

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.



Massey University
COLLEGE OF SCIENCES

**The Effect of the Recovery Duration
between Warm-up and Competition on
Physiological and Psychological Markers
in Well-Trained Football Players**

Submitted by Terry O'Donnell to Massey University as a thesis for the degree
of a Master of Science in Exercise and Sport Science (February, 2013)

I certify that all material in this dissertation which is not my own work has
been identified and that no material is included which has been submitted for
the granting of a degree by this or any other university institution.

.....

Acknowledgements

This thesis would not have been possible without the considerable guidance and expertise provided by my supervisor Dr. James Faulkner. His help and patience throughout the entire research process has been fundamental and deeply appreciated.

Thanks must also be expressed towards David Gleadon and Wendy O'Brien, who made the experimental testing far easier than it otherwise, would have been. Assistance from student helpers Robert Bukton, Peierh Aui and Christy Mccash made the multiple testing sessions possible and your time spent collecting pages of numbers was much appreciated.

I particularly valued the support of friends, family and work colleagues who provided an extra pair of hands, went through multiple critiques of drafts, covered for me when experiments conflicted with work requirements or simply listened to my complaints.

My final thanks and appreciation goes to the participants who gave up their evenings to subject themselves to repetitive hours of running in the name of science. This research would really not have been possible without you and the healthy banter made the process far more enjoyable. In particular I would like to thank the Wellington United football club who provided the majority of participants for this study.

Abstract

Purpose: Football players at the elite level are required to cease warming up 20 minutes prior to matches commencing (Blatter & Linsi, 2003). Since a duration of 15-20 minutes may cause muscles cooling, this time period could be problematic for athletic performance (Bishop, 2003a). Therefore the aim of this research study was to investigate the effect of varied recovery durations post warm up on physiological, perceptual and performance measures of football players during the Loughborough Intermittent Shuttle Test (LIST).

Methods: Thirteen male football players completed five assessment sessions; a graded exercise test (GXT) to maximal functional capacity, a baseline assessment for athletic performance (sprint, agility and vertical jump), and three experimental trials. After completing a standard active warm up, the experimental trials required participants to passively recover for either 5, 10 or 20 minutes before performing assessments of sprinting, vertical jump and agility. Thereafter, participants completed a 90 minute intermittent shuttle protocol (LIST). Heart rate (HR), blood lactate (BLa), the feeling scale (FS), felt arousal scale (FAS) and rating of perceived exertion (RPE) were collected at regular intervals throughout the LIST. All subjects completed the test on 3 separate occasions under each recovery condition.

Results: Sprint performance following a 5 minute recovery was significantly slower than the baseline performance assessment ($2.52 \pm 0.12s$ *cf.* $2.43 \pm .09s$ $P < 0.016$). Although both sprint and agility performance showed a trend towards being negatively affected by a 20 minute recovery duration ($P = 0.032$ and 0.031 respectively), participants vertical jump typically improved following only 10 minute recovery duration. Participants were less aroused and experienced lower levels of pleasure (FAS and FS) throughout testing following

Abstract

the 20 minute recovery duration (1.50 ± 0.97 cf. 2.80 ± 1.14 , and $.50 \pm 1.88$ cf. 3.17 ± 1.33 , $P < .05$). When investigating the physiological and perceptual response during the LIST, the recovery duration did not significantly influence participants' HR, BLA, RPE or performance response.

Conclusion: This study would suggest that a recovery period of 10 minutes post warm up may improve FAS, FS and VJ during exercise. However, ambiguous findings observed for BLA failed to provide physiological data to support these findings. The small sample size is the primary reason for these equivocal results. Future research should consider the effect of a larger sample size, inclusion of sport-specific skills and mechanisms for maintaining temperature during this interim period.

List of contents

Acknowledgements	2
Abstract	3
List of contents	5
List of figures	8
List of tables	10
Chapter 1: Introduction	11
Chapter 2: Literature review	14
2.1 Active and passive warm up	15
2.2 Physiological advantages of increased temperature due to Warm Up	16
2.2.1 Force/velocity	16
2.2.2 Vasodilation and dissociation	18
2.2.3 Nerve conduction.....	19
2.2.4 Muscle and joint Stiffness	20
2.3 Post activation potentiation	21
2.4 Metabolic effects	23
2.5 Oxygen consumption	24
2.6 Effect of WU on mental preparation	25
2.7 Performance improvements following warm wp	27
2.8 Stretching.....	28
2.9 Application of WU protocol in elite football	30
2.10 Warm up intensity and duration.....	32
2.11 LIST.....	33
2.11.1 Running distance.....	34
2.11.2 Turns	35
2.11.3 Sprints	35
2.11.4 Time spent at different exercise intensities.....	36
2.12 Recovery duration following Warm Up	37
2.13 Conclusion and study rationale.....	40

List of contents

2.14 Hypothesis	41
Chapter 3: Methods	42
3.1 Participants	42
3.2 Procedures	43
3.3 GXT to maximal functional capacity.....	44
3.4 Baseline performance measures	45
3.4.1 Sprint.....	45
3.4.2 Agility	46
3.4.3 Vertical Jump	47
3.5 Experimental trials	47
3.5.1 Pre-measures	47
3.5.2 Warm up	48
3.6 LIST.....	49
3.7 Measures of perception.....	51
3.7.1 FS and FAS.....	51
3.7.2 RPE	51
3.8 Heart rate.....	52
3.9 Statistical analysis	52
Chapter 4: Results.....	54
4.1 GXT to maximal functional capacity.....	54
4.2 Pre-LIST performance markers	54
4.3 Physiological and perceptual markers pre- and post-warm-up (WU).....	56
4.4 Physiological and perceptual markers following 5, 10 and 20 min recovery duration	56
4.5 Physiological and perceptual markers during LIST.....	57
4.6 Sprint times.....	59
4.7 Time to exhaustion	60
4.8 Physiological and perceptual markers following the completion of LIST	60
Chapter 5: Discussion	61
Performance effects	61
Sprint, Agility and VJ	61
Sprints during LIST	64
Time to exhaustion during the LIST	64
Physiological responses pre, during and post LIST	65
Blood lactate	65

List of contents

Heart rate.....	67
Perceptual effects.....	67
FAS and FS.....	68
Limitations	69
Temperature	69
Limitations of LIST.....	70
Future research.....	72
Conclusions and applications.....	72
References:.....	73
Appendices.....	96

List of figures

Figure 2.1 Force velocity curve showing the effect of temperature. Temperatures range from 22.2°C (Black box) on the left to 37.1°C (Clear circle) on the right. De Ruiter, C. J., & De Haan, A. (2000). Temperature effect on the force/velocity relationship of the fresh and fatigued human adductor pollicis muscle. *Europeans Journal of Physiology* , 440(1): 163-170.....**16**

Figure 2.2 Effect of increasing or decreasing temperature on the oxyhaemoglobin dissociation curve. Tb on the right denotes an increased blood temperature while Tb on the left shows a lowered blood temperature. PO2 stands for the partial pressure of oxygen. Bishop, D. (2003a). Warm up 1. Potential mechanism and the effects of passive warm up on exercise performance. *Sports Medicine* , 33 (6): 439-454.....**18**

Figure 2.3 Example of match day schedule for teams competing at elite FIFA sanctioned tournaments. Adapted from guidelines for FIFA match officials (Blatter & Linsi, 2003).....**31**

Figure 3.1 Schematic of agility test performed during baseline measures.....**46**

Figure 3.2: Schematic of running protocol during LIST. This cycle is repeated for the 15 minutes of each block in part 1 of LIST. Lengths were performed to a computerised beep programme with jog being 55% of $\dot{V}O_2$ max while fast cruise corresponded to 95% of $\dot{V}O_2$ max.....**50**

List of figures

Figure 3.3: Schematic of experimental protocol. Red arrows indicate BLA sampling and blue arrows indicate collection of perceptual markers (RPE, FS and FAS). Shaded areas represent 3 minute rest periods.....**52**

Figure 4.1: Mean (\pm SD) sprint (**A**), agility (**B**) and vertical jump (**C**) performance at baseline, 5-Rec, 10_Rec and 20_Rec.....**55**

Figure 4.2: Mean \pm SD times during the LIST protocol under 3 different recovery conditions (5_Rec, 10_Rec and 20_rec).....**59**

List of tables

Table 4.1: Physiological and physical data from GXT to maximal functional capacity. Data are reported as mean \pm SD.....**54**

Table 4.2: Resting measures (pre-WU) of weight, HR and BLA. Data is reported as mean \pm SD.....**56**

Table 4.3: Post WU BLA, FS and FAS. Data is reported as mean \pm SD.....**56**

Table 4.4: Means \pm SD for BLA, HR, FAS and FS after 5_Rec, 10_Rec and 20_rec.....**57**

Table 4.5: Measures of BLA, HR, RPE, FAS and FS under the different condition (5_Rec, 10_Rec and 20_Rec) during the five blocks of LIST. Data is reported as mean \pm SD.....**58**

Table 4.6: Weight changes and water consumed during LIST protocol for different recovery durations (5_Rec, 10_Rec and 20_Rec). Data is reported as mean \pm SD.....**60**