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Research article

The Influence of a Pacesetter on Psychological Responses and Pacing Behavior during a 1600 m Run

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Abstract
This study compared the effects of following a pacer versus following a self-paced plan on psychological responses and pacing behavior in well-trained distance runners. Pacing in the present study was individually tailored where each participant developed a personal strategy to ensure their goal time was achieved. We expected that following a pacer would associate with goal achievement, higher pre-run confidence, positive emotions and lower perceived exertion during performance. In a mixed-design repeated-measures study, nineteen well-trained runners completed two 1600m running time trials. Ten runners had a pacer (paced group) who supported their individual pacing strategy, and nine participants self-paced running alone (control group). Both groups could check pace using their wrist watch. In contrast to our expectation, results indicated that the paced group reported higher pre-run anxiety with no significant differences in finish time, goal confidence, goal difficulty, perceived exertion, and self-rated performance between groups. We suggest that following a pacer is a skill that requires learning. Following a personalised pacer might associate with higher anxiety due to uncertainty in being able to keep up with the pacer and public visibility of dropping behind, something that is not so observable in a self-paced run completed alone. Future research should investigate mechanisms associated with effective pacing.

Key words: Emotion, pacing, perceived exertion, running, self-regulation

Introduction

In many endurance sports where the goal is to win the race or to attain a personal best, performance is significantly impacted by pacing strategy. An inability to maintain a desired pace is considered poor pace management and as such research has focused on what is the best pacing strategy to follow (Thiel et al., 2012). Brick et al. (2014) outlined that pace management is a key aspect of endurance performance. Feedback on how to monitor effective pacing is highly important. An athlete might choose to regulate their pace using their watch for feedback and/or perceived exertion where they regulate effort based on sensations of fatigue. One strategy is to use a pacesetter or pacer who has outwardly agreed to run at a certain pace; for example, to pace an 800m to be run in 3 minutes by running two consecutive 90-second 400m laps. In this example, an athlete could achieve the goal of running 800m in 3 minutes if he/she followed closely behind the pacer. In these circumstances, following a pacer might be beneficial as the athlete knows that the key cues are to stay with the pacer rather than monitor a watch and calculate progress during the run.

Knowledge that your run is supported by a pacer should have positive psychological benefits in terms of preparation. Of the array of psychological factors that could be influenced by pacing, candidates worth investigation include changes in self-efficacy and emotion. Self-efficacy is defined as the self-belief in abilities to achieve goals and associated with the selection, intensity and persistence of effort (Bandura, 1997). Research shows high self-efficacy associates with self-control, that is following an intended plan and performance (Graham et al., 2017). Emotion involves physiological responses (i.e., increased arousal and muscle tension) and has specific action tendencies, which may mediate subsequent behaviors (Beedie and Lane, 2012; Hanin, 2010; Lane et al., 2011; Lazarus, 2000). In short, emotions can be predictive of performance directly or influence decision-making that underpins performance. In the context of achieving a running goal, if an individual believes that the goal is too difficult and therefore unlikely to be attained, then unpleasant emotions such as sadness, anger, and anxiety are likely to emerge. Conversely, if the individual is confident that the goal will be achieved then happiness is likely to be experienced. If attaining the goal involves reducing a large discrepancy between current performance and the standard required to reach the goal, then emotions such as anger, anxiety and excitement might prompt a physiological response to facilitate the action in question (Lazarus, 2000).

Following a pacer provides ongoing information on the relative proximity to delivering the goal. If you are close to the pacer, then it should follow that your goal will be achieved. In an experimental laboratory based study, Wilson et al. (2012) showed that athletes struggle to monitor pace using internal sensations only, and moreover, feedback in relation to achieving a goal influenced the intensity of emotion felt and the strategy for goal achievement. The authors manipulated performance feedback and examined changes in pacing behavior during 10-mile laboratory cycling. They provided false feedback, informing athletes that they were ahead or behind their intended goal. They found negative feedback associated with increased anxiety. In addition, there was a marked physiological effect with increased ventilation, lactate production and heart rate. The behavioral strategy was to increase exercise intensity to get back to goal pace. In contrast, when riders were informed they were on target

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to achieve their goal, they reported higher pleasant emotions, maintained a smooth pacing strategy, and increased their power output towards the end of the trial. Wilson et al. (2012) argued that having positive beliefs that attaining your goal associated with an even pacing strategy seemed to lead to the preservation of physiological resources for faster performance over the final stages where motivation is sufficient to sustain high perceived exertion. An important aspect of Wilson et al's findings was that there was no significant difference in performance between positive and negative feedback conditions. Thus, it raised the question as to whether the provision of ongoing positive feedback, made possible by following a pacer, could help individuals attain personal goals.

Although it is commonly suggested that following a pacer is beneficial to performance, few studies have examined the influence of a designated pacer on psychological responses during running. While Bath et al. (2012) examined performance, pacing strategy and Rating of Perceived Exertion during a 5km time trial with a pacer, the authors did not disclose the pacer's role to the participants. Despite no significant difference in performance times, all 11 participants believed that they had run faster - and nine said it felt easier - with the pacer. Although the researchers did not investigate performance intentions, they suggested that practically it may be important to performance to know that someone is running to try to help you achieve a faster time, and importantly, success can be attained by enacting a relatively simple instruction of following closely behind the pacer.

Brick et al. (2014) argued that a key characteristic of endurance athletes is that they regularly monitor performance in relation to performance goals. However, despite knowledge of pacing strategies, athletes typically make poor pacing decisions. In a study that recruited participants to investigate the effectiveness of intervention strategies to help regulate emotions, Lane et al. (2016) found that intense anxiety associated with running a fast first lap and then speeding up for the final lap in a 1600m running trial. Lane et al. (2016) also found that calmness and low anxiety associated with a more even pacing strategy, but as with Wilson et al. (2012), there was no overall difference in performance. Lane et al. (2016) suggested that the use of a pacer(s) could be an effective strategy to counteract any anxiety experienced from making pace judgments, by providing ongoing external feedback.

A methodological challenge for researchers in this area is to find an appropriate control condition. It is not easy to compare a paced group with a group that has no goals for an event. Evidence shows endurance athletes organically set goals, and that these goals are associated with performance (Brick et al., 2014). Agreeing to perform at maximal intensity for the given distance represents a goal in itself – a process goal with intentions to work maximally. The act of completing a trial, by default, provides evidence that the participant acted on goal intentions. Accordingly, the present study compared using a pacer against self-paced performance using a test-retest design. This research design would allow identification of the effect of using a pacer in comparison to self-paced performance in terms of one's own performance. By having a control group who performed the self-paced run twice, it enabled us to examine the possible effects of learning to pace the run, and also examine whether following a pacer would lead to greater improvements in performance than repeating a self-paced run. Greater attention was placed on differences in perception between the two conditions than differences in performance times between groups. The purpose of this study was to investigate the effects of a designated pacesetter on perception, emotion, goal self-efficacy, and pacing behavior during a 1600m run. We expected that following a pacer could be associated with significantly faster performance, but this would depend on the paced group setting a goal that was significantly faster than the baseline goal. The research design did not attempt to manipulate goal difficulty, nor did it encourage participants to set a more difficult goal as it sought to ensure ecological validity. Examination of factors associated with following a pacer would cast light on the mechanisms that might explain effectiveness. If participants pursued a goal of a similar time, we expected that following a pacer would associate with a positive psychological state characterised by high goal-confidence and positive emotions. Specifically, following a pacer should be associated with lower pre-run anxiety, which in turn should help pacing, evidenced by lower scores of ratings of perceived exertion. Our overarching expected finding was that following a pacer should be associated with achieving the same outcome (or better) for less effort.

Methods

Participants

Nineteen well-trained endurance runners (Male: n = 16, Female: n = 3; age, 29.4 years, SD = 8.8) were recruited from local running clubs to participate in the study. "Well-trained" was defined as taking part in regular, structured training (>5 days per week) for competition, for a minimum of two years. All participants had experience of running on an outdoor 400m track. The study protocol was approved by the first author's institution's local ethics committee. Before data collection, all participants provided written informed consent.

Measures

Pacing strategy: Participants were asked what their pacing strategy was and given the options to run even laps, or to run the second half of the run faster.

Self-set goal time, goal confidence and goal difficulty: Before each trial, participants were asked to indicate the time (mins; seconds) they were targeting as a performance goal for the trial. The time set as a goal was important as it was used to develop an objective self-referenced performance measure.

They were then asked to rate their confidence towards achieving the goal (0 = cannot do at all to 10 = highly certain can do) (Bandura, 2006) and its difficulty (1= not at all and 10 = extremely). It is important to assess goal difficulty alongside goal self-efficacy as confidence to achieve a goal could be high, and the relative difficulty of the goal easy. By implication, achieving a personal best

performance is a difficult goal or the previous performance was relatively slow. When comparing the effects of following a pacer versus following a self-paced goal, it is important to control for the relative difficulty of goals.

Emotions: Participants completed the same 7-item measure of emotions previously used by Lane et al. (2016) before, and after, each 1600m. Emotion was measured using the items "Happy", "Anxious", "Dejected", "Energetic", "Fatigued", "Angry", and "Excited", using a 7-point Likert scale with anchors of not at all (1) to extremely (7). As emotions were assessed multiple times during the study a brief measure of emotion was intentionally used.

Performance: Performance was measured objectively in terms of finish time and 400m lap times. The distance of 1600m was chosen as it meant there were 4 laps of a standard track of the same distance. A self-referenced measure of performance was calculated by subtracting goal-time from finish time. A negative value indicated that participants ran faster than their goal time.

Self-rated performance assessment: Post trials, participants were asked to rate how well they performed on a scale from 1 (not very well) to 10 (extremely well). A self-rated subjective performance was used to provide greater sensitivity towards performance assessment. This is especially relevant as runners were doing the 1600m twice, and so fatigue from the first completion could be influential.

Rating of perceived exertion: Post trials, participants were asked to rate perceived exertion (RPE) during each lap from 1 (no effort at all) to 10 (maximal effort) (CR-10; Borg, 1982). The rationale for doing this was to provide a measure of the pacing process through which the goal was achieved.

Procedure

Participants were informed that the purpose of the study was to examine pacing strategies during 1600m running, but they were not made aware of the research aims and hypotheses. They were also informed they would be performing two consecutive 1600m time trials (TTs), separated by a ten-minute rest period, and that they should attempt to perform each trial as maximal efforts. Participants were instructed to arrive for testing in a rested and fully hydrated state, having refrained from eating for at least 3 hours, and having avoided strenuous exercise in the preceding 24 hours.

Before testing, participants completed a 5-minute self-paced warm-up followed by a 5-minute self-selected stretching routine (Smith and Jones, 2001). Participants performed two consecutive 1600m TTs on an outdoor 400m track, with runs hand-timed to the nearest second. All participants first completed a 1600m TT following a self-selected pacing strategy. Participants were then randomised to either a pacer or control group. The control group was asked to perform a second self-paced trial whereas the paced group was asked to run a second 1600m TT with another runner (pacer). Both pacesetter and participants were allowed to wear their own watches to help pace themselves. In addition, participants were provided with time feedback every 400m. During the trials, split times were recorded every lap at 400, 800, 1200 and 1600m. The mean lap time was then calculated.

Pacesetter: In the paced group, an experienced runner acted as a pacer to help each participant achieve his/ her performance goal. Participants were instructed to request the pace they would like the pacer to run at (e.g., run at their mean pace from the first trial for each lap). To replicate normal competition, the pacer and participants were allowed to wear a watch, and were given time splits every 400m lap.

Data analysis

Data analysis in the present study sought to test hypotheses that running with a pacer would influence psychological responses which would lead to improved performance. Prior to analyses, assumptions such as normality and sphericity were checked as appropriate. When the sphericity assumption was violated, the Greenhouse-Geisser correction was employed. With a small sample size, the focus was on the size of the effect rather than rely on its significance.

A series of two-way (condition x pre/post) mixed repeated measures ANOVA were used to examine differences in the time set as a goal, performance, self-referenced performance (finish time - goal), perceived goal confidence, and perceived goal difficulty. A significant interaction effect should show the paced group set a faster goal than the self-paced group, with a main effect for time showing both groups set a faster time as a goal for the second trial. Pearson's correlation coefficient (r) was used to indicate the strength of the relationship between goal time and actual performance time.

A repeated measures MANOVA (condition x pre/post) was used to compare pre-run emotions. The focus was on the extent to which following a pacer associated with experiencing higher scores of pleasant emotions and lower scores on unpleasant ones.

A series of two-way (Condition x Lap) mixed repeated measures ANOVA were used to assess the lap times and RPE across each 400m distance, with post-hoc tests conducted on significant interaction effects to establish significant changes between successive measurement points.

Statistical analysis was conducted using SPSS statistics software Version 22.0 (SPSS Inc. Chicago, IL). Significance was accepted at $P < 0.05$. Data are presented as means (SD).

Results

Overall performance times for both trials were given in Table 1. A repeated measures ANOVA to investigate differences in goal time between paced and control groups indicated no significant interaction effect ($F(1,17) = 0.013$, $p = 0.91$, $\eta_p^2 = 0.001$) and no pre-post effect ($F(1,17) = 1.60$, $p = 0.22$, $\eta_p^2 = 0.09$). Therefore, following a pacer did not appear to lead to increasing the relative difficulty of the goal. Further, a repeated measures MANOVA of goal confidence and goal difficulty by paced/control group over time indicated no significant difference over time (Wilks' lambda $_{2,16} = 0.83$, $p = 0.22$, $\eta_p^2 = 0.17$) and no

Table 1. Overall performance times for both trials.

Trial	Trial Times (s)									
	Control (n = 9)					Paced (n = 10)				
	Goal	Act	Diff	r	p	Goal	Act	Diff	r	p
1	287 (18)	293 (20)	7 (10)	.86	.003	326 (19)	324 (29)	2 (17)	.96	.001
2	290 (22)	293 (20)	4 (6)	.85	.001	329 (36)	328 (30)	-1 (11)	.96	.001

Goal = Goal Time; Act = Actual Time

Table 2. Differences between trials by group for overall performance times, goal confidence and difficulty, self-rated performance, and emotion.

			95% CI for diff	
	t(17)	P value	Lower	Upper
Overall Performance Time	-0.86	.40	-15.33	6.44
Goal Confidence	0.12	.91	-2.28	2.55
Goal Difficulty	-1.23	.23	-2.37	0.62
Self-Rated Performance Assessment	1.68	.11	-4.00	3.60
Happy	-1.87	.08	-1.56	0.09
Anxiety	2.28	.04 *	0.11	2.91
Dejection	-0.53	.61	-0.50	0.30
Energetic	-1.34	.20	-2.66	0.60
Fatigue	0.30	.77	-1.07	1.42
Anger	0.42	.68	-0.66	1.00
Excited	0.56	.58	-1.13	1.95

* p < 0.05

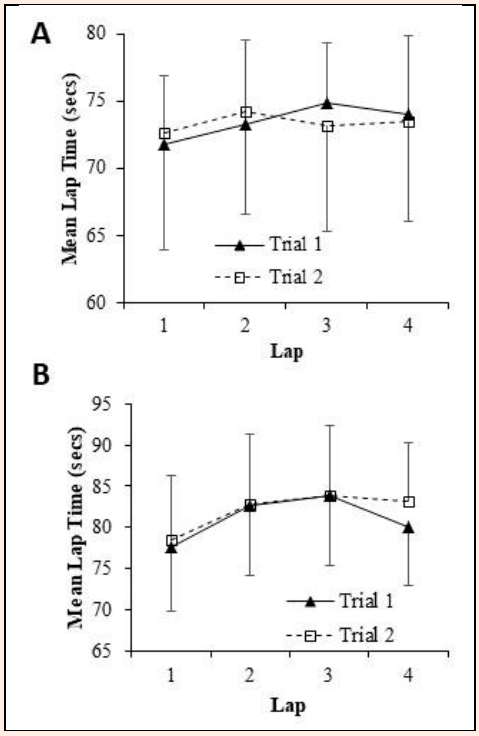

Figure 1. Pacing profiles during trial 1 and trial 2 for self-paced (A) and paced groups (B).

significant interaction effect (Wilks' lambda 2,16 = 0.80, p = 0.16, η_p^2 = 0.20). Further results showed strong correlations between self-set goal time and actual finish for both the self-paced and paced groups, and relationships were stronger for the second trial: Trial 1 (control: r = 0.86, p = 0.003; and paced: r = 0.85, p = 0.001) and Trial 2 (control: r = 0.96, p < 0.001; and paced: r = 0.96, p < 0.001). Therefore, results indicate there was no significant difference in beliefs to achieve the goal for both groups.

A repeated measures ANOVA (pre-post x self-paced/paced group) to compare self-referenced performance (actual time - goal time) indicated no significant interaction effect (Pre-post x group: F(1,17) = 0.83, p = 0.47, η_p^2 = 0.005) and no significant difference between trials (Pre-post F(1,17) = 0.54, p = 0.76, η_p^2 = 0.031). Further, there was no significant interaction effect for differences in self-rated subjective performance (F (1,17) = 2.85, p = 0.11, η_p^2 = 0.14) and no significant effect over time (F (1,17) = 0.18, p = 0.68, η_p^2 = 0.01). Thus, there was no significant effect on performance outcome.

Emotions by paced and control group: A repeated measures MANOVA of differences in emotions by paced and control group indicated a large but not significant interaction effect (Wilks' lambda 7,11 = 0.39, p = 0.09, η_p^2 = 0.612) and a moderate effect over time (Wilks' lambda 7,11 = 0.52, p = 0.29, η_p^2 = 0.485). Interaction results indicated that anxiety significantly increased in the paced group and reduced in the self-paced group (F(1,17) = 5.21, p = 0.036, η_p^2 = 0.24) (Table 2).

Split times across split distances of 400m distance for all trials: A two-way mixed repeated measures ANOVA on lap split revealed significant differences (F(2.20, 37.42) = 8.46, p = 0.001, η_p^2 = 0.33). The post-hoc tests showed lap splits differed significantly by Group between Lap 1—2 (F(1,17) = 4.88, p = 0.04, η_p^2 = 0.22) and by trial between Lap 2—3 (F(1,17) = 4.84, p = 0.04, η_p^2 = 0.22) (see Figure 1).

Rating of perceived exertion: Ratings of perceived exertion significantly increased for each lap during for both trials and for each groups (F(2.01, 34.20) = 29.83, p < 0.001, η_p^2 = 0.64). This finding was not significant between trials (F(1,17) = 3.37, p = 0.084, η_p^2 = 0.17) or groups (F(1,17) = 3.066, p = 0.098, η_p^2 = 0.153) (see Figure 2). There was no a significant difference for the 3-way interaction between paced/self-paced group, pre-post and RPE (F(1,17) = 0.76, p = 0.53, η_p^2 = 0.132).

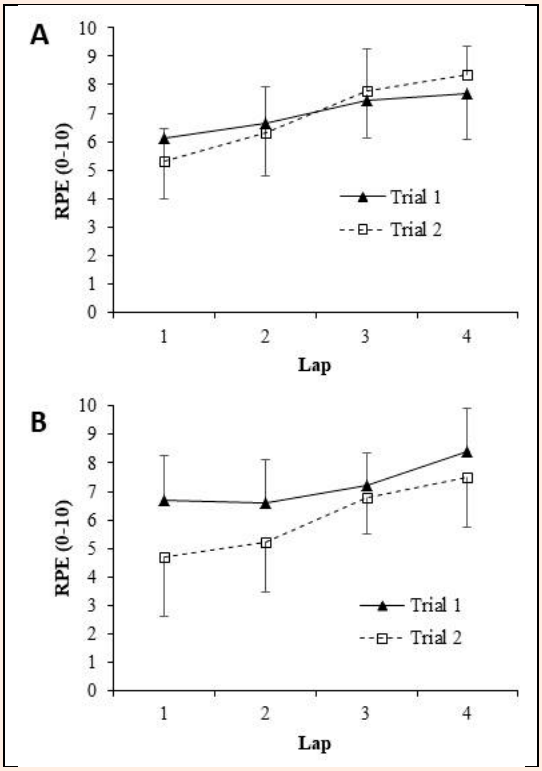

Figure 2. RPE values for each lap during both time trials for self-paced (A) and paced group (B).

Discussion

The aim of this study was to examine the influence of a pacesetter on behavioral and psychological responses during a 1600m run. Results indicated no significant differences in performance between the paced and self-paced groups which is contrary to expectations. We offer two reasons to explain this finding. First, following a pacer versus following a self-paced plan could represent two similar goals when participants have access to ongoing feedback. As such, it might not be reasonable to find significant differences; however, this would require the self-paced group to make a pacing error, something that did not happen in the present study. Second, the time set as a goal was not significantly faster for either group for the second trial. Both the paced and self-paced groups showed improvements in performance between trials, and a strong significant correlation between goal time and actual performance, with the correlation being stronger for the second test. Results suggest that both groups learned to pace the distance more effectively for the second trial. Clearly, runners in the paced group would need to set a significantly faster time as a group if improved performance is expected. Results of the present study also indicated no significant difference in confidence in the goal and difficulty of the goal, while anticipation of following a pacer did not appear to have positive psychological effects. Therefore, if practitioners sought to improve confidence by using a pacer, the finding of the present study indicates that this approach does not offer a quick solution.

We argue that findings offer insight as to how runners regulate their intentions to achieve a challenging goal, and the role of factors such as confidence, goal difficulty, emotions, perceived exertion and satisfaction. It was expected that a pacer would help promote adaptive and pleasant emotions by offering a strategy to achieve goals (Lane et al., 2016). However, results demonstrated that following a pacer associated with significantly higher anxiety. Following a personalised pacer might associate with higher anxiety due to uncertainty in being able to keep up with the pacer and public visibility of dropping behind, something that is not so observable in a self-paced run completed alone. It might be that participants are less anxious when they self-select and implement a pacing strategy because this reflects their perceived physiological capabilities and environmental conditions. Although results suggest that this associates with a conservative pacing strategy, it could be argued that self-pacing builds a more robust pacing template and alleviates anxiety around pacing decisions. In contrast, when athletes have to run with others then they are faced with multiple decisions such as where to direct attention and how to react to others' actions. Under such circumstances, the exercise intensity is imposed rather than self-selected and could well exceed that which is preferred. It is quite possible that the perceived lack of autonomy regarding pace selection is why they felt more anxious before the paced trial, and likely to be exacerbated if they had no prior experience of running with a pacer.

It might not be reasonable to expect performance to improve immediately, even though following a pacer might seem a simple skill. Devonport et al. (2016) highlighted that introducing skills that require self-regulation might not be beneficial in the early stages of learning. This suggests that novel strategies, such as following a personally designed pacing strategy, may require more deliberation than instinctive self-pacing, and thus potentially use more self-regulatory resources (Baumeister et al., 2007). Marken and Powers (1989) suggest that people vary their behavior by modulating somatosensory inputs so as to adapt to environmental disturbances on a trial-by-error basis rather than relying on learned action patterns. It might be argued that the pacer interfered with the behavioral self-regulation of physical effort, in that the runners focused less on perceptually-regulated cues (i.e., fatigue and discomfort) and more on external cues provided by a pacer. In short, the potential benefits of following a pacer might require experience of following one, which may in turn enhance confidence in one's physiological and psychological resources for maintaining pace.

In terms of how a pacing strategy affected performance specifically, results show that the self-paced group changed their pacing strategy between trials, opting for a faster start (i.e., Lap 1 and 2), which resulted in a significant decrease in pace between Lap 2—3 during their second trial. The paced group reported greater anxiety before their paced trial, and adopted a similar fast-start strategy to their previous [self-paced] trial. This finding is consistent with those reported by Lane et al (2016), who reported that higher anxiety is associated with a running a fast first lap, and Wilson et al. (2012), who reported asso-

ciations with intense physiological responses and an erratic pacing strategy.

When athletes self-pace, they may subconsciously conserve effort (St. Clair Gibson and Noakes, 2004). Support for this notion was provided in the present study whereby the self-paced group changed their pacing strategy between trials, reducing pace between laps 2 and 3 during their second trial. Pennebaker and Lightner (1980) suggest that the self-perception of fatigue may control the degree of physical effort a person is willing to exert. They found that when participants were free to run at their own pace on a running track versus cross-country, they ran slower on the track; a finding they suggested was due to track-based running providing fewer distracting stimuli and thus allowing the participants to focus on internal sensory stimuli. Athletes can feel forced to run at a markedly faster pace than their best performance (e.g., when racing against faster competitors) and this could result in a decisive and progressive slowing down in pace.

Although not showing a significant improvement in performance, results of the present study are useful for researchers and practitioners studying pacing. A key issue when examining pacing is acknowledging the methodological challenges faced by researchers. A control group or condition is a necessary quality of research in order to compare the effects of change. A control condition in the present study would involve participants completing the two 1600m under normal conditions. This was our intention for the self-paced group in the present study, and in terms of not receiving additional coaching, this decision could be justified. However, participants in the present study were experienced runners, interested in improving performance and therefore active in their efforts to improve performance. Knowledge of results and the strategy through which to improve performance were available to participants, and could be used to modify their strategy in the light of clear feedback (Brick et al., 2014). Lane et al. (2016) found that when runners in a control condition were allowed to modify their running strategy via self-regulation, they improved performance to a similar degree as runners receiving an intervention. We argue that strength of our research design was based on examination of the mechanisms through which following a pacer might work. Recently, Hurst et al. (2017) argued for the importance of addressing mechanisms of effect as interventions could work under placebo conditions.

Future recommendations

The self-pacing strategy task used in this study was hypothesized to create greater anxiety around pace judgment and therefore require greater self-regulation than an imposed pacing strategy task. However, the findings did not support this proposal. Whilst a pacer could offer a potential performance benefit, our findings showed that paced participants experienced greater anxiety before their paced trial. The pacer did influence behavior in that the paced group ran a slower first lap with the pacer than during their self-paced trial, however, this did not result in faster 1600m times. The evidence from this study suggests that being paced represents a novel run experience, which requires practice. Based on findings of the present study, we argue that although running with others can enhance performance (e.g., increased motivation, reduced perception of effort), it may require greater self-regulation through continuous monitoring of behavior against the pacer's actions. It is plausible that following practice, the real (e.g., reduced energy cost of overcoming wind resistance) and potential (e.g., optimal pacing, enhanced confidence) benefits of running with a pacer are more likely to be accrued.

Conclusions

In conclusion, the present study showed that the use of a pacer as a technique for influencing the self-regulation of pacing behavior did not improve overall performance. However, the presence of a pacer did influence perception, emotion and pacing behavior. Self-pacing might be hypothesized as more effortful than following an imposed pacing strategy, but the results of the present study suggest that self-pacing appears to represent an instinctive behavior, and may therefore require less self-regulation. Athletes will typically self-pace during training and arguably develop strategies to respond to situational demands during competitions, whilst exercising within the confines of their physical capabilities.

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Key points

- The presence of a pacer associated with greater pre-run anxiety and a fast-start pacing strategy during a 1600m time trial, but did not improve performance.
- The findings offer insight as to how runners self-regulate their pacing behavior to achieve a challenging goal, and the role of factors such as confidence, goal difficulty, emotions, and perceived exertion.
- Although the use of a pacer is proposed to offer a performance benefit, the evidence from this study suggests that being paced represents a novel run experience and may therefore require greater self-regulation through continuous monitoring of behavior against the pacer's actions.

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