATA FOR HRV – NAME OF PLAYER AND NUMBER:**

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**Recovery group: CWT or PAR (encircle the relevant option)**

Note: The following tests have been completed over four different time periods: baseline, pre-anaerobic, post-anaerobic and post-recovery

TEST COMPONENT	1 <sup>ST</sup> TIME
LACTATE	

## THE STELLENBOSCH MOOD SCALE

Name and Surname:

Date and time:

Below is a list of words that describe feelings people have. Please read each one carefully. Mark [X] the answer that best describes **how you feel right now**. / Hieronder is 'n lys van woorde wat gevoelens beskryf wat mense ervaar. Lees asseblief elkeen noukerig en merk [X] die antwoord wat die beste beskryf hoe jy op hierdie oomblik voel.

AFRIKAANS	<i>Gladnie</i> / Not at all	<i>Effens</i> / A little	<i>Taamlik</i> / Moderately	<i>Bate / Quite</i> a bit	<i>Uiters /</i> Extremely	ENGLISH
Verward	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Confused
Vermoeid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Worn out
Vererg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Annoyed
Verbitterd	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Bitter
Vaak	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Sleepy
Uitgeput	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Exhausted
Senuweeagtig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Nervous
Paniekerig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Panicky
Op en wakker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Alert
Ontwrig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Muddled
Onseker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Uncertain
Ongelukkig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Unhappy
Neerslagtig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Depressed
Moeg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tired
Mismoedig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Downhearted
Lewendig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Lively
Kwaad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Angry
Humeurige	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Bad tempered
Energiek	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Energetic
Ellendig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Miserable
Deurmekaar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mixed up
Bekommerd	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Worried
Angstig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Anxious
Aktief	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Active

# Appendix C: Questionnaire: Demographic and general information

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## General Demographic and Information Questionnaire for the Rugby Recovery Project

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### 1.2 Age:

<u>Years:</u>	<u>Months:</u>
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### 1.3 Birth date:

<u>Year:</u>	<u>Month:</u>	<u>Day:</u>
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### 1.4 Permanent residential address in South Africa:

<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
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### 1.5 Permanent postal address in South Africa:


**1.6 Phone numbers:**

<u>Home:</u>	<u>Work:</u>
<u>Fax:</u>	<u>Cell:</u>
<u>E-mail:</u>	

**1.7 Ethnic group**

White	Coloured	Black	Indian
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*In the next few question cross out the answers that are applicable to you!!*

**2. INFORMATION REGARDING TRAINING HABITS****2.1 Years you've been playing rugby - since you started to specialise in rugby.**

1-2 years	3-4 years	5-6 years	7-8 years	8-9 years	10-11 years	12 or more
-----------	-----------	-----------	-----------	-----------	-------------	------------

**2.2 Frequency of training - how many days per week do you normally train?**

1 day	2 days	3 days	4 days	5 days	6 days	7 days
-------	--------	--------	--------	--------	--------	--------

**2.3 Frequency of training - how many days per week do you normally do weight training?**

1 day	2 days	3 days	4 days	5 days	6 days	7 days
-------	--------	--------	--------	--------	--------	--------

**2.4 Frequency of training - how many days per week do you normally have field sessions?**

1 day	2 days	3 days	4 days	5 days	6 days	7 days
-------	--------	--------	--------	--------	--------	--------

**2.5 How many hours per day do you normally train?**

1 hour	2 hours	3 hours	4 hours	5 hours	6 hours	7 or more
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**2.6 How many hours per day do you normally spend on weight training?**

1 hour	2 hours	3 hours	4 hours	5 hours	6 hours	7 or more
--------	---------	---------	---------	---------	---------	-----------

**2.7 How many hours per day do you normally spend on training on the field?**

1 hour	2 hours	3 hours	4 hours	5 hours	6 hours	7 or more
--------	---------	---------	---------	---------	---------	-----------

**2.8 Do you spend any time on psychological preparation for rugby and competitions?**

Never	*Sometimes	*Often	*Always
-------	------------	--------	---------

**\* Please specify the type of psychological preparation you do if you marked any of these three options:**


**3.1 Please describe any past or current musculoskeletal conditions you have incurred (i.e., muscle pulls, sprains, fractures, surgery, back pain, or any general discomfort):**

<b>Head/Neck:</b>
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**Shoulder/Clavicle:**

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**Arm/Elbow/Wrist/Hand:**

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**Back:**

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**Hip/Pelvis:**

<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
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<hr/> <hr/>
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**Thigh/Knee:**

<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
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**Lower leg/Ankle/Foot:**

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**3.2 Please list any medication being taken currently and/or taken during the last year:**

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**3.3 List any other illness or disorder that a physician has told you of:**

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**4.1 At what level are you competing this year?**

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**4.2 What is the highest level that you competed at last year?**

Club:	Provincial:	National:	International:
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**4.3 How many matches, approximately, have you played?**

Club:	Provincial/National:
-------	----------------------

**4.4 What were the highest achievements you attained the past two years?**

Achievement	Competition	Date

**4.5 What position/s do you usually play during matches?**

1.
2.
3.

# Appendix D: Questionnaire:

## Stellenbosch Mood Scale (STEMS)

### THE STELLENBOSCH MOOD SCALE

Name &amp; Surname:

Date:

Below is a list of words that describe feelings people have. Please read each one carefully. Mark [X] the answer that best describes **how you feel right now**. / Hieronder is 'n lys van woorde wat gevoelens beskryf wat mense ervaar. Lees asseblief elkeen noukerig en merk [X] die antwoord wat die beste beskryf hoe jy op hierdie oomblik voel.

AFRIKAANS	<i>Gladnie</i> / Not at all	<i>Effens</i> / A little	<i>Taamluk</i> / Moderately	<i>Bate / Quite</i> a bit	<i>Uiters /</i> Extremely	ENGLISH
Verward	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Confused
Vermoeid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Worn out
Vererg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Annoyed
Verbitterd	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Bitter
Vaak	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Sleepy
Uitgeput	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Exhausted
Senuweeagtig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Nervous
Paniekerig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Panicky
Op en wakker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Alert
Ontwrig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Muddled
Onseker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Uncertain
Ongelukkig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Unhappy
Neerslagtig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Depressed
Moeg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tired
Mismoedig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Downhearted
Lewendig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Lively
Kwaad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Angry

<b>Humeurig</b>	<input type="checkbox"/>	<b>Bad tempered</b>				
<b>Energiek</b>	<input type="checkbox"/>	<b>Energetic</b>				
<b>Ellendig</b>	<input type="checkbox"/>	<b>Miserable</b>				
<b>Deurmekaar</b>	<input type="checkbox"/>	<b>Mixed up</b>				
<b>Bekommerd</b>	<input type="checkbox"/>	<b>Worried</b>				
<b>Angstig</b>	<input type="checkbox"/>	<b>Anxious</b>				
<b>Aktief</b>	<input type="checkbox"/>	<b>Active</b>				

# Appendix E: Guidelines for authors: International Journal of Sport and Exercise Psychology

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## Instructions to authors

*International Journal of Sport and Exercise Psychology* uses ScholarOne Manuscripts (previously Manuscript Central) to peer review manuscript submissions. Complete guidelines for preparing and submitting your manuscript to this journal are provided below.

*International Journal of Sport and Exercise Psychology* considers all manuscripts on the strict condition that:

- The manuscript is your own original work, and does not duplicate any other previously published work, including your own previously published work.
- The manuscript has been submitted only to *International Journal of Sport and Exercise Psychology*; it is not under consideration or peer review or accepted for publication or in press or published elsewhere.
- The manuscript contains nothing that is abusive, defamatory, libellous, obscene, fraudulent, or illegal.

*International Journal of Sport and Exercise Psychology* use CrossCheck™ software to screen manuscripts for unoriginal material. By submitting your manuscript to *International Journal of Sport and Exercise Psychology* you are agreeing to any necessary originality checks your manuscript may have to undergo during the peer-review and production processes.

Any author who fails to adhere to the above conditions will be charged with costs which *International Journal of Sport and Exercise Psychology* incurs for their manuscript at the discretion of *International Journal of Sport and Exercise Psychology* 's Editors and Taylor & Francis, and their manuscript will be rejected. This journal is compliant with the Research Councils UK OA policy.

## **Manuscript preparation**

### **General guidelines**

- Manuscripts are accepted in English. British English spelling and punctuation are preferred. Please use double quotation marks, except where “a quotation is ‘within’ a quotation”. Long quotations of 40 words or more should be indented without quotation marks.
- A typical manuscript will not exceed 7500 words including tables, references, captions, footnotes and endnotes. Manuscripts that greatly exceed this will be critically reviewed with respect to length. Authors should include a word count with their manuscript.
- Manuscripts should be compiled in the following order: title page; abstract; keywords; main text; acknowledgements; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figure caption(s) (as a list).
- Abstracts of 250 words are required for all manuscripts submitted.
- Each manuscript should have 3 to 5 keywords.
- Search engine optimization (SEO) is a means of making your article more visible to anyone who might be looking for it.
- Section headings should be concise.
- All authors of a manuscript should include their full names, affiliations, postal addresses, telephone numbers and email addresses on the cover page of the manuscript. One author should be identified as the corresponding author. Please give the affiliation where the research was conducted. If any of the named co-authors moves affiliation during the peer review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after the manuscript is accepted. Please note that the email address of the corresponding author will normally be displayed in the article PDF (depending on the journal style) and the online article.
- All persons who have a reasonable claim to authorship must be named in the manuscript as co-authors; the corresponding author must be authorized by all co-authors to act as an agent on their behalf in all matters pertaining to publication of the manuscript, and the order of names should be agreed by all authors.
- Biographical notes on contributors are not required for this journal.
- Please supply all details required by any funding and grant-awarding bodies as an Acknowledgement on the title page of the manuscript, in a separate paragraph, as follows:

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- Authors must also incorporate a Disclosure Statement which will acknowledge any financial interest or benefit they have arising from the direct applications of their research.
- For all manuscripts non-discriminatory language is mandatory. Sexist or racist terms must not be used.
- Authors must adhere to SI units. Units are not italicized.
- When using a word which is or is asserted to be a proprietary term or trade mark, authors must use the symbol ® or TM.

### **Style guidelines**

Advice to authors on preparing a manuscript:

- Please follow any specific instructions for authors provided by the Editor of the journal
- Font: Times New Roman, 12 point. Use margins of at least 2.5 cm (1 inch). Further details of how to insert special characters, accents and diacritics are available here.
- Title: Use bold for your article title, with an initial capital letter for any proper nouns.
- Authors' names: Give the names of all contributing authors on the title page exactly as you wish them to appear in the published article.
- Affiliations: List the affiliation of each author (department, university, city, country).
- Correspondence details: Please provide an institutional email address for the corresponding author. Full postal details are also needed by the publisher, but will not necessarily be published.
- Anonymity for peer review: Ensure your identity and that of your co-authors is not revealed in the text of your article or in your manuscript files when submitting the manuscript for review.
- Abstract: Indicate the abstract paragraph with a heading or by reducing the font size.
- Keywords: Please provide five or six keywords to help readers find your article. Advice on selecting suitable keywords is available here.
- Headings: Please indicate the level of the section headings in your article:

- First-level headings (e.g. Introduction, Conclusion) should be in bold, with an initial capital letter for any proper nouns.
- Second-level headings should be in bold italics, with an initial capital letter for any proper nouns.
- Third-level headings should be in italics, with an initial capital letter for any proper nouns.
- Fourth-level headings should also be in italics, at the beginning of a paragraph. The text follows immediately after a full stop (full point) or other punctuation mark.

Tables and figures: Indicate in the text where the tables and figures should appear, for example by inserting [Table 1 near here]. The actual tables and figures should be supplied either at the end of the text or in a separate file as requested by the Editor. Ensure you have permission to use any figures you are reproducing from another source. Advice on artwork is available [here](#). Advice on tables is available [here](#).

- Running heads and received dates are not required when submitting a manuscript for review.
- If your article is accepted for publication, it will be copy-edited and typeset in the correct style for the journal.
- Word templates are available for this journal. If you are not able to use the template via the links or if you have any other template queries, please contact [authortemplate@tandf.co.uk](mailto:authortemplate@tandf.co.uk).

### **Description of the Journal's reference style**

*International Journal of Sport and Exercise Psychology* use APA (American Psychological Association) reference style. APA references are widely used in the social sciences, education, engineering and business. For detailed information, please see the *Publication Manual of the American Psychological Association*, 6th edition, <http://www.apastyle.org/> and <http://blog.apastyle.org/>.

### **Guide to using mathematical scripts and equations**

- Special care should be taken with mathematical scripts, especially subscripts and superscripts and differentiation between the letter “ell” and the figure one, and the letter “oh” and the figure zero. If your keyboard or PC does not have the characters you need, or when using longhand, it is important to differentiate between: K and k; X, x and × (multiplication); asterisks intended to appear when published as multiplication signs and those intended to

remain as asterisks; etc. Special symbols, and others used to stand for symbols not available in the character set of your PC, should be highlighted in the text and explained in the margin. In some cases it is helpful to supply annotated lists of symbols for the guidance of the sub-editor and the typesetter, and/or a “Nomenclature” section preceding the “Introduction”.

- In both displayed equations and in text, scalar variables must be in italics, with non-variable matter in upright type.
- For simple fractions in the text, the solidus “/” should be used instead of a horizontal line, care being taken to insert parentheses where necessary to avoid ambiguity. Exceptions are the proper fractions available as single type on keyboards and in character sets (e.g.  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ ).
- The solidus is not generally used for units: m s<sup>-1</sup> not m/s, but note electrons/s, counts/channel, etc.
- Displayed equations referred to in the text should be numbered serially ((1), (2), etc.) on the right-hand side of the page. Short expressions not referred to by any number will usually be incorporated in the text.
- Symbols used to represent tensors, matrices, vectors and scalar variables should either be used as required from the character set of the application you are using or marked on hard-copy by underlining with a wavy underline for bold, a straight underline for italic and a straight red underline for sans serif.
- The following styles are preferred: upright bold sans serif **r** for tensors, bold serif italic *r* for vectors, upright bold serif **r** for matrices, and mediumface sloping serif *r* for scalar variables. In mathematical expressions, the use of “d” for differential should be made clear and coded in roman, not italic.
- Typographical requirements must be clearly indicated at their first occurrence, e.g. Greek, Roman, script, sans serif, bold, italic. Authors will be charged for corrections at proof stage resulting from a failure to do so.
- Braces, brackets and parentheses are used in the order { [( )] }, except where mathematical convention dictates otherwise (e.g. square brackets for commutators and anticommutators; braces for the exponent in exponentials).
- For units and symbols, the SI system should be used. Where measurements are given in other systems, conversion factors or conversions should be inserted by the author.
- Mathematical equations should preferably be typewritten, with subscripts and superscripts clearly shown. It is helpful to identify unusual or ambiguous symbols in the margin when

they first occur. Please ensure all symbols are described in the text. If equations are numbered, consecutive Arabic numbers in parentheses should be used. Equations may be referred to in the text as “equation (1)”, “equations (2)–(4)”. To simplify typesetting, please use: (1) the “exp” form of complex exponential functions; (2) fractional exponents instead of root signs; and (3) the solidus (/) to simplify fractions e.g. 3/4, exp  $x^{1/2}$ . Other letters not marked will be set in roman type. Please supply reproducible artwork for equations containing ring formulae and other complex chemical structures. Schemes should also be numbered with consecutive Arabic numbers

### **Figures**

- Please provide the highest quality figure format possible. Please be sure that all imported scanned material is scanned at the appropriate resolution: 1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour.
- Figures must be saved separate to text. Please do not embed figures in the manuscript file.
- Files should be saved as one of the following formats: TIFF (tagged image file format), PostScript or EPS (encapsulated PostScript), and should contain all the necessary font information and the source file of the application (e.g. CorelDraw/Mac, CorelDraw/PC).
- All figures must be numbered in the order in which they appear in the manuscript (e.g. Figure 1, Figure 2). In multi-part figures, each part should be labelled (e.g. Figure 1(a), Figure 1(b)).
- Figure captions must be saved separately, as part of the file containing the complete text of the manuscript, and numbered correspondingly.
- The filename for a graphic should be descriptive of the graphic, e.g. Figure1, Figure2a.

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because ScholarOne Manuscripts is not able to convert LaTeX files into PDFs directly. All LaTeX source files should be uploaded alongside the PDF.

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# Appendix F: Guidelines for authors: Journal of Applied Sport Psychology

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## **Instructions to authors**

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The *Journal of Applied Sport Psychology* uses CrossCheck™ software to screen papers for unoriginal material. By submitting your paper to the *Journal of Applied Sport Psychology* you are agreeing to any necessary originality checks your paper may have to undergo during the peer review and production processes.

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The *Journal of Applied Sport Psychology* is a nonproprietary journal that is operated by the Association for Applied Sport Psychology for the promotion of quality research in the field of applied sport psychology. The publisher of the *JASP* is Taylor and Francis, Inc. of Philadelphia, PA. The *JASP* is published four times a year, and is a refereed publication with all submissions reviewed by three peers via blind review process. The editor of the journal is selected by the Executive Board of AASP by a formal vote. He/She is appointed to a three-year term with one consecutive renewal possible if so voted by the Executive Board. The Associate Editors are approved by the Executive Board of the Association and serve staggered terms ranging from three to five years. An individual holding an AASP Executive Board office as a Division Head cannot serve as an Associate Editor. Editorial Board members are appointed to three, four or five-year terms as determined by the Editorial staff of the *JASP*. Editorial Board members may be reappointed to one consecutive term or may be asked to retire their seat on the Board at the discretion of the Editorial staff. The journal is a direct benefit of membership in AASP and is received by student and professional members.

The *JASP* is designed to advance thought, theory and research on applied aspects of sport psychology. Submissions such as position papers, reviews, theoretical developments specific to sport and/or exercise and applied research conducted in these settings or having significant applied implications to sport and exercise are appropriate content for the *JASP*.

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All parts of the manuscript should be typewritten, double-spaced, with margins of at least one inch on all sides. Articles will normally be no more than 30 double-spaced pages in length (including tables, figures and references). Articles should also include a title page, a 100-word abstract and complete references. The title of the manuscript should reappear on the first page of the text. Authors should also supply a shortened version of the title suitable for the running head, not exceeding 50 character spaces. Research notes (13 pages including references, tables, figures, 100-word abstract) are welcomed submissions. Manuscripts, including tables, figures and references, should be prepared in accordance with the Publication Manual of the American Psychology Association (Sixth Edition, 2010). Copies of the manual can be obtained from the

Publication Department, American Psychological Association, 750 First Street NE, Washington, DC 20002-4242; phone (202) 336-5500.

Authors are to avoid the use of sexist, racist and otherwise offensive language. Manuscript copies should be clear and legible and all figures must be camera ready. All reviews are blind and conducted by two reviewers and Associate Editors with the review process taking 8–10 weeks. Authors will receive typed feedback regarding the editorial decisions made on their manuscript and any suggested revision recommendations. Authors should be prepared to provide their raw data if requested during the review process. A file copy of the manuscript should be kept by the author.

### **Illustrations**

Illustrations submitted (line drawings, halftones, photos, photomicrographs, etc.) should be clean originals or digital files. Digital files are recommended for highest quality reproduction and should follow these guidelines:

- 300 dpi or higher
- sized to fit on journal page
- EPS, TIFF, or PSD format only
- submitted as separate files, not embedded in text files

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A short descriptive title should appear above each table with a clear legend and any footnotes suitably identified below. All units must be included. Figures should be completely labeled,

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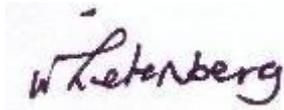
Search Engine Optimization (SEO) is a means of making your article more visible to anyone who might be looking for it.

# Appendix G: Proof of language editing

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## LANGUAGE EDITOR DECLARATION

I hereby declare that I completed the text editing on this dissertation, entitled *A comparison between the acute effects of different recovery techniques on the mood states of university-level rugby players*, submitted in fulfilment of the requirements for the degree Magister Scientiae in Sport Science at the North-West University, Potchefstroom Campus, for Erika van die Bijl, student number 11287195.



Wilna Liebenberg

MA Applied Linguistics.

SATI Accredited Editor and Translator