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Head-to-head running race simulation alters pacing strategy, performance, and mood state

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HIGHLIGHTS

- Head-to-head running improves 3 km performance compared to individual running.
- The fast start is improved by the presence of competitors.
- The end-spurt is decreased by the presence of competitors.
- The decrement in vigor is higher in the presence of competitors during running.

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ABSTRACT

The objective of this study was to analyze the influence of the presence and absence of competitors on pacing, overall running performance, and mood state during a self-paced 3-km run. Nine recreational runners participated in this study. They performed the following tests: a) an incremental test to exhaustion to measure the respiratory compensation point (RCP), maximal oxygen uptake, and peak treadmill speed; b) a submaximal speed-constant test to measure running economy; and c) two 3-km running time trials performed collectively (COL, head-to-head competition) or individually (IND, performed alone) to establish pacing and running performance. The COL condition was formed of a group of four runners or five runners. Runners were grouped by matched performance times and to retain head-to-head characteristics. A mood state profile questionnaire was completed before and after the 3-km running timetrial. The overall performance was better in the COL than in the IND (11.75 ± 0.05 min vs. 12.25 ± 0.06 min, respectively; $p = 0.04$). The running speeds during the first 500 m were significantly greater in COL (16.8 ± 2.16 km·h^{-1}) thanin IND (15.3 ± 2.45 km·h^{-1}) ($p = 0.03$).The gain in running speed from IND to COL during the first 400 m (i.e. running speed in COL less running speed in IND) was significantly correlated with the RCP ($r = 0.88$; $p = 0.05$). The vigor score significantly decreased from pre- to post-running in COL ($p = 0.05$), but not in IND ($p = 0.20$). Additionally, the post running vigor was significantly higher in IND compared to COL ($p = 0.03$).These findings suggested that the presence of competitors induces a fast start, which results in an improved overall performance and reduced post-exercise vigor scores, compared to an individual run.

1. Introduction

Over the past 90 years, it has been demonstrated that running endurance performance is closely related to several physiological parameters, such as maximal oxygen uptake $\dot{V}O_2$ max[1], respiratory compensation point (RCP) [2], running economy (RE) [3,4], and peak treadmill speed (PTS) [5,6]. Recently, it has also been suggested that success in middle and long-distance running events might be influenced by the pacing strategy [7]. The pacing strategy refers to the manner in which the runners distribute their running speed and, consequently, their energetic expenditure during a given race [8]. Several authors have argued that to prevent the premature termination of exercise, athletes adjust their pacing by comparing the actual perception of effort with a desired perception of effort based on previous experience [9,7,10]. Because various afferent feedback signals from the periphery and environment appear to be collated and processed in the brain to generate a verbal representation of the

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perceived effort, it is conceivable that the exercise intensity might be adjusted by the synchronous interpretation of both internal (i.e., muscle metabolite accumulation) and external (i.e., environment of the competition) cues [11,12].

Despite the known importance of external cues [11,12], some studies have performed individual running races, ignoring the fact that during official competitive running races, the athletes compete in a head-to-head manner. The presence of other competitors would provide a greater number of external cues (e.g., runner position during the race), which might alter the pacing relative to that typical of the individual condition. Only a few studies have demonstrated that during head-to-head competition, the athletes adopt a more aggressive pacing, resulting in an improved overall performance [11,12]. Corbett et al. [12] observed an enhanced 2000-m cycling time trial performance in the presence of a sham competitor, which was determined based on the individual cycling performance. Bath et al. [11] found that the perception of effort was lesser when a second competitor was introduced during a 5-km running race simulation, compared to when the first competitor was running alone. These findings suggest that during a competition the decision to choose a given pacing could be a resultant of the balance among different aspects of fatigue as physiological and psychological demands. It seems to be reasonable to suppose that the external psychological cues resulting from the presence of the competitors may partially overlap some physiological signals related to fatigue, improving the performance of the athlete. However, an ignored point until the moment is that the magnitude by which a given psychological stimulus, such as the presence of the competitors, can overlap some physiological signals related to fatigue might be dependent of runner's fitness. Runners with better physiological parameters related to endurance performance (e.g. $\dot{V}O_2$ max, RCP, RE, and/or PTS) might be more enabled to support the higher imposed running speeds during head-to-head race than lesser trained athletes.

It has been suggested that the precompetitive vigor and fatigue feelings are two of the principal psychological aspects of athletic performance [13,14]. In 1971, MacNair et al. [15] created the Profile of Mood State Questionnaire (POMS) to support the evaluation of patients with psychological disturbances. Since the ability to produce and control emotional feelings is known to be an important characteristic for athletic performance [13], the POMS has been adapted to be used in sports. Previous studies have showed that the athletic performance is strictly related with higher levels of vigor and lower levels of tension, depression, confusion, and fatigue, a state known as 'iceberg profile' [13,14]. Based on the POMS, previous studies have suggested that athletes who are more vigorous and less anxious, angry, depressed, confused, and fatigued will be more successful than athletes who exhibit the opposite profile [13,16]. A positive correlation between exercise overload during a training session and mood disturbance has been also reported [17]. In particular, the greatest decrement in vigor and increment in fatigue have been found in athletes who were subjected to intense and prolonged exercise [18,17]. This is in accordance with previous definition suggesting vigor as synonymous with vitality or a manifested power state [19], while fatigue has been commonly typified by feelings of mental and physical tiredness [20]. Considering that the presence of competitors leads to superior external cues and a greater intensity of exercise [12], it is plausible to expect that a head-to-head race condition might promote a greater disturbance in mood state, in particular in vigor and fatigue, than the exercise when individually performed. However, to the best of our knowledge, it is still unknown whether the mood state before and following a race can be altered in the presence of other competitors.

Therefore, the main aim of the present study was to analyze the influence of competitors on pacing, overall performance, and mood state profile during a middle-distance running time trial. Based on previous findings suggesting that internal cues from cardiorespiratory and neuromuscular systems have low influence during the initial phase of a middle distance running race [21], it was hypothesized that during head-to-head competition the runners would adopt a more intense running speed at the beginning of a 3-km running. This increased running speed at the start might carry to an improved overall performance, but at the expense of a greater exercise-induced decrement in vigor and increment in fatigue, compared with individual running.

2. Material and methods

2.1. Participants

Nine male recreationally trained long-distance runners who participated in local competitions were invited to participate in this study (Table 1). The runners performed only low-intensity continuous aerobic training (~4 times per week at 60–70% $\dot{V}O_2$ max). All were nonsmokers. They were free of neuromuscular and cardiovascular dysfunction and were not taking any medications at the time of data collection. The participants received a verbal explanation of the possible benefits, risks, and discomfort associated with the study and signed a written informed consent before participation in the study. The study was conducted in accordance with Ethical Standards laid down by Declaration of Helsinki in 1975, and was approved by the local Ethics Committee for Human Studies. Because we were examining the effect of competitors, the participants had no information about the aim of the study until all experimental procedures had been concluded. Initially, they were only asked to perform the two 3-km races as fast as possible.

2.2. Experimental design

The participants visited the laboratory on five separate occasions. They performed the following experimental sessions: 1) anthropometric measurements, taking in accordance with Lohman [22], and body fat estimated from the Brozek et al. equation [23], and maximal incremental test; 2) speed-constant test; 3) familiarization with the 3-km running race and POMS questionnaire; 4) individual 3-km running race simulation (IND); and 5) collective 3-km running race simulation (COL). Sessions four and five were performed in a counterbalanced manner, with five participants firstly performing the IN condition, while the other four participants firstly performed the COL condition. The POMS questionnaire was filled out before and after sessions four and five. These tests were performed during the same period of the day to avoid any interference caused by circadian rhythms. All participants were asked to refrain from any exhaustive or unaccustomed exercise in the 48 h preceding the test and were instructed not to consume caffeinated beverages 2 h before the experimental sessions, as well as from taking nutritional supplements throughout the experimental period.

2.3. Maximal incremental test

Participants performed a maximal incremental test on a motor-driven treadmill (model TK35, CEFISE, Nova Odessa, Brazil) to determine $\dot{V}O_2$ max, PTS, and RCP. After a 3-min warm-up at 8 km·h^{-1}, the speed was increased by 1 km·h^{-1} every minute until exhaustion. The slope was kept at 0% throughout the test. The subjects received

Table 1
Characteristics of the participants ($n = 9$).

Characteristics of participants	Mean ± SD
Age (years)	32.4 ± 9.6
Body mass (kg)	64.5 ± 3.6
Height (cm)	174.5 ± 7.7
Body fat (%)	12.5 ± 6.0
Running training (years)	9.0 ± 5.8
Weekly training volume (km)	42.3 ± 19.1
Weekly training (days)	4.0 ± 1.0

Data are means ± standard deviations.