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The relationship between pacing and cognitive strategies during 800m for collegiate students

Yuya Maruo[1] *

[1]*Faculty of Physical Education, Tokyo Women's College of Physical Education,*

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ABSTRACT: We investigated whether pacing strategies differ between participants with good records and poor records. Athletes in middle- and long-distance running must expend all their energy until they cross the finish line to achieve their best performance. For better pacing strategy, it is believed that the central governor, which has been conceptualized by a recent study, is an essential cognitive function. Limited studies have examined the function of central governors based on behavioral and psychological data. Fifty-three female participants were recruited. We employed an 800m maximal time trial as the running performance. We used the strategy scale for recalling the pace. For the upper group, there was no significant slowdown up to 400m, suggesting that pacing strategy for the upper group gradually decreased after 400m. In the lower group, there was a significant decrease in pace after 100m, suggesting that pacing strategy was all-out for the lower group. There was a negative relationship between cognitive and pacing strategies, with participants who ran with someone else displaying better running performance. Additionally, participants who were more concerned about their time displayed a better running performance. These results might suggest that central governor function for pacing was different in running performance.

KEY WORDS Pacing strategy; cognitive strategy; long-distance running; central governor model

INTRODUCTION

Athletes in middle- and long-distance running must expend all their energy until they cross the finish line to achieve their best performance. Numerous previous studies have reported several pacing techniques (1-5), the analysis of race patterns (e.g., (6)), physiological changes during the race (e.g., (5)), and psychological characteristics for pacing strategies (7-10). For better pacing strategy, the central governor that has been conceptualized by recent research (e.g., (11)) may be an essential cognitive function (for review, see (5)). Central governor makes some predictions for finish line and oversees peripheral function during exercise. It is believed that central governor ensures that runners are not completely exhausted, so that they can pick up the pace in the last part of the race. However, few studies have examined the function of central governors based on behavioral and psychological data.

Pacing strategies can be classified into six categories: positive, negative, even, all-out, parabolic-shaped, and variable (2, 5, 12-14). A positive pace strategy is one in which speed is gradually reduced throughout the race. This decrease in speed was thought to be caused by a lack of energy during the race. A negative pace strategy involves gradually increasing speed during the race. In a negative-pace strategy, athletes increase their speed during the last spurt while keeping in mind the remaining distance of the race. In longer-distance races, an even pace strategy is believed to be the optimal strategy (2). The all-out pacing strategy involves starting the exercise with maximum effort and maintaining it for as long as possible. This strategy is not paced. The parabolic-shaped strategy is to run at a fast pace at the start and then gradually slow down. After that, the athlete increases the speed for the last spurt. The variable pacing strategy is useful for adapting to external factors such as temperature, wind, and running with other athletes. Previous studies have demonstrated that the positive pace strategy for 800m and 1500m is the best strategy to achieve a record (15, 16).

A recent study for central governor model reported that inexperienced participants can improve their pacing strategy over repeated 800m time trials (16). Lambrick et al. (16) have found that participants regulated better pacing behavior during 800m time trials. Specifically, it is difficult for inexperienced participants to adopt optimal pacing strategy and expend all their energy until they cross the finish line. According to these findings, it is estimated that some predictions for finish line in central governor should be different in running performance.

Previous studies on athletes have reported the psychological characteristics of pacing strategies (7-10). For example, Morgan and Pollock (7) found that elite marathon runners focused on respiration and fatigue, whereas non-elite marathon runners did not. Smith, Marcora (9) reported that mental fatigue was related to running performance. They suggested that when participants were mentally fatigued, the running speed was lower in low-intensity running than in high-intensity running. These findings suggest that internal attention to body information may improve endurance performance. Moreover, attentional focus on external information is also effective in improving performance. According to the constrained-action hypothesis, external attention facilitates automatic movement control (17). The effect of external attention on performance has been reported in a variety of exercises, such as sprinting tasks (18) and swimming (19). For example, Ille et al. (18) found that internal attention to body information improves running performance in sprinting tasks.

It is debatable which cognitive strategies (internal or external attention) are better for pacing strategies in middle-and long-distance running. Takai (20) tested the cognitive strategy for long-distance runners' pacing strategy and found that it was associated with seven psychological factors (i.e., following other runners, focusing on perceived exertion of the body, focusing on running pitch, focusing on perceived exertion of legs, imaging previous running, focusing on body movement, and referring to time). They found that well-trained long-distance runners focused on the internal information related to body awareness, respiration, and fatigue. However, few studies have examined the relationship between pacing and cognitive strategies.

The goal of this study is to investigate whether pacing strategies differ between participants with good records and poor records. We employed an 800m run as the running performance. If participants with good records can predict their pacing for the finish line, they should use positive pace strategy, which speed is gradually reduced throughout the race. We also investigate the relationship between pacing and cognitive strategies (internal or external attention) during 800m. If novice runners ignore fatigue and focus on the strategy of following other runners (7, 10), the 800m running time would be better for individuals with higher scores in using the strategy of following other runners.

METHODS

Participants

Fifty-three female participants (mean age ± SEM = 19.8 ± 0.1 years) were recruited from Tokyo Women's College of Physical Education. Written informed consent was obtained from all the participants. This study was approved by the Ethics Committee of the Tokyo Women's College of Physical Education. This study was carried out in accordance with the Helsinki Declaration.

Procedure

Running performance consisted of 800m maximal time trial (16) on a 300m outdoor track. Participants were asked to run 800m as fast as possible to the finish line. Colored cones were positioned at each 100m point of the 800m distance around the track. The 800m running test was recorded by video (JVC Kenwood, GZ-RX500-N). The total time for the 800m and the split time for each 100m were recorded using a video. Participants were grouped according to the following target times: 2'50, 3'00, 3'10, 3'20. Each group had five to six people. No feedback was provided to the participants until the finish line. Kinovea (version 0.9.3) was used to retrieve video data. The split times for every 100m were calculated using Kinovea.

Questionnaire

Participants filled out the strategy scale for recalling the pace developed by Takai (20) after 800m maximal time trial. The 34-item scale measures seven psychological domains, which comprise the following sub-scales: attending to the exertion of the whole body (e.g., How often do you attend to your respiration rate?), attending to the running tempo (e.g., How often do you attend to the rhythm of your footfalls?), at-tending to the exertion of the legs (e.g., How often do you attend to the sensation of your legs?), imaging past running (e.g., How often do you imagine running that you performed well?), attending to self-motion (e.g., How often do you attend to the motion of the whole body?), a strategy of following other runners (e.g., How often do you chase the other to run the whole distance?), and the strategy of checking time (e.g., How often do you refer to a watch to check your pace?). Participants were asked to indicate on a 7-point rating scale how often the strategies reflected in the items were used for pacing in the race (1 = never; 7 = very often).

Data Analysis

To compare the pacing strategy, we formed two groups based on a median split of the 800m time. 800m total time was subjected to a two-way repeated-measures analysis of variance (ANOVA), including the factors "group" (upper group/lower group) and "interval time" (100/200/300/400/500/600/700/800). The degrees of freedom of all F-ratios were adjusted using the Greenhouse-Geisser procedure. The Bonferroni correction was applied for post hoc comparisons. We determined whether the 800m running test correlated with the strategies for recalling pace scores using two-sided Pearson's correlations.

STATISTICAL RESULTS

Performance measures

The means of 800m total time for each group were 182.1 sec (SEM = 1.65) for upper group, and 220.1 sec (SEM = 4.13) for lower group, respectively. Figure 1 depicts each interval time for each group. The means of interval time for upper group in 0-100, 100-200, 200-300, 300-400, 400-500, 500-600, 600-700, and 700-800 were 20.6 sec (SEM = 0.27), 20.7 sec (SEM = 0.34), 21.8 sec (SEM = 0.28), 22.5 sec (SEM = 0.25), 23.8 sec (SEM = 0.30), 24.4 sec (SEM = 0.33), 23.9 sec (SEM = 0.39), and 23.9 sec (SEM = 0.57), respectively. The means of interval time for lower group in 0-100, 100-200, 200-300, 300-400, 400-500, 500-600, 600-700, and 700-800 were 23.3 sec (SEM = 0.41), 24.0 sec (SEM = 0.48), 25.4 sec (SEM = 0.47), 27.0 sec (SEM = 0.64), 28.9 sec (SEM = 0.74), 30.6 sec (SEM = 0.90), 30.3 sec (SEM = 0.78), and 30.6 sec (SEM = 0.76), respectively.

A two-way ANOVA revealed that the interaction between interval and group was significant ($F(2, 44) = 7.80$, $p < .01$). Post-hoc test revealed that interval time for upper group was faster in 0-100 than 400-500, 500-600, 600-700, and 700-800 (ps < .01). Interval time for upper group was faster in 100-200 than 400-500, 500-600, 600-700, and 700-800 (ps < .01). Interval time for upper group was faster in 200-300 than 400-500 ($p < .01$), 500-600 ($p < .01$), 600-700 ($p < .05$), and 700-800 ($p < .05$). For upper group, there were no differences between the other interval. Post-hoc test also revealed that interval time for lower group was faster in 0-100 than 200-300 ($p < .01$), 300-400, 400-500, 500-600, 600-700, and 700-800 (ps < .01). Interval time for lower group was faster in 100-200 than 300-400, 400-500, 500-600, 600-700, and 700-800 (ps < .01). Interval time for lower group was faster in 200-300 than 400-500, 500-600, 600-700, and 700-800 (ps < .01). Interval time for lower group was faster in 300-400 ($p < .05$) than 400-500, 500-600, 600-700, and 700-800 (ps < .01). Interval time for lower group was faster in 400-500 ($p < .05$) than 400-500, 500-600, 600-700, and 700-800 (ps < .01).

Correlation between 800m and scores of pacing strategy

Figure 2 shows Scatter plots showing correlations between scores for strategy and 800m total time. We calculated correlations between scores of pacing strategy and interval time. We found that the faster 800m total time was associated with higher scores for strategy of following other runners ($r = -.36$, $p < .05$) and strategy of checking time ($r = -.35$, $p < .05$). There were no significant correlations between other scores for pacing strategy and 800m time.

We found that for upper group the faster 100-200m time was associated with higher scores for attending to exertion of the whole body ($r = -.60$, $p < .01$) and strategy of checking time ($r = -.44$, $p < .05$). We found that for lower group the faster 100-200m time was associated with higher scores for attending to exertion of the whole body ($r = -.47$, $p < .05$) and strategy of checking time ($r = -.51$, $p < .01$). We found that for lower group the faster 200-300m time was associated with higher scores for strategy of checking time ($r = -.39$, $p < .05$). There were no significant correlations between other scores for pacing strategy and 800m time.

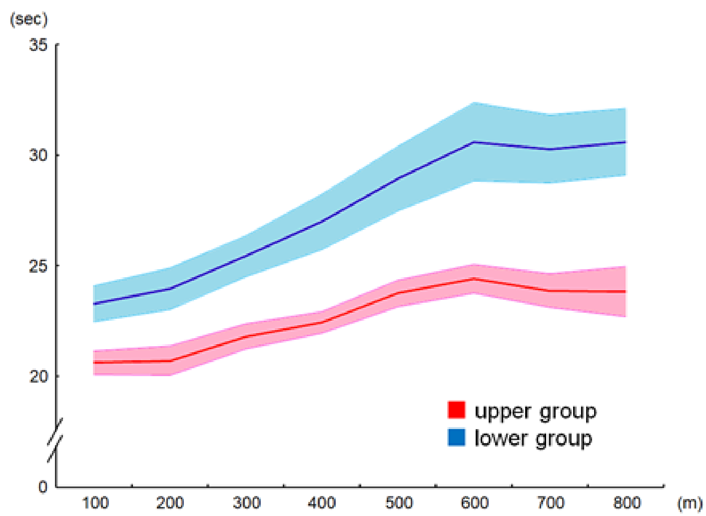

Figure 1. Average lap time (sec) (SE) for each group with 95 % confidence intervals.

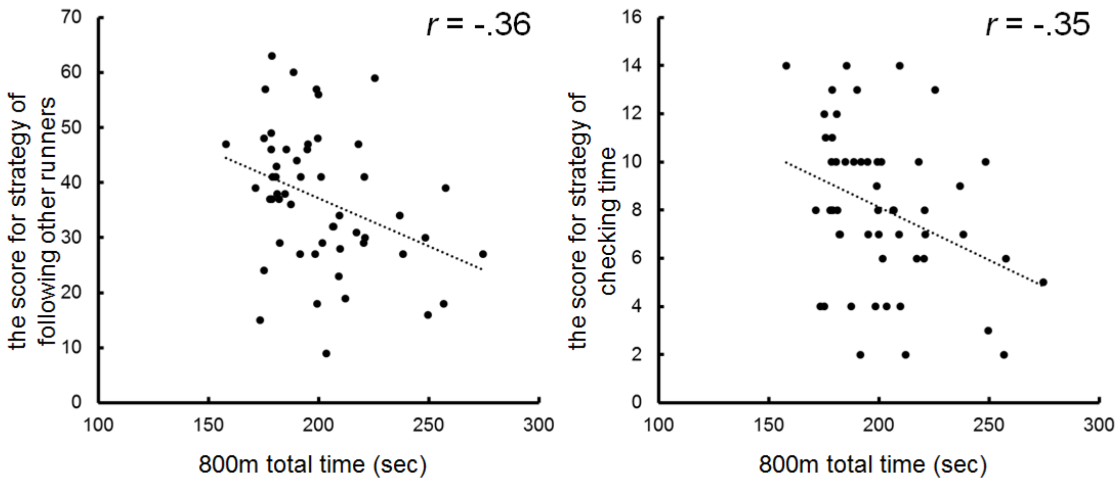

Figure 2. Left panel: Scatter plots showing correlations between scores for strategy of following other runners and 800m total time. Right panel: Scatter plots showing correlations between scores for strategy for checking time and 800m total time.

DISCUSSION

We aimed to investigate whether pacing strategies differ between participants with good records and poor records. Participants were asked to perform 800m maximal time trial and compare the pacing strategy. For the upper group, there was no significant slowdown up to 400m. However, there was a gradual decrease in pace after 400m. In the lower group, there was a significant decrease in pace after 100m. There was a negative relationship between cognitive and pacing strategies, with participants who ran with someone else displaying better running performance. Additionally, participants who were more concerned about their time displayed a better running performance.

Interval time per 100m was interacted with by the group (i.e., upper group vs. lower group). The upper group displayed less deceleration till the first 400m. The upper group may have had a positive pacing strategy or even a pacing strategy because there were few significant slowdowns. This is consistent with previous reports revealing that participants with better goal times used more positive strategies (15). On the one hand, for the lower group, we found that there was a significant slowdown after 100m. It seems that the participants in the lower group adopted an all-put pacing strategy. It is possible that differences in the running ability of the participants may cause them to differ in their pacing strategy. These findings suggested that central governor function for pacing was found to be different in both groups.

Inexperienced runners might use a gradually slowing down strategy (positive or all-put). For example, Morgan and Pollock (7) found that less-trained marathon runners slowed down in the second half of the race and used a cognitive strategy that distracted them from their own fatigue and suffering. Lambrick et al. (16) similarly found that inexperienced children used a positive pacing strategy during 800m, and Rating of Perceived Exertion (RPE) was higher in the second half than in the first half. Collectively, these findings suggest that inexperienced runners slow down when dealing with fatigue and pain.

We found a negative correlation between the score for the strategy of following other runners and the 800m total time. The strategy of running behind others may lead to a good record. According to previous studies that have examined the aerodynamic effect (21, 22), running behind other runners causes a reduction in aerodynamic drag and improves performance. To the best of our knowledge, this is the first study to describe the relation-ship between running performance and cognitive strategy following other runners. Previous studies have reported that during race and practice, well-trained long-distance runners focus on internal information related to body awareness, respiration, and fatigue (7, 10). It is likely that inexperienced runners paid more attention to external information (e.g., others' running pace) than to internal physical information such as respiration and fatigue.

In addition, we found a negative correlation between the scores for the strategy of checking time. This result suggests that participants who paid attention to running time had a better running performance. According to the constrained-action hypothesis, external attention facilitates automatic movement control (17). It is possible that attentional focus on external information, such as checking the time, is effective in improving performance.

We did not find significant correlations between the other scores for pacing strategy and 800m time. This finding is consistent with a previous study indicating that non-elite marathon runners did not focus on respiration or fatigue (7). It is possible that inexperienced runners may not pay attention to internal body information. Further studies are needed on pacing strategies in inexperienced runners.

In conclusion, the upper group may have had a positive pacing strategy or even a pacing strategy because there were few significant slowdowns. For the lower group, we found that there was a significant slowdown after 100m. The participants in the lower group adopted an all-put pacing strategy. Central governor function for pacing was found to be different in both groups. We found a negative correlation between the score for the strategy of following other runners and the 800m total time. It is likely that inexperienced runners paid more attention to external information (e.g., others' running pace) than to internal physical information such as respiration and fatigue. This study has certain limitations. Physiological changes (e.g., heart rate) during the 800m race were not recorded, which is a major weakness of this study. Recording both physiological and psychological data would provide further evidence for the central governor model. Furthermore, we did not compare inexperienced and experienced participants. It is necessary to obtain more data on superior endurance runners. The present findings provide further evidence for the psychological characteristics of inexperienced collegiate students.

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