objective in clinical research. Circadian rhythms of haematological parameters may have diagnostic implications in clinical medicine and sports sciences. The majority of clinical studies have focused on the circadian rhythms of red blood cells (RBC) indices at rest (Touitou *et al.*, 1986: *Clinical Chemistry,* **32**, 801–4). Despite the important role of exercise in health and disease, no study has attempted to determine the effects of time of day on RBC indices in response to exercise. Therefore, the present study was designed to examine the effects of time of day on R.BC responses to resistance exercise.

Ten healthy male subjects (mean $\pm$ *SD:* age, 29.3 $\pm$ 4.5 *yr*; weight, 78.5 $\pm$ 9.2 *kg;* height, 178.5 $\pm$ 6.8 *cm*) signed a written informed consent approved by the University's ethics committee. On completion of two familiarisation sessions and determination of one repetition maximum (1RM), subjects undertook identical bouts of resistance exercise on two separate occasions (at least 3 days apart). The protocol consisted of three phases. In phase I, subjects remained seated for 30 minutes, and a series of baseline readings were taken after this phase. Phase II consisted of the performance of 3 sets of 7 repetitions of six exercises at 80% of 1RM. This phase started at 08:00 (morning) or 20:00 (evening). The exercises and order of performance were as follows: latissimus pull down, knee extension, triceps pushdown, leg curl, bench press, and back squat. Phase III consisted of 30 minutes of recovery, with the subjects remaining seated throughout. Three blood samples (7 ml) were obtained before exercise, immediately after exercise and after 30-mm of recovery. Blood samples were analysed for RBC indices including: RBC count, haemoglobin, haematocrit, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red blood cell distribution width (RDW). Plasma volume changes were calculated according to Dill and Costill (1974: *Journal of Applied Physiology,* **37**, 247–248). Data were analysed using a two-factor (trial, 2 $\times$ times, 3) repeated measures ANOVA.

Although plasma volume decreased in response to resistance exercise in both morning ($-$10.4%) and evening ($-$10.16%) trials, the difference between the two trials was not statistically significant ($P > 0.05$). The RBC count increased immediately after resistance exercise by 5.5 % and 5.6% in the morning and evening, respectively. Haemoglobin concentration (mean $\pm$ *SEM)* increased above baseline values following resistance exercise in the morning (14.65 $\pm$ 0.37 $g.dl^{-1}$ *vs* 15.4 $\pm$ 70.31 $g.dl^{-1}$) and evening (14.67 $\pm$ 0.32 $g.dl^{-1}$ *vs* 15.52 $\pm$ 0.32 $g.dl^{-1}$). Similarly, haematocrit increased significantly in response to resistance exercise from 42.6 $\pm$ 1.12% to 45.1 $\pm$ 0.96% and from 42.5 $\pm$ 0.94% to 45.3 $\pm$ 0.95% in the morning and evening trials, respectively. The changes in these variables in response to resistance exercise were transient and returned to pre-exercise level at the end of the recovery period. The other RBC parameters including MCV, MCH, MCHC, and RDW did not show significant changes in response to resistance exercise. No significant difference between responses of all measured RBC parameters to resistance exercise at two different times of day (morning and evening) was observed. In addition, resting values were not statistically different.

The significant increases in RBC count, haemoglobin, and haematocrit, immediately after resistance exercise in the present study are in agreement with findings of previous studies that reported similar increases following short intense endurance exercise protocols (Szygula *et al.*, 1985: *Sports Medicine,* **10**, 181–197). The increases in these variables following resistance exercise might be attributed to a reduction in plasma volume since more than a 10% reduction in plasma volume was observed immediately after resistance exercise. In conclusion the responses of RBC indices to resistance exercise do not appear to be related to the time of day.

PART V: PSYCHOLOGY

1. The effect of exercise intensity on visual choice reaction times performances

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In many sport activities participants are required to make rapid and accurate decisions despite a great deal of physical exertion. Past laboratory-based research studying how exercise intensity affects reaction time performances does not show clear trends (e.g., Etnier et al., 1997: *Journal of Sport and Exercise Psychology,* **19,** 249–277; Tomporowski, 2003: *Acta Psychologica,* 112, 297–324). The objective of the present study was to investigate the effects of different exercise intensities on Visual Choice Reaction Time (VCRT) performances.

A controlled, cross-over randomised design with repeated measures was employed. Twenty healthy young adults (7 male and 13 female; 19.1 $\pm$ 1.59 yrs) performed the VCRT task on five occasions: pre-test (rest), 40–45% heart rate reserve (HRR), 80–85% HRR, post-test 1, and post-test 2. After familiarisation with the equipment (Lode Corival 400 ergometer and Lafayette 63035 VCRT apparatus), each participant performed the pre-test, which consisted of 15 consecutive VCRT trials whilst static on the bicycle ergometer. Each participant then completed the same task at the specified steady state heart rate (40–45% HRR or 80–85% HRR); the two conditions were counterbalanced with one week between each and were statistically different regarding heart rate (P=0.000; 40–45%: 123.95±4.68; 80–85%: 175.45±2.06). Seven days later each participant returned to the laboratory to perform the post-test 1 and 12 weeks after this date performed the post-test 2. Both tests were administrated under the same heart rate conditions as the pre-test ($P>0.05$; pre: 84.35±10.32; post-1: 82.85±9.04; post-2: 81.95±8.16). A one-way correlated Analysis of Variance (ANO VA) for repeated measures was conducted.

Results indicated that there were no significant differences between the five conditions ($F_{2.1, 40.8}$=2.517, P=0.09; the Greenhouse-Geisser test of within-subjects effects was considered). However, there were trends to suggest that certain tendencies had occurred. Therefore, paired t-tests were performed on the data (significance set at $P<0.015$ after Bonferroni adjustment) and showed that VCRT significantly decreased when exercising at 80–85% HRR (0.49±0.78 seconds) compared to when at rest (0.54±0.76 seconds). No significant differences were found between rest (0.54±0.76 seconds) and 40–45% HRR (0.49±0.86 seconds) nor between 40–45% HRR (0.49+0.86 seconds) and 80–85% HRR (0.49+0.78 seconds). However, a significant difference was found between the pre-test (0.54±0.76 seconds) and the post-test 1 (0.48+0.07 seconds) but none with the post-test 2 (0.51±0.09 seconds).

The findings showed that high intensity exercise (80–85% HRR) resulted in faster visual choice reaction time performances compared to a low intensity exercise (40–45% HRR) or a rest condition. The results of post-test 1 suggested that learning had influenced reaction time performances; however, this learning effect disappeared in post-test 2. These findings highlight both the importance of a solid experimental protocol (accounting for both the intensity and the duration of the exercise) and the limits of previous research, which had not systematically included counterbalanced groups, post-tests conditions, or time-intervals between trials. Further research is needed to accurately study the impact of different physiological exercise intensities on the full range of human cognitive performances. However, although differences can be detected between rest and exercise conditions with small sample sizes (less than 30 participants), consideration must be given to the fact that to detect significances differences with reasonable power (i.e. power=0.90, P =0.05) between different exercise intensities, a large number of participants would be required.

2. A meta-model of stress, emotions and performance: Conceptual foundations, theoretical framework, and research directions

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Described here is the development of a meta-model of stress, emotions and performance. Following an extensive review and synthesis of pertinent psychological theories, a model emerged outlining the theoretical relationships among key processes, moderators and consequences of the stress process (Figure 1). The model offers a supraordinate perspective of the stress-emotion-performance relationship by building upon conceptual advances which emphasise the transactional nature of stress as a dynamic process (see Lazarus, 1998: **Fifty Years of the Research and Theory of R.S. Lazarus: An Analysis of Historical and Perennial Issues**. Mahwah, NJ: Lawrence Erlbaum Associates; Lazarus, 1999: **Stress and Emotion: A New Synthesis**. London: Free Association Books). The basic premise being that stressors arise from the environment the performer operates in, are mediated by the processes of perception, appraisal and coping, and, as a consequence, result in positive or negative responses, feeling states, and outcomes. This ongoing process is moderated by various personal and situational characteristics.

The meta-model can be divided into three main theoretical stages: (a) person-environment (P-F) fit; (b) emotion-performance (E-P) fit; and (c) coping and overall outcome (COO). The first stage focuses on the notion of P-F fit, which is either explicitly or implicitly common to most contemporary theories of psychological stress. It proposes that strain arises not from the person or environment separately, but rather by their misfit or incongruence with one another. Central to this stage are personal perception and an (initial) cognitive process of relational meaning involving the appraisal of stressors resulting in emotional responses. The second stage focuses on the notion of E-P fit which proposes that negative feeling states occur when the relationship between an emotion and performance is out of equilibrium. A negative feeling state reflects those emotional responses that are interpreted as debilitative to performance. Central to this stage is a (further) cognitive process of relational meaning involving the appraisal of emotions resulting in feeling states. The third stage focuses on coping with these reactions and proposes that negative outcomes occur through the inadequate or inappropriate use of coping strategies.