ANNOTATION

THE REPRODUCIBILITY OF SUBMAXIMAL WORK HEART RATES — SUPPLEMENTARY NOTE to the article published in BJSM Vol. 10, No. 2, June 1976

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The previous article was based on two assumptions — (a) that the work heart rate (WHR)/work intensity slopes were the same for all subjects on all days; and (b) that any carry over of fatigue from the previous work bout would probably be small and would in any case be lumped into the residual error. This confounding of the carry-over effect of fatigue with the error term was one reason behind the selection of the Latin Cube design.

Failure of either assumption would lead to an inflation of the error term and may partially explain the wide confidence limits of ± 12.7 beats.

It is desirable to test both assumptions at the same time. A multiple correlation, with dummy variables to specify each hypothesis under test, was set up. The calculation can be arranged in FOUR cases:

Case 1: analysis of WHR data.
Case 2: analysis of WHR data including previous work bout.
Case 3: analysis of WHR data including immediate pre-exercise heart rate (PEHR).
Case 4: analysis of WHR data including both previous work bout and PEHR.

Each of these cases must be considered in THREE stages:

Stage 1: 16 lines of possibly different slopes — i.e. slopes may be different for any subject and may be different from day to day. Therefore 4 subjects on 4 different days will give a possibility of 16 different slopes (subject x day interaction on slopes, 16 degrees of freedom). There are, of course, 16 intercepts (subject x day interaction on intercepts, 16 d.o.f.).
Stage 2: allow each subject to have an individual slope which must be maintained from day to day (subject slopes, 4 d.o.f.). Although the slope must be held constant from day to day, the intercept may change (subject x day interaction on intercepts, 16 d.o.f.).
Stage 3: have the same slope for all subjects for all days — i.e. "same slope hypothesis". (one slope, 1 d.o.f.). The intercept may change from subject to subject and from day to day (subject x day interaction on intercepts, 16 d.o.f.).

The results are summarized in Table I. For convenience, 95% confidence limits have been calculated for each Stage within each Case — these range from ± 8.2 to ± 8.9 beats — which shows quite clearly that the same slope hypothesis is not dismissed by this data. Formal F tests have been performed and confirm this conclusion.

TABLE 1

	RESIDUAL SUM OF SQUARES	*RESIDUAL DEGREES OF FREEDOM*	*95% CONFIDENCE LIMITS* ±
CASE 1			
Subject x Day slopes	605.0	32	8.9
Subject slopes	798.4	44	8.6
Same slope	898.6	47	8.8
CASE 2 — include previous work bout			
Subject x Day slopes	443.2	28	8.2
Subject slopes	679.9	40	8.3
Same slope	772.3	43	8.5
CASE 3 — include PEHR			
Subject x Day slopes	542.8	31	8.5
Subject slopes	753.9	43	8.4
Same slope	863.2	46	8.7
CASE 4 — include previous work bout and PEHR			
Subject x Day slopes	440.0	27	8.3
Subject slopes	679.4	39	8.4
Same slope	772.3	42	8.7

Total number of degrees of freedom for the Latin Cube = 64
Uncorrected total sum of squares = 1457032

NOTE: In all the above cases 16 degrees of freedom are taken up by the subject x day interaction on intercepts.

THEREFORE IT IS FELT THAT THE SAME SLOPE HYPOTHESIS IS REASONABLE.

The next step in the calculations is to investigate the role of Pre-exercise heart rate (PEHR) and previous work bout. In order to do this it is necessary to take account of the following three factors: (a) the same slope hypothesis has been shown to be reasonable. (b) as shown in the previous article the day to day effect is nonsignificant. (c) whilst the subject x day interaction is 99% significant it is, at this stage, impossible to take into account and must, therefore, be allocated to the error term. When the calculation is set up to take these factors into account it is found that PEHR is 90% significant and previous work bout is nonsignificant. This meansd that PEHR contains almost all the information which is given by previous work bout, but that the previous work

bout is not sufficient to replace PEHR. In the absence of previous work bout, PEHR goes up to 99.5%. In spite of the fact that previous work bout was found to be non-significant over and above PEHR it is in fact interesting to calculate the coefficient, i.e. the carry over effects from each work bout (Table II).

TABLE II

Carry over effects from previous work bout, not accounted for by pre-exercise heart rate

Previous work bout (Intensity in Watts)	Elevation of current work heart rate
0	0.0
100	0.4
150	0.0
200	1.6
250	3.8

This suggests that recovery from 3-minute work bouts of 100, 150 and 200 watts is virtually complete in the 20-minute rest interval, whereas after 3 minutes work at 250 watts the next work heart rate will on average be about 4 beats high, and that this inflation of work heart rate is not allowed for by the observed PEHR. This implies that one could achieve the same pre-exercise heart rate in different states of fatigue and these differences would be subsequently shown in higher work heart rates at the same standardized work bout.