

OUR BODIES' NATURAL RHYTHMS

By

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The construction of training schedules, practices, measurements and competitions are all vital components to the progression of teams and players whether elite or grass-roots. However, trainers and coaching and support staff need to be aware that the physiological functions that the players are working tirelessly to improve, do exhibit circadian rhythms that display maximum and minimum capacities at specific times of the day. This study of biological rhythms concerns oscillatory fluctuations in cells, tissues, organs and the more complex control systems within a twenty four hour period (Manfredini *et al.*, 1998). When planning training sessions, training periods and comparing player performances, the influence of circadian rhythms on player performance needs to be considered in the quest for optimal player performance.

The following article draws upon physiological research to discuss the impact of the time-dependent alteration of physiological components and the effect of transmeridian flights on player performance. Each section shall be accompanied by relative implications to planning.

Physiological Components.

There has been a great deal of research conducted concerning circadian rhythms in many physiological and psychophysiological systems (displayed in table 1) that can all affect the performance of a rugby player. For example, Reilly *et al.* (2000) reports that, independently of muscle group measured, muscle strength peaks in the early evening. Trunk flexibility was reported to peak at 1330 hours (Baxter and Reilly, 1983), but lower limb measures in knee flexion and extension have been higher in training sessions conducted at 1800 – 1900 hours (Wyse *et al.*, 1994). Improvements in muscle strength after training sessions scheduled in the early evening have been found to be 20% higher than those conducted in the morning (Manfredini *et al.*, 1998). Resultant data suggests that any comparisons of strength should be conducted at similar times of the day (± 30 mins.) Torii *et al.* 1992) studied the effects of aerobic training at different times of the day and suggested that, when aiming to increase

VO_{2max} and decrease heart rate and blood lactate levels, then training should occur between 1500 and 1530 hours.

Psychological Components.

Rhythms in cognitive variables have relevance in influencing strategies, decisions and recollection of complex coaching instructions (Reilly *et al.*, 2000). Reaction time was found to peak in the early evening (1500 – 1800 hours) but information processing abilities peak over a longer period between 1400 and 2100 hours.

The impact of these “windows” that enable optimal performance can be seen in relation to training and scheduling in table 1.

Transmeridian Flights.

Modern rugby requires many teams to cross several time zones to reach their destination and the knowledge and influence of circadian rhythms and biological functions will be important when selecting an optimal time for training and competition with the aim of increasing personal and team performances. The games and training scheduled for domestic, European and international competition result in travel that induces tiredness and fatigue, commonly known as ‘jet lag’. The jet lag phenomenon occurs as a result of the desynchronization of the body’s circadian rhythm and reflects a *temporary* mismatch between the local time and the traveller’s biological time. The key is for coaching and support staff to facilitate the reduction of this mismatch, aiding the adjustment to the local time.

Table 1: The influence of circadian rhythms on physiological and psychological components (Adapted from Winget *et al.* (1993) and Cappaert (1999))

Variable	Component	Time of Peak Effect (h)	Training Component
Sensory Motor	Reaction Time	1500-1800	Skills Training
Psychomotor	Hand-eye Co-ordination	1430	Skills Training
Sensory Perceptual	Pain Threshold	0300- 0634	Aim to complete no training
Cognitive	Information Processing	1400-2100	Strategies and Technical Information
Affective	Mood	1400-1600	Psychological Skills Training
Psychophysiological	Arousal	0600-1400	Psychological Skills Training, Motivation
Cardiovascular	Heart Rate	1545-1700	Aerobic Training
Metabolic	Body Temperature, oxygen consumption	1500-1840	Aerobic Training
Aerobic Capacity	Maximal Oxygen Consumption	1500-2000	Aerobic Training
Neuromuscular	Strength	1400-1845	Strength Training

Reilly and Mellor (1988) reported that normal, evening performance of rugby league players who travelled to Australia was reversed for five days upon arrival. Research involving British Olympic Squad members showed decrements of 3-4% in choice reaction time, 6-13% in arm strength, impairments in elbow flexor strength, leg and back strength and sprint times when compared to that of pre-flight values (Reilly *et al.*, 1997). It has been concluded that just allowing one day to adapt for each time zone crossed is not sufficient for all athletes to become adjusted to their new external and internal environments.

The following suggestions to alleviate the effects of jet lag have been adapted from Reilly (2005) and Reilly *et al.* (2000).

Strategies for alleviating the effects jet lag.

Scheduling travel

Travel arrangements should be made so that the athletes arrive well in advance of the competition dates, usually one day for each time zone crossed. The time taken to adapt to their new environments can be influenced by exploiting the factors that reset the biological clocks (rest/exercise, darkness/light, meals) (Reilly, 2005). The key is to allow the athletes to adapt to their new external environment as soon as possible.

During Travel

Jet lag symptoms are more pronounced during eastward flights than those to the west when crossing the same number of time zones. During daytime flights, the athletes should be encouraged to stay awake and keep mentally active. Night flights should be planned to allow your athletes to sleep and miss the in-flight meals that disrupt the body's blood levels and digestive system. Some British sports teams have been prescribing their athletes sleeping pills for long-haul flights, but this should be avoided as the motor performance effects of such pills have not been researched. They may also be counter-productive if administered at the wrong time; if an athlete sleeps when he merely feels drowsy, sleeping can keep him in his (former) sleep-wake cycle, resisting the adaptation to the new zone. Players should be encouraged to move throughout the flight as a restrained posture for hours on end can aid joint stiffness. Performing isometric or flexibility exercises will alleviate the effects of this.

Strategy upon Arrival

When arriving at their destination, it is of utmost importance for the players to adjust to the characteristics of their new environment as soon as possible. It is generally accepted that, when travelling westward, athletes may benefit from retiring to bed early; after an eastward flight, a light training session in the evening would be beneficial in instilling local cues into their circadian rhythms. Training should not involve full efforts in the first few days and practices that require co-ordination are likely to be detrimental to a player's development, possibly leading to injuries and accidents.

Napping

Prolonged naps should be avoided as subsequent sleep will prove more difficult and the adjustment of the new biological clock will be hindered.

Diet

A high-protein breakfast should be encouraged each morning as this promotes alertness, which is a benefit when suffering from time-phase shifts. A diet that incorporates high carbohydrate in the evening will promote sleep.

Melatonin Capsules

In normal time zones the body secretes melatonin between the hours of 21.00 and 07.00 hours. This is regarded as the internal time cue and induces the body to close down its functions for a night's sleep. Melatonin capsules can be taken in the evening during local time of the new time zone to reduce the symptoms of jet lag.

Bright Light Exposure

Natural light can adjust the body clock, assuming that the timing of exposure is correctly implemented. The correct timing of exposure should be opposite to that of melatonin ingestion. For example, bright light in the morning (05.00 to 11.00 hours) advances the body clock and bright light in the evening (21.00 and 03.00) delays it. Table 2 displays correct exposure times for westward and eastward flights. Consider a westward flight through eight time zones. Exposure to bright light at 21.00 to 03.00 hours body time and avoidance at 05.00 to 11.00 hours will delay the body clock. By the new local time, this then becomes equivalent to 13.00 to 19.00 hours for bright light and 21.00 to 03.00 hours for dim light.

Table 2: Bright light exposure to adjust the body clock after eastward and westward travel

	Bad local times for exposure to bright light	Good local times for exposure to bright light
Time zones to the west		
4h	01.00-07.00 b	17.00-23.00 a
8h	21.00-03.00 b	13.00-19.00 a
12h	17.00-23.00 b	09.00-15.00 a
Time zones to the east		
4h	01.00-07.00 a	09.00-15.00 b
8h	05.00-11.00 a	13.00-19.00 b
10-12h	Treat this as 12-14hrs to the west	

a will advance the body clock

b will delay the body clock

A poor competitive or training performance may result when players, coaching and support staff ignore the influence of circadian rhythms. When a player performs

several hours before or after their circadian peak 'window', he will potentially be performing with less than optimal efficiency (Manfredini *et al.*, 1998) and limit the desired outcomes of a session or competition. If coaching and support staff plan daily timetables around these 'windows', ensuring the selection of optimal circadian time, it can result in as much as a 10% increase in player performance. This article highlights the potential issues that should be considered in an attempt to gain this 10% increase in performance.

Key references:

- Manfredini, R., Manfredini, F., Fersini, C., and Conconi, F. (1998). Circadian Rhythms, Athletic Performance and Jet Lag. *British Journal of Sports Medicine*, **32**, 101-106.
- Reilly, T., Atkinson, G., and Waterhouse, J. (2000). Chronobiology and Physical Performance. In W.E. Garrett, Jr. and D.T. Kirkendall. (Eds.), *Exercise and Sports Science*. Philadelphia: Lippincott Williams and Wilkins.