

Perceptual Responses in Free vs. Constant Pace Exercise

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Key words

- perceived exertion
- estimated time limit
- velocity

Abstract

▼ The purpose of the present investigation was to study the influence of free versus constant pace on perceived exertion (RPE) and estimated time limit (ETL). Ten athletes performed a graded test aimed to determine maximal oxygen uptake ($\dot{V}O_{2max}$) and the velocity associated with $\dot{V}O_{2max}$ ($v\dot{V}O_{2max}$), a constant run to exhaustion at 90% $v\dot{V}O_{2max}$ to determine the time and distance to exhaustion at this relative velocity, a free paced run over the distance to exhaustion set by the time to exhaustion at 90% $v\dot{V}O_{2max}$. Oxygen uptake and velocity during constant pace and free

pace runs were both averaged throughout the entire period of exercise and without the last lap. The results did not show any significant effect of free versus constant pace on RPE and ETL. Averaged oxygen uptake between free and constant pace runs was not significantly different, whereas averaged $v\dot{V}O_{2max}$, % $v\dot{V}O_{2max}$ and time to exhaustion was significantly higher for free pace runs only for the entire exercise. Consequently, compared to the constant pace run, the free pace one only allowed athletes to finish the run by a sprint which was effective in increasing performance, but not to perceive the free pacing run as being less strenuous than the constant pace one.

Introduction

▼ Although steady state exercise conditions may prevail in long-distance running races such as the marathon, most endurance races are characterised by multiple changes of pace and intensity throughout the duration of the event. Athletes spontaneously choose to modulate their pace during the race to avoid becoming overfatigued before reaching the finishing line [5]. Indeed, best performances in middle distance running are usually characterised by relatively large intra-event variability in velocity (the range of coefficients of variation in velocity is from 1% to 5% calculated from the last three world records over 1500, 3000, 5000 and 10 000 m) [9]. Numerous studies, which have already dealt with velocity variability, have examined different patterns of pacing and the physiological differences between constant-intensity and variable-intensity effort [2,10,13,20,27,28,33,38,40].

During constant-intensity effort, the subjects were asked to maintain the constant pace or power as long as possible, whereas during variable-intensity effort, the subjects were asked to run or cycle as fast as possible the same over the

distance or duration they had previously performed.

During closed loop races (runs performed with a known endpoint, Saint Clair Gibson et al. [35]), subjects have to appropriately distribute energy resources so that they are exhausted just at the end of the race. Spontaneous velocity throughout the race is therefore a strategy to minimize the physiological strain [6]. From a practical viewpoint, athletes seek optimal pace strategy allowing them to run with both the least strain and stress in order to achieve optimal performance. Consequently, it may be of interest to attest whether a small variation in exercise velocity would result both in significant changes in oxygen uptake and performance, and also in perceived exertion. However, only a few authors have dealt with the effect of velocity variability on psychological factors such as rating of perceived exertion (RPE, from 6–20) in their experiments [5,12,18,21,27].

This category rating scale (from 6–20) described by Borg in 1970 [7] is the most commonly applied one in the field of exercise science [31]. Perception of physical exertion includes feelings of effort, strain, discomfort and/or fatigue experi-

accepted after revision
June 27, 2007

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DOI 10.1055/s-2007-989237
Published online Nov. 14, 2007
Int J Sports Med 2008; 29:
453–459 © Georg Thieme
Verlag KG Stuttgart · New York ·
ISSN 0172-4622

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enced during exercise [26]. A second perceptually-based scale regarding subjective estimation of exhaustion time (estimated time limit, ETL) has also been used in addition to RPE during exercise to further understand how the subject is feeling [14,15]. The RPE scale provides an estimation of the intensity of the signals of exertion associated with exercise, whereas the ETL scale deals with a subjective prediction of how long the current exercise level can be maintained.

Most of the authors who studied the effect of velocity variability on RPE reported no significant difference for RPE between constant and free pace runs [5,18,21,27]. Moreover, the effect of velocity variability on the subjective prediction of time limit has never been studied. Therefore, the purpose of the present study was to examine the influence of free versus constant pace run on RPE and ETL.

Saint Clair Gibson et al. [36] suggested that both the generation of exercise intensity and perceived exertion during an event may be controlled by the same regulatory processes in the brain. This very control mechanism which determines both power output and RPE would seem to be utilising the same scalar time parameters set by knowledge of the distance to cover and memory of similar prior exercise bouts [36]. Consequently, we may suggest that, during closed loop races, perceived exertion would similarly follow the velocity variations which could occur during free pace runs. Therefore, it is hypothesised that RPE and ETL are influenced by velocity variability, i.e., that athletes perceive the exercise as being lighter and feel that they can endure a longer time duration during a free pace run than during a constant pace one.

Methods



Participants

Ten male trained endurance runners (39 ± 10 years; 70 ± 5 kg; 173 ± 4 cm) participated in the study. These subjects were long-distance runners training for the semi-marathon. They were chosen to avoid a long-term planned race strategy and to obtain a stochastic pace (i.e., a variation in pace involving probability arising from chance). They trained five times per week (70 ± 20 km·wk⁻¹) and were medically examined before they signed an informed consent form about the purpose and procedures of the experiment. The approval of the Comité Consultatif de Protection des Personnes pour la Recherche Biomédicale de Lille was obtained for tests.

Materials

Perception was expressed according to two scales: a French translation [37] of the rating of perceived exertion scale (RPE) [7], which consisted of 15 assessments between 6 and 20 (from "very very light" to "very very hard"), and a second scale based on subjective estimation of time limit (ETL) [15], which consisted of 20 assessments between 1 and 20 (from "more than 16 hours" to less than "2 minutes"). This scale was designed as a function of the logarithm of the estimated exhaustion time (tlim) ($ETL = 21 - \log_2 [tlim]$ where tlim was expressed in min). The validity [15] and the reliability [16] of the ETL scale have previously been attested.

Oxygen uptake ($\dot{V}O_2$) was measured using a portable system (Cosmed® K4b², Rome, Italy). Before each test, the O_2 and CO_2 analysis systems were calibrated using ambient air and a gas of known O_2 and CO_2 concentrations. The calibration of the K4b²

turbine flowmeter was performed using a 3–1 syringe (Quinton Instruments®, Seattle, WA, USA). This analyser has previously been validated over a wide range of exercise intensities [22]. Breath-by-breath $\dot{V}O_2$ was averaged every 15 seconds.

Procedures

Subjects performed three tests until exhaustion on an outdoor synthetic track 400 m long. The first test was a graded exercise to determine the maximal oxygen uptake ($\dot{V}O_{2max}$) and the velocity associated with $\dot{V}O_{2max}$ ($v\dot{V}O_{2max}$). Initial velocity was set according to previous $v\dot{V}O_{2max}$ values measured two months previously, so that exhaustion occurred for each subject within 20 min [11]. Each subject began the test at a pace of 10 km·h⁻¹, followed by 1 km·h⁻¹ velocity increments every 2 minutes to exhaustion. Each stage was separated by a 30-sec rest period in a standing position. Maximal oxygen uptake was defined as the highest $\dot{V}O_2$ obtained in two successive 15-sec intervals, and $v\dot{V}O_{2max}$ as the minimal running velocity maintained for more than 1 min that elicited $\dot{V}O_{2max}$ [4]. If, during the last stage, an athlete achieved $\dot{V}O_{2max}$ that was not sustained for at least 1 min, the velocity during the previous stage was retained as his $v\dot{V}O_{2max}$. If this velocity resulting in fatigue was only sustained for ≥ 1 min and < 2 min, then $v\dot{V}O_{2max}$ was considered to be equal to the velocity during the previous stage plus half the velocity increase between the last two stages (i.e., $1 \text{ km} \cdot \text{h}^{-1} / 2 = 0.5 \text{ km} \cdot \text{h}^{-1}$) [19].

Two days later, the subjects performed one constant pace run at 90% $v\dot{V}O_{2max}$ to determine the time to exhaustion and distance to exhaustion (i.e., the maximal distance covered at exhaustion) at this relative velocity. This velocity was chosen because it is commonly used in training programmes to improve $\dot{V}O_{2max}$ [32]. During this run, the subjects were asked to maintain the constant pace as long as possible. Maximal performance (i.e., time and distance to exhaustion) was indicated to the subjects. Four days later, they performed one free paced run over the distance to exhaustion set by the constant pace run at 90% $v\dot{V}O_{2max}$. Therefore, they performed their free pace run over the same distance to exhaustion to compare the average velocity and the exhaustion time with the constant and free pace trials. For the free pace run, the runners were asked to run as fast as possible over the same distance they had previously covered at 90% $v\dot{V}O_{2max}$. During the test, the subjects had no knowledge of their velocities.

During the two days separating these tests, the subjects were asked either to rest or to do light training (i.e., 30 min at 60% of $v\dot{V}O_{2max}$). The constant and free pace runs were preceded by a standardised warming-up period of 20 min (15 min of jogging at 50% $v\dot{V}O_{2max}$ and 5 min of stretching). For each test, each subject was verbally encouraged to give maximum effort. During these runs, the subjects could not use any kind of timing device. These exercises were performed on the same running track and at the same time of day.

Velocity was checked during the incremental and the constant exercises by the experimenters. On the track, the athletes followed a pacing cyclist travelling at the required velocity. The cyclist received audio cues via a Walkman (Sony®, Paris, France), the cue rhythm determining the velocity needed to cover 20 m. Visual marks were set at 20-m intervals along the track (inside the first lane) [5]. The cyclist had to position himself in front of each mark at each audio cue to allow the runner to be at the true pace. At the end of each step in the incremental test, the subjects were informed of the beginning of a new step. For the constant

pace run, the cyclist riding in front of the subject imposed the velocity, whereas during the free pace run, the cyclist rode next to the subject so that the latter could impose the velocity. For the graded and constant run exercises, exhaustion was defined when the subject was unable to sustain the velocity, i.e., when the runner was more than 5 m behind the cyclist, whereas during the free pace run, subjects were informed by external experimenters at the end of the run that their target distance had been covered. Each subject was verbally encouraged to give maximum effort for each test. Moreover, two experimenters independently measured the time required to complete 20 m in order to check the pacer's and runner's velocity with a chronometer (Digisport Instruments®, Seyssins, France). Since it was operated manually, the registration of the two operators was checked for similarity. During previous training sessions, the subjects were familiarised with both scales and a copy of the scales was provided to each subject. Instructions on the scales were read by the subjects and the scales were explained to each of them before every exercise, as recommended by Noble et al. [25], to help participants to link their full exercise stimulus range with their full ratings of perceived exertion response range [17]. Instructions for the scales were given straight after each other. These scales were written on a board fixed on the back of the experimenter who rode in front of the subject during the incremental and constant exercises, and who rode next to the subject during the free exercise so that subjects could read each of these scales. The subjects were asked "How heavy and strenuous does the exercise feel to you?" [8] and "How long would you be able to perform an exercise at this intensity to exhaustion?". During both exercises, ratings were collected by a second experimenter who rode next to the runner. For the incremental exercise, subjects had to give ratings corresponding to their sensations during the last 15 sec of each stage. They had to point to a value on the perceived exertion scales and the ratings were collected during the 30-sec rest. For the constant and free pace exercises, the procedure was the same but subjects expressed the perceived exertion values with their fist (= 10 points) or their fingers (each one = 1 point) every 2 min up to the end of exercise. This 2-minute time-delay allowed subjects to appraise their feeling of exertion and give a number on both scales. The order of RPE and ETL was the same during both exercises for each subject but was counterbalanced between subjects in order to eliminate any effect of the order in which the scales were presented on perceptual responses.

Statistical analysis

Results are presented as mean (M) $\pm$ standard deviation (SD) values.

During the free-pace runs, the time (t) required to cover 20 m was recorded. The running velocity between two successive interval marks was thus computed as $v \text{ (m} \cdot \text{sec}^{-1}) = 20 \text{ (m)}/t \text{ (sec)}$. Consequently, 143.1 ± 46.4 velocity values were collected during free pace runs.

Oxygen uptake and velocity during constant pace and free pace runs were averaged over the entire period of exercise and without the last lap (i.e., the last 400 m). Statistical differences for averaged $\dot{V}O_2$, velocities and exhaustion times between the constant and free pace runs were tested with a Student's *t*-test for paired data.

As there is a large interindividual variability of time to exhaustion or distance to exhaustion [4], the 2-minute fixed measurement period could correspond to a higher or lower percentage of maximal distance (i.e., distance to exhaustion) per subject. Moreover, this 2-minute fixed measurement period may not have corresponded to the same distance between exercise modality for a given subject. Consequently, in order to compare RPE and ETL between constant and free pace runs, we expressed the running distance as a percentage of distance to exhaustion. For the constant and free pace runs, RPE and ETL values were calculated for each participant at 20, 40, 60, and 80% distance to exhaustion by regression analysis.

Thereafter, statistical significance according to RPE and ETL values was studied by means of a two-way repeated factor ANOVA with two repeated factors (distance and pace) and if necessary completed by the Tukey post hoc test.

Velocity variability was presented as the coefficient of variation ($100 \times \text{SD}/\text{mean velocity}$ calculated per 20 m-interval). This value corresponded to the part of SD relative to the average velocity (i.e., to a percentage of average velocity).

Data were analysed with Sigma Stat® (Jandel, Germany). For all analysis, the level for significance was set a priori at .05.

Results



Maximal oxygen uptake and $\dot{V}O_{2\text{max}}$ were $55.0 \pm 7.5 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$ and $17.2 \pm 2.0 \text{ km} \cdot \text{h}^{-1}$, respectively. Physiological and performance values are presented in **Table 1**. Averaged velocities and exhaustion times were only significantly different between constant and free paces for the entire exercise ($p < .001$, **Table 1**). Averaged $\dot{V}O_2$ remained the same between the two exercise conditions ($p > .05$, **Table 1**). The percentage of $\dot{V}O_{2\text{max}}$ was

Table 1 Mean and standard deviations values of distance limit (dlim), velocities, exhaustion times (tlim) and oxygen uptake ($\dot{V}O_2$) during constant and free pace runs, for entire exercise and without the last lap (400 m), for endurance-trained runners ($n = 10$)

	dlim (m)	Constant pace ($\text{km} \cdot \text{h}^{-1}$)	Free pace ($\text{km} \cdot \text{h}^{-1}$)	tlim at constant pace (sec)	tlim at free pace (sec)	$\dot{V}O_2$ at constant pace ($\text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$)	$\dot{V}O_2$ at free pace ($\text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$)
For entire exercise	2871 $\pm$ 930	15.5 $\pm$ 1.8 *	16.2 $\pm$ 1.8	657 $\pm$ 154 *	630 $\pm$ 161	51.9 $\pm$ 6.9	52.7 $\pm$ 7.5
Without the last lap	2471 $\pm$ 930	15.5 $\pm$ 1.8	15.4 $\pm$ 1.7	564 $\pm$ 158	569 $\pm$ 169	51.0 $\pm$ 7.0	52.2 $\pm$ 7.6

Constant pace was run at 90% of the velocity associated with maximal oxygen uptake. * Significantly statistically different, $p < .001$

Table 2 Ratings of perceived exertion (RPE) and estimated time limit (ETL) according to type of exercise (constant vs. free pace runs) and percentage of distance limit (20, 40, 60, 80% dlim) in male trained endurance runners (n = 10)

	RPE		ETL	
	mean	SD	mean	SD
Constant pace run				
20% dlim	13.9	1.0	14.7	1.6
40% dlim	15.9	0.7	16.6	1.4
60% dlim	17.0	0.9	17.7	1.4
80% dlim	17.8	1.0	18.5	1.5
Free pace run				
20% dlim	14.2	1.1	14.3	1.4
40% dlim	15.9	0.9	16.3	1.1
60% dlim	16.9	1.0	17.6	1.1
80% dlim	17.6	1.1	18.4	1.2

Significant differences for RPE or ETL between all distances, $p \leq .002$

significantly higher for the free pace run compared to the constant pace run ($94.5 \pm 2.9\%$ vs. 90% , $p < .001$, respectively), whereas there was no significant difference when the comparison was made without the last lap ($89.6 \pm 1.9\%$ $\dot{V}O_{2max}$ for the free pace run, $p > .05$). The results of the two-way repeated factor ANOVA with two repeated factors (distance and pace) showed that only distance had a significant effect on RPE and ETL ($[F(3.27) = 151.6]$, and $[F(3.27) = 155.4]$, $p < .001$, respectively). The Tukey post hoc test showed significant differences for RPE or ETL between all distances ($p \leq .002$, **Table 2**). In free-pace runs, velocity variability was $3.3 \pm 0.9\%$ and $3.0 \pm 0.7\%$ for the entire race and without the last lap, respectively. An example in a typical subject for $\dot{V}O_2$ and velocity during constant and free pace runs is presented in **Fig. 1**. Low ve-

locity variations occurred during the race, which ended with a final sprint during the last lap.

Discussion

The main findings of this study were that RPE, ETL and averaged $\dot{V}O_2$ were not influenced by the variability of the velocity, whereas performances (exhaustion times and velocities) were different for the free versus constant pacing during an exhausting run over a distance to exhaustion at 90% $\dot{V}O_{2max}$. This result means that athletes perceived the free pace exercise as being as strenuous as the constant pace one. They also felt that they could endure the free pace exercise as long as the constant pace one, for a faster averaged velocity during the free pace run. Similarly, Liedl et al. [21], Palmer et al. [27], Billat et al. [5] and Kang et al. [18] reported no significant difference for RPE between constant and free pace runs. Only Edwards et al. [12] found the opposite results, but this study was only carried out with 3 subjects. A possible explanation is that during free pace runs, short bouts of low- and high-intensity work alternated rapidly during the race (velocity was calculated every 20 m, i.e., every 3–5 sec), whereas RPE values were collected only every 2 min up to the end of the race. Moreover, according to Noakes et al. [23], pacing strategy would occur at a subconscious level in an apparently oscillatory manner, whereas the ratings of perceived exertion would change more regularly with activity. In the same way, during endurance cycling, Liedl et al. [21] reported similar RPE values during constant effort at mean power equal to 78% $\dot{V}O_{2max}$ compared to variable power alternating only $\pm 5\%$ of mean power every 5 min during 1 h. It may be hypothesised that greater variations in exercise intensity would allow lower RPE to be observed during low-intensity phases. However, Palmer et al. [27] and Kang et al. [18] did not find any RPE differ-

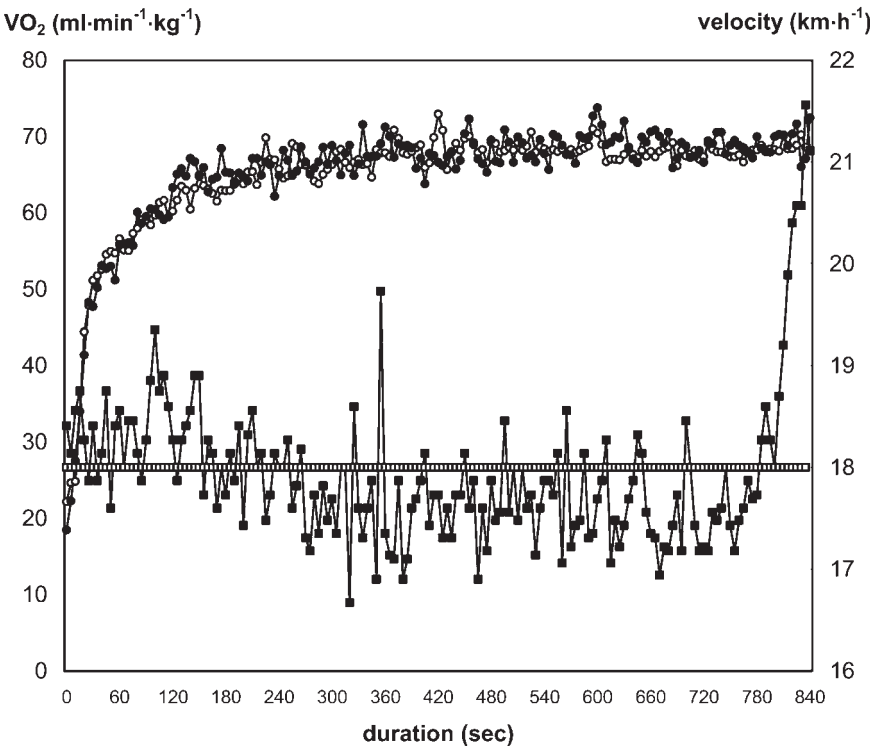


Fig. 1 Example in a typical subject for oxygen uptake ($\dot{V}O_2$) and velocity during constant and free pace runs. $\dot{V}O_2$ is indicated by empty circles and black dots, velocity by empty and black squares, for constant and free pace runs, respectively.

ences either, despite larger variations in exercise intensity (140 min of exercise at average exercise intensity equal to $58 \pm 11\%$ peak power output compared to five repeated 20-min periods of variable intensity from 35 to 77% peak power output interspersed with four 10-min periods of work at constant power output in the study by Palmer et al. [27], and 30 min exercise at average exercise intensity equal to $67 \pm 3\%$ maximal heart rate vs. a Spinning® workout at 60 to 80% maximal heart rate in the study by Kang et al. [18]). In the latter studies, exercise intensity varied every 2 min and every 4 to 8 min, respectively. Probably a protocol comprising both greater variations in exercise intensity and duration would bring about RPE and ETL differences.

In this case, a change in a particular perceptual state could occur, which we would become aware of, and only if the quanta of RPE was different from the previous RPE level, would we feel that a change of effort perception occurred [36]. Such a protocol has been proposed by Yaspelkis et al. [41] (30 min cycling at 45% $\dot{V}O_{2\max}$ followed by 6 repeated 16-min periods of alternate cycling at 75 and 45% – 8 min each). However, this protocol would be a simulation far from real conditions in competition.

The lack of influence of velocity variability on RPE and ETL was maybe linked with the experimental protocol. Indeed, the experimental design was inherently not counterbalanced in terms of order of trials (the constant pace run at 90% $\dot{V}O_{2\max}$ was always performed following the incremental test and before the free paced run in order to impose the distance to exhaustion set by the constant paced one). Therefore, the RPE values during the free paced run may have been influenced by learning factors from the previous trials. However, in order to limit this possible influence of familiarisation during the last test, the subjects had no knowledge of their RPE values collected during the constant pace run.

Finally, this lack of significant difference for RPE and ETL between constant and free pace runs could be due to the low power, which depends, in part, on the relatively small sample size in this study.

As in the study by Kang et al. [18], the lack of discrepancy in averaged $\dot{V}O_2$ values between constant and free pace runs may be attributable to the fact that each higher velocity did not last long enough, was not of sufficient magnitude, and was always followed by a period of milder intensity. Consequently, these low velocity variations (less than 4%) did not increase the oxygen cost during free pace runs. The higher intensity phase (a sprint) probably did not last long enough to allow an increase in $\dot{V}O_2$. The same result was obtained when analysing data without the last lap. Robertson [30] and Shephard et al. [37] have shown that RPE varies with the % $\dot{V}O_{2\max}$. Consequently, as for $\dot{V}O_2$, RPE values were not significantly different between constant and free pace runs. As suggested by Liedl et al. [21], small variations in power (3.3% in our study and $\pm 5\%$ in the Liedl et al. study) as regards to a relatively high mean power output are physiologically sustainable and would result in nonsignificant increases in $\dot{V}O_2$ or RPE mean values. Moreover, such small variations in exercise velocity would be effective in our study in enhancing time trial competitive performance.

Several authors have hypothesised that a learned subconscious anticipatory/regulation system exists, known as “teleoanticipation” originating from the central nervous system [39]. This subconscious feedback mechanism serves to decrease efferent output from the motor cortex. Prior to the beginning of a given exercise, it is hypothesised that the athlete's central nervous system is aware of the athlete's fitness level, endurance capacity and

limitations, gained from previous similar exercises. The total exercise load and time the athlete's body can tolerate the given metabolic level is known. Having this information and using psychophysiological feedback, the athletes are able to arrange their degree of exertion (i.e., exercise velocity) in order to avoid premature fatigue prior to the completion of the event [39].

This optimal adjustment of metabolic rate during heavy exercise using a feedback control system has recently been further developed by St Clair Gibson and Noakes [34]. These authors suggested that before and continuously during exercise, the brain performs subconscious calculations of the metabolic cost required to complete a given exercise task, and then computes how this will be influenced by the prevailing environmental conditions and the current physical state. This allows the selection of an optimum pacing strategy that will allow completion of the task in the most efficient way while maintaining internal homeostasis and a metabolic and physiological reserve capacity. This is true for maximal intensity endurance exercises but also for closed loop activity which is defined when either the distance or time required to complete the activity is known before the exercise begins [34].

For most subjects, velocity varied during the race and increased during the last lap (● Fig. 1). According to the St Clair Gibson and Noakes' theory, the initial pace chosen at the beginning of the free race was subconsciously calculated on the basis of prior experience. However, as the trial progressed, metabolic and other changes could have initiated subconscious integrative calculations establishing that the initial pace would require not enough or too strong sensations of fatigue to maintain homeostasis at this exercise intensity. As a result of these subconscious calculations, power output might be successively increased and decreased till the end of the race. Finally, as the last lap approached, these calculations would establish that the intensity could be increased for the end of the race. The athletes completed the free pace run by a final sprint during the last lap and decreased their running exhaustion times compared to the constant paced one. Only this final sprint was effective in increasing performance. Consequently, compared to the constant pacing run, the free pacing one performed over the same distance to exhaustion allowed athletes to be at a significantly higher % $\dot{V}O_{2\max}$.

As presented above, Saint Clair Gibson et al. [36] suggested that before and continuously during exercise, the brain performs subconscious calculations (in part from knowledge of the end-point and memory of pacing strategy from prior events) to allow the athlete to set an appropriate pacing strategy to achieve optimal performance. Albertus et al. [1] have completed this theory adding that RPE at the onset of the exercise bout would be determined by the expected duration or distance of exercise. Moreover, the RPE values would increase according to this expected duration or distance and/or by the duration or distance of exercise that remains [24]. Therefore, anticipating the maximal RPE that the individual will tolerate, the brain centre responsible for the generation of the RPE then increases that RPE according to the percentage of the total exercise duration or distance that has been completed (or the percentage of duration or distance that remains) [24].

Indeed, other authors like Rejeski and Ribisl [29], and Baden et al. [3] have also shown that RPE values may be influenced by the expected running duration or distance. Contrary to our hypothesis, as the result of the present study showed that RPE and ETL were not influenced by the velocity variability, the expected

running distance could be an important determinant of RPE. Therefore, as in the study by Albertus et al. [1], our results support a dissociation between RPE and work rate because changes in velocity were not followed by changes in RPE and ETL values. This last comment is, however, in conflict with Saint Clair Gibson et al. [36], who suggested that both the control of exercise intensity and the perceived exertion during an event would be controlled by the same regulatory processes in the brain. Future research is needed to explore how both changes in exercise intensity and perceived exertion are processed.

Conclusion

The results of the present study demonstrated that subjects' RPE and ETL values did not reflect the alterations in exercise velocities. Moreover, it would seem that these variations did not have an effect on perceptual responses during exercise as long as the average $\dot{V}O_2$ was kept the same. Probably a protocol comprising both greater variations in exercise intensity and exercise duration would bring about RPE and ETL differences.

Acknowledgements

This study was supported by grants from the Caisse Centrale des Activités Sociales d'Electricité et Gaz de France. The authors gratefully acknowledge Mr. John Hall for his expert advice in the revision of the manuscript.

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