Eur J Appl Physiol (1987) 56:222—224

European Journal of
Applied
Physiology
and Occupational Physiology

Use of perceived effort ratings to control exercise intensity in young healthy adults

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Summary. The purpose of this study was to evaluate the use of the rating of perceived exertion (RPE) as a means of regulating the intensity of exercise during running. The subjects were healthy, relatively fit young adults (16 men and 12 women). Estimates of effort were recorded using the Borg 6—20 Scale whilst the maximal oxygen uptake of the subjects was measured as they ran on an electrically driven treadmill. In a further session, the same subjects were requested to run on the treadmill at constant exercise intensity based on their interpretation of levels 9, 13 and 17 of the Borg Scale. They regulated their running speed and the treadmill gradient but had no knowledge of performance from the equipment display panel. A linear regression analysis was carried out to examine the relationship between heart rate, perceived exertion and relative metabolic demand. This revealed that the rating of perceived exertion was at least as good a predictor of exercise intensity as heart rate in both the graded exercise test and effort production test. The results support the view that RPE may be used to predict relative metabolic demand, especially at higher workloads and could be a useful medium for controlling intensity of effort during vigorous exercise in such subjects.

Key words: Effort perception — Exercise intensity control

Introduction

The rating of perceived exertion (RPE) (Borg 1977) is used in conjunction with physiological measures to prescribe training intensity levels in both adult fitness and cardiac rehabilitation programmes (ACSM 1986; Carton and Rhodes 1985; Pandolf 1983; Noble 1982). A potentially useful variant of this application of the RPE would be for an exercising person to use or, if necessary, 'learn to use', an appropriate version of the scale to control the intensity of work, for example, during training for endurance in athletics. This would obviate constant reference to complex laboratory facilities. A limited amount of research concerned with perceived effort and exercise prescription supports the viability of such an application but the evidence does not provide clear direction. Borg and Linderholm (1970), using cycling ergometry with men and women who had suffered cardiovascular disease and a control group of healthy subjects, reported that RPE was as reliable as heart rate for producing two work loads which corresponded to heart rate reference levels of 130 and 170 beats/min. But, Smutok et al. (1980) have reported that prescription of exercise by use of RPE for active, adult men is only reliable at heart rates above 150 beats/min (80% HR_{max}) and running speeds of 9 km/h.

For RPE to be generally useful for self-regulation of exercise intensity, reliability across a fairly wide range of intensities would be desirable. However, lack of firm evidence concerning the precise relationship between perceiving effort whilst engaged in exercise and producing effort at the same level to that previously experienced, detracts from the validity of perceptual ratings as prescriptive or regulatory devices. The assumption that the two processes are equivalent has drawn a cautionary note and a call for further research from both Noble (1982) and Pandolf (1983). Thus, the purpose of this study was to evaluate the use of RPE as a frame of reference

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for the poduction of a range of treadmill running intensities by active, relatively fit young men and women.

Methods

Sixteen healthy men (age 21 ± 2.5 years, height 179.6 ± 4.3 cm, weight 74.0 ± 6.8 kg, $\dot{V}_{O_{2max}}$ 57.6 ± 4.5 ml · kg^{-1} · min^{-1}, max h 179.1 ± 7.1 bpm, R 1.03 ± 0.04) and 12 healthy women (age 23.2 ± 4.8 years, height 169.2 ± 7.1 cm, weight 63.2 ± 5.3 kg, $\dot{V}_{O_{2max}}$ 42.3 ± 4.6 ml · kg^{-1} · min^{-1}, max h 180.7 ± 6.4 bpm, R 1.01 ± 0.05)) volunteered to take part in this study.

The subjects attended the laboratory 3 times. The first visit consisted of a brief practical introduction to treadmill running. On the second occasion they completed a graded exercise test on an electrically driven treadmill (Woodway, ES1) to assess maximal oxygen uptake ($\dot{V}_{O_{2max}}$). The protocol for this test was that recommended by Thoden et al. (1983) with the exception that after warm-up the duration of each 2% increment in gradient was at least three minutes to elicit steady state $\dot{V}_{O_2}$ and HR. For men, the treadmill speeds were maintained at 12.9 km · h^{-1} (runners, i.e., those running over 10 miles per week) and 12 km · h (non-runners). For women the treadmill speeds were maintained at 8.9 km · h^{-1} (runners) and 8 km · h (non-runners). $\dot{V}_{O_2}$ was measured continuously using an Oxycon 4 ergoanalyser (Mijnhardt). Exercise heart rate (HR) was measured by a Lifetrace 12 Cardiometer (Albury Instruments). RPE was collected using the Borg 6—20 Scale in the last 15 s of each incremental steady state $\dot{V}_{O_2}$ using the standard procedure recommended by Morgan (1981). On a subsequent occasion, no sooner than 2 days and no later than 7 days, subjects were requested to run at constant exercise intensities which they perceived to be 9, 13 and 17 on the Borg Scale in that order. Subjects were reminded of the purpose of the scale and requested to recall their feelings of exertion as experienced in the previous test. A sufficient time limit was allowed to adjust the treadmill speed and gradient to match the assigned RPE value and to ensure that steady state $\dot{V}_{O_2}$ was attained. Information about the speed and gradient of the treadmill registering on the equipment display panel was eliminated.

Results and discussion

Table 1 sets out the results of a linear regression analysis of the relationships between HR, RPE and relative metabolic demand (% $\dot{V}_{O_{2max}}$). This shows the RPE to be at least as good a predictor of exercise intensity as heart rate in both the graded exercise test and the effort production test. Table 2 compares % $\dot{V}_{O_{2max}}$ at three levels of steady state effort production (RPE equal to 9, 13 and 17) for both men and women. It is notable that there was no statistically significant difference between the relative metabolic demand of men and women at each level of steady state effort production. This finding is in agreement with Noble et al. (1981). As a whole, the results support the view that RPE can be used to regulate exercise intensity when those using such a scale are healthy and fit. The reliable application of effort ratings in the control of exercise intensity is dependent upon the production of similar levels of work at an equivalent metabolic demand across a range of exercise intensities, on different occasions. Although confirmation that this was possible could not be statistically verified in this study, comparison of predicted % $\dot{V}_{O_{2max}}$ and predicted % HR_{max} with actual values (see Table 2) indicates that the production of accurate effort production from RPE is reasonably accurate at higher levels of RPE (13 and 17), but is somewhat less accurate at its lower level (9). This observation agrees broadly with the findings of Smutok et al. (1980).

The results also indicate that an RPE of 13 (somewhat hard) is a practically useful index of

Table 2. Means ($\bar{x}$), standard deviations (SD) and ranges (R) of % $\dot{V}_{O_{2max}}$ at exercise intensity levels corresponding to an RPE of 9, 13 and 17 during the effort production test

RPE		Men %	Women %	t	p
9	$\bar{x}$	49.9	47.4	0.65	NS
	SD	8.1	12.7		
	R	37.2—59.7	30.7—66.9		
13	$\bar{x}$	70.2	70.8	0.26	NS
	SD	6.3	7.1		
	R	59.3—82.0	60.5—83.9		
17	$\bar{x}$	90.0	87.6	1.17	NS
	SD	5.8	4.6		
	R	79.6—100	78.1—96.3		

Table 1. Regression equations for RPE: % $\dot{V}_{O_{2max}}$ and RPE:% HR_{max} in the graded exercise test and effort production test

	Relationship	Graded exercise test	r	Effort production	r
Men ($n = 16$)	RPE:% $\dot{V}_{O_{2max}}$	% $\dot{V}_{O_{2max}}$ = 21.4 + 4.082 (RPE)	0.91	% $\dot{V}_{O_{2max}}$ = 4.9 + 5.011 (RPE)	0.93
	RPE:% HR_{max}	% HR_{max} = 58.3 + 2.192 (RPE)	0.87	% HR_{max} = 38.4 + 3.335 (RPE)	0.90
Women ($n = 12$)	RPE:% $\dot{V}_{O_{2max}}$	% $\dot{V}_{O_{2max}}$ = 29.3 + 3.566 (RPE)	0.87	% $\dot{V}_{O_{2max}}$ = 3.2 + 5.031 (RPE)	0.89
	RPE:% HR_{max}	% HR_{max} = 56.9 + 2.270 (RPE)	0.84	% HR_{max} = 31.0 + 3.780 (RPE)	0.88

appropriate exercise intensity for active individuals. This falls approximately midway in the range of 50—85% $\dot{V}_{O_{2max}}$ which has been recommended by the American College of Sports Medicine (1986). Purvis and Cureton (1981) also reported that the mean RPE at anaerobic threshold in a sample of men and women students corresponds to a rating of 'somewhat hard' (13.6 ± 1.2). They concluded that an exercise intensity which equates with anaerobic threshold could be prescribed by reference to this perceived level of relative effort production. In the present study, $\%\dot{V}_{O_{2max}}$ values corresponding to an RPE of 13 were all within the range 60—84%. However, this range should be interpreted critically. Clearly, a perceived level of effort eliciting 80% $\dot{V}_{O_{2max}}$ would be inappropriate for certain populations.

In summary, the results of this study support the contention that percepts of effort as rated by the Borg Scale are useful indices of relative metabolic demand during a graded exercise test. Such ratings apparently form a useful perceptual frame of reference for selecting appropriate exercise intensities during the regulation of effort production when exercise mode, environmental conditions and the physical status of those exercising are held constant.

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Accepted October 13, 1986