



External Feedback Does Not Affect Running Pace in Recreational Runners

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ABSTRACT

International Journal of Exercise Science 11(5): 384-390, 2018. Many runners receive external feedback, such as running pace, during training; however, it is unknown if this feedback increases the intensity of a given exercise session. Therefore, the purpose of this study was to examine the effect of the provision of pace feedback on self-selected submaximal running pace, heart rate, and perceived exertion in recreational runners. Ten runners (6 female, 4 male) completed four 30-min treadmill running bouts in random order, each on a separate day. In each session, participants adjusted their pace as desired; however, all treadmill display information was concealed from the runners. During each bout, participants were given feedback regarding running pace every five minutes as follows: 1) no pace feedback, 2) accurate pace feedback 3) false positive pace feedback (5% faster than the actual pace), or 4) false negative pace feedback (5% slower than the actual pace). Average running paces were $5:35 \pm :12$, $5:32 \pm :12$, $5:30 \pm :12$, and $5:30 \pm :12$ min:sec/km for the no pace, accurate pace, false positive, and false negative feedback conditions, respectively, which were not statistically different. The different feedback conditions also yielded no significant differences in average heart rate, maximal heart rate, or rating of perceived exertion. These results suggest that periodic external feedback regarding running pace does not affect overall self-selected running pace or exercise intensity during a running bout in recreational runners.

KEY WORDS: Pacing, augmented feedback, motivation

INTRODUCTION

In endurance sports, it has become common for competitors to utilize external devices to receive task-related feedback (e.g., current speed, average pace, cadence, heart rate, distance, etc.) during competition and training. Bicycle computers have received heavy use for decades, as the spinning wheels could be readily used to calculate speed and distance. More recently, runners have been able to utilize GPS technology embedded in wrist-watches or smart-phone applications to monitor running pace in real time.

Recent studies have attempted to ascertain the importance of enhanced feedback on performance in brief, intense efforts as well as during endurance-type exercise. Participants receiving enhanced feedback, sometimes called augmented feedback, improved vertical jumping performance (7, 13) and maximal leg press (5); however, in endurance events, results have been equivocal. Several authors have stated that during time trial situations, experienced

athletes primarily rely on their internal bodily feedback and prior knowledge of the task demands of a particular distance, making enhanced external feedback superfluous (8, 11, 14). This conclusion is supported by studies showing that external feedback did not alter performances in either 4-km (8, 14) or 20-km cycling time trials (11). On the other hand, Faulkner et al. (4) reported that runners' completion times for a 6-km run were significantly slower when exercising with no feedback.

While the conclusions of previous studies regarding the impact of external feedback on exercise performance vary depending on the type of exercise, the effect of pace feedback on self-paced running has been largely unexplored (4). Furthermore, the protocols to date have been designed to assess the effect of feedback on time trial performance, rather than on submaximal exercise intensity during a training session. Exercise training generates adaptations of the cardiovascular and muscular systems involved in the activity, and the degree of adaptation is influenced by, among other factors, the intensity of the exercise effort. Therefore, strategies that increase exercise intensity during training bouts should enhance the magnitude of the adaptive response (2), which may subsequently enhance performance. Thus, the purpose of this study was to examine whether external feedback, specifically that of running pace, affects submaximal exercise intensity in recreational runners during a standard training run.

METHODS

Participants

Ten healthy, physically active participants (6 female, 4 male) who were asymptomatic of illness and pre-existing injuries volunteered for the study. Inclusion criteria were consistent running training and knowledge of average running pace. Participant characteristics are provided in Table 1. A full explanation of data collection methods and risks were given to all participants, who then provided written informed consent. The study parameters were approved by the Institutional Review Board of Transylvania University.

Table 1. Participant characteristics.

Age (yr)	27.5 ± 3.3
Body Mass (kg)	67.7 ± 2.4
Height (cm)	175.5 ± 2.0
VO ₂ max (ml/kg/min)	49.8 ± 2.2
Training frequency (days/wk)	4.4 ± 0.6
Training distance (km/wk)	21.2 ± 4.3

Data are reported as mean ± SE.

Protocol

Participants completed five treadmill tests, including an incremental test to exhaustion and four self-paced 30 minute training runs performed in random order. At least 48 hours separated each running session, which were performed on a motorized treadmill (Life Fitness, Rosemont, IL, USA). During all running sessions, heart rate (HR) was monitored using a chest strap telemetry system (Polar, Lake Success, NY, USA).

VO₂ max test: During the first visit to the laboratory, participants completed a maximal incremental treadmill exercise test to exhaustion, during which oxygen consumption (Parvo Medics True One 2400, Sandy, UT, USA), respiratory exchange ratio (RER), and HR were measured continuously. The test commenced at a treadmill speed of 7.1 km/hr and a grade of 3%. Every two minutes, speed and grade increased by 1.3 km/hr and 1%, respectively. Participants voluntarily terminated the test when they could no longer maintain the required work rate.

Self-Paced Training Runs: Participants were instructed to complete each of the four self-paced 30 minute runs as if they were training for an upcoming five kilometer race. For each session, the treadmill grade was set at 1% to mimic the energetic cost of running outdoors (5). Participants had complete control of the treadmill speed and were allowed to alter their running velocity at their discretion. All treadmill display information was concealed from the runners throughout each running session, so that while participants could alter the treadmill speed, they could not see the actual running pace. These four sessions were completed either with no pace feedback, accurate feedback, or inaccurate (two sessions) feedback. Participants provided a subjective rating of perceived exertion (RPE) using the Borg Scale at the end of each training run.

No Pace Feedback: In the no pace feedback condition, participants were not informed of their running pace at any time during the running session; however, they were informed of the elapsed time at 5, 10, 15, 20, 25, and 30 minutes. This trial was designed to mimic a training run in which the runner utilized a timing device without GPS capability.

Accurate Pace Feedback: In the accurate pace feedback condition, participants were informed of the elapsed time and their average running pace at 5, 10, 15, 20, 25, and 30 minutes. This trial was designed to mimic a training run in which the runner utilized a GPS-enabled device programmed to give periodic feedback.

False Positive or False Negative Feedback: In the inaccurate feedback sessions, participants received either false positive or false negative feedback at 5-minute intervals. In the false positive condition, runners were told they were running 5% faster than their actual pace. In the false negative condition, runners were told they were running 5% slower than their actual pace. These trials were designed to mimic the accurate pace feedback running session and to provide additional data regarding the influence of periodic enhanced feedback on running pace and exercise intensity.

Statistical Analysis

An *a priori* power analysis based on our expected outcomes, with a power level of 0.8 at an α level of 0.05 indicated a requirement of 63 participants. Because this exceeded our logistical capability, we accepted that fact that the statistical calculations regarding overall running pace would have low power. A one-way repeated measures analysis of variance (ANOVA) was used to compare average pace, average HR, maximal HR, and RPE values recorded during the four training runs. A two-factor repeated measures ANOVA (feedback condition x time point)

assessed potential differences in the actual running pace and the change in pace for each 5-minute segment across conditions. Bonferroni correction was used for multiple comparisons, statistical significance was accepted at $p < 0.05$, and data were analyzed using SPSS statistical software, version 19 (IBM Corporation, Armonk, New York).

RESULTS

There were no significant differences ($p > 0.05$) in the average running pace between the four feedback conditions (Table 2). Furthermore, both average and maximal HR values were similar across the four running sessions, as was RPE (Table 2).

Table 2. Performance and physiological data for each feedback condition.

	No Pace Feedback	Accurate Feedback	False Positive	False Negative
Average Pace (min:sec/km)	5:35 \pm 0:12	5:32 \pm 0:12	5:30 \pm 0:12	5:30 \pm 0:12
Average HR (bpm)	165 \pm 5.4	161 \pm 7.3	166 \pm 4.6	164 \pm 5.8
Maximum HR (bpm)	181 \pm 5.5	182 \pm 5.0	180 \pm 4.5	182 \pm 5.0
RPE	14.5 \pm 0.5	14.6 \pm 0.7	13.9 \pm 0.5	14.7 \pm 0.7

Data are reported as mean \pm SE.

Table 3 shows the average running pace for each 5-min period during each training run. There was no difference in pace between feedback conditions within any time point. Although not statistically significant ($p = 0.07$), runners in the accurate feedback condition tended to improve their running pace to a greater extent after the first five minutes than when receiving no pace feedback.

Table 3. Running pace of each 5-minute time period during each feedback condition (min:sec/km).

	0-5 min	5-10 min	10-15 min	15-20 min	20-25 min	25-30 min
No Pace Feedback	5:40 \pm 0:14	5:39 \pm 0:12	5:38 \pm 0:18	5:40 \pm 0:15	5:30 \pm 0:09	5:29 \pm 0:18
Accurate Feedback	6:00 \pm 0:15	5:31 \pm 0:17	5:22 \pm 0:15	5:27 \pm 0:14	5:33 \pm 0:18	5:20 \pm 0:13
False Positive	5:48 \pm 0:14	5:26 \pm 0:13	5:23 \pm 0:11	5:38 \pm 0:15	5:43 \pm 0:20	5:06 \pm 0:10
False Negative	5:47 \pm 0:14	5:33 \pm 0:12	5:21 \pm 0:11	5:29 \pm 0:15	5:32 \pm 0:12	5:21 \pm 0:19

Data are reported as mean \pm SE.

DISCUSSION

The primary purpose of this study was to assess whether feedback regarding running pace affected overall running pace, heart rate, or RPE. Secondly, by using inaccurate feedback, we hoped to ascertain the degree to which enhanced feedback might be a motivating factor. Our protocol required participants to complete four 30-minute self-paced training runs on a treadmill, which were designed to mimic exercise sessions conducted either with or without pace feedback that athletes would normally receive from a GPS-enabled device. The data indicate that, in this group of recreational runners, the provision of enhanced feedback during training did not increase their running velocity during a training session.

The data in Table 2 indicate a striking consistency in our dependent variables over the course of four different running sessions. Participants' average pace, heart rates, and RPE were similar across trials, which is a novel finding regarding the provision of feedback during

submaximal endurance running training sessions. Our research design is similar to that of Faulkner et al. (4), who analyzed the effects of both accurate and inaccurate feedback on 6-km running time. In that study, participants recorded significantly slower times in the No Feedback condition, suggesting that feedback was necessary for optimal performance. However, because their runners were completely blinded as to both elapsed time and distance, a more cautious approach to pacing might be expected so as to prevent premature fatigue.

Although the running pace data for each 5-min segment are not statistically different (Table 3), it is apparent that our runners used slightly different pacing strategies during the different feedback conditions. First, when receiving no pace feedback, our participants maintained a nearly constant pace for the first 20 minutes, followed by a faster pace until the end of the run. Alternatively, when given either accurate or inaccurate pace feedback, our runners increased their running pace at 5:00 and 10:00, but then slowed their speed over the next ten minutes prior to their end spurt. This latter parabolic-shaped strategy is often observed in endurance exercise (3) and seems to be an attempt of the athlete to achieve maximal RPE at the exercise end-point (12).

Based on our hypothesis that pace feedback would motivate our runners to increase their intensity, we expected that the false negative condition, in which participants were told they were running slower than their actual pace, would result in the fastest overall pace. However, Tables 2 and 3 indicate that the false negative condition did not alter the overall pace, effort, or pacing strategy as compared to the other feedback conditions. Indeed, the similarity of the heart rate and RPE data (Table 2) suggest that the chosen running pace was based on a pre-determined intensity and not on our pace feedback. Similar results have been reported by others. Micklewright et al. (9) found that completion time, average power, and average speed in a 20-km cycling time trial was not altered by accurate or inaccurate distance feedback. Also using a 20-km cycling time trial, Albertus et al. (1) reported that completion time was unaffected by providing inaccurate distance feedback to 15 well-trained male cyclists. Together, these studies seem to affirm the notion that pace and effort in endurance training or competition is influenced primarily by internal physiological cues and prior knowledge of pacing strategy for a particular distance.

We are aware of only a single study on the impact of smart-phone applications on the psychological, physiological, and performance variables of individuals while running. Moran and Coons (10) reported that college-aged runners were more inspired while using the auditory exergame *Zombies, Run!* than while running with no auditory stimulus. Additionally, female participants recorded higher RPE values while playing the game (10). While the aims of this exercise game experiment were different than those of the present study, it provides an example of how smart-phone technology can be used to enhance the intensity of a training session. Although we did not employ the use of smart-phone technology in the current study, our protocol attempted to mimic training runs performed either with or without the types of feedback that these applications can provide.

This study has several limitations that should be addressed. First, and most apparent, is that participants' training runs were conducted in the laboratory on a treadmill, which may limit the applicability to "real world" training situations. To standardize environmental conditions, we elected to conduct the study indoors, as even small changes in temperature, humidity, and wind speed can substantially influence running pace. Future research on outdoor running is thus warranted. A second concern is that the study employed relatively few participants, which elevated the potential for type II error. However, because overall running pace, heart rates, and RPE values were so notably similar, we feel that a type II error is unlikely in this data set. A final concern relates to the use of deception in providing pace feedback. We suspect that a few runners may have been aware of their incorrect feedback and thus disregarded it during either the false positive or false negative feedback runs. However, we think this knowledge had little effect on our final conclusion since only a single participant expressed concern with our accuracy and we observed a similar running pace, HR, RPE, and pacing strategy in all three of the feedback conditions.

In summary, there were no significant differences in average running pace, heart rate, or perceived exertion between the no pace feedback and accurate or inaccurate feedback conditions in this group of recreational runners. Overall running pace appears to have been primarily based on RPE and less so on external feedback. Therefore, external feedback regarding running pace does not increase exercise intensity in a submaximal bout of running.

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