The Effect of Feedback on Exercise Performance in Recreationally-Active Young Adults

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ABSTRACT

It has been shown that certain athletes, through training and competitive experience, can develop an effective pacing strategy before exercise begins that is unaffected by external feedback. The purpose of this study was to determine the effect of external feedback on exercise performance in recreationally-active young adults. Twenty-nine college-aged adults (14 men; 15 women) completed two treadmill exercise bouts on separate days: without feedback (NFB) and with feedback (FB). During both exercise bouts, subjects were instructed to cover as much distance as possible in twenty-minutes. When performing the FB bout, subjects received information regarding distance travelled and time remaining at five minute intervals, while neither was provided during the NFB bout. The subjects travelled a longer distance when provided with feedback during the exercise test (1.94 ± 0.45 vs. 1.81 ± 0.48 miles, p = 0.004). This pattern also remained when the data was examined relative to gender; men (2.12 ± 0.50 vs.1.95 ± 0.55 miles, p = 0.011), women (1.76 ± 0.34 vs.1.66 ± 0.37 miles, p = 0.015). Mean heart rate, treadmill speed, and perceived exertion values were not statistically different between the FB and NFB trials. Without previous training experience, recreationally-active young adults appear to rely upon external feedback in order to develop an appropriate pacing strategy and improve performance.

Keywords: Central Governor Model; External feedback; Internal feedback; Pacing strategy; Teleoanticipation

Previous research has demonstrated that exercise performance is influenced by both external and internal feedback (Hampson *et al.,* 2001; Mauger *et al.,* 2009). Endurance athletes often utilize “pacing strategies” to control rate of fatigue and improve performance during competition and training (Albertus *et al.,* 2005; Mauger *et al.,* 2009). As previously described (Faulkner *et al.,* 2008), the formation of a pacing strategy may be dependent upon several factors including, but not limited to, individual specific (e.g., aerobic capacity, motivation, knowledge, experience), event-related (e.g., duration, distance, exercise mode, level of competition) and environmental conditions (e.g., temperature, humidity). According to Ulmer’s theory of “teleoanticipation,” the pacing strategy during self-paced exercise may be regulated in a subconscious anticipatory manner based on one’s expectation of the exercise duration prior to exercise commencing (Ulmer, 1996). Furthermore, this theory proposes that the individual, using both physiological and external feedback, continuously adjusts the initial exercise pace during the exercise bout in order to prevent potential injury and exhaustion (Ulmer, 1996).

Specific types of external feedback, such as time remaining and distance covered, are usually known when athletes compete. Although knowledge of this information may allow athletes to adjust their exercise pace in order to finish the predetermined distance in the shortest amount of time, it has been shown that some athletes are not influenced by feedback during the exercise test (Albertus *et al.,* 2005; Mauger *et al.,* 2009). It appears that the familiarly with the distance to be completed may enable athletes to set the pacing strategy before exercise begins. These findings suggest that the anticipatory component of Ulmer’s theory may be more important in regulating the pacing strategy than external feedback during the exercise session (Ulmer, 1996; Albertus *et al.,* 2005;

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Mauger *et al.,* 2009). The role that exercise feedback has on the exercise performance of individuals with less training experience is unclear. As such, the purpose of this study was to examine the effect of external feedback (i.e., time remaining and distance travelled) on exercise performance in recreationally active young adults. It was anticipated that this group of subjects may be more influenced by external feedback given their limited experience with creating pacing strategies. The findings from this study may be of benefit to coaches and exercise professionals that often work with novice athletes or individuals just beginning a training program.

METHODS

Subjects

Twenty-nine, healthy adults (15 women; 14 men) between 19 and 29 years of age volunteered to participate in this study. All subjects, recruited from Lock Haven University, were recreationally active and had previous experience using a motorized treadmill. The study protocol and methods were approved by the Institutional Review Board at Lock Haven University and all subjects signed an informed consent form prior to participation.

Study Procedures

Each subject was instructed to complete two twenty-minute exercise bouts on a motorized treadmill (TrackmasterTMX425C; Newton, KS) on separate days: a bout with no feedback (NFB) and a bout with feedback (FB). Body mass and height were measured using a leg-to-leg body composition analyzer (Model TBF-300A, Tanita Corporation of America, Inc., Arlington Heights, IL) and a wall-mounted stadiometer (Tanita Corporation of America, Inc., Arlington Heights, IL). In addition, all subjects were fitted with a heart rate monitor (Polar Electro, Woodbury, NY) to assess heart rate during exercise. Body composition was examined using a hand-to-hand bioelectrical impedance analyzer (Model HBF-306C; Omron Healthcare, Inc., Bannockburn, IL) before and after both exercise tests for the purpose of deception. All subjects were told that the purpose of the study was to examine the effect of exercise on body composition determined by hand-to-hand bioelectrical impedance. Knowledge of the actual purpose of this study may have influenced the exercise performance of the subjects. By disguising the study as a body composition study and instructing the subjects to “cover as much distance as possible,” it allowed us to examine the impact that feedback had on exercise performance. Prior to each exercise bout the following instructions were read to the subject:

> For the exercise portion of this experiment, we ask that you walk, jog or run for twenty minutes on the treadmill. Whether you walk, jog or run is up to you. The ultimate goal is to cover as much distance as possible in the twenty minute time period. During the exercise bout, you may increase or decrease the speed of the treadmill at any time to change between walking, jogging or running as often as you would like. I will be nearby to record your heart rate and how you feel using a ratings of perceived exertion (RPE) scale. However, conversation between us will be kept at a minimum as I want you to focus on the exercise test. After twenty minutes, you will cool-down on the treadmill until your heart rate is below 120 beats per minute and I will perform a second body fat analysis using the bioelectrical impedance analyzer. Do you have any questions?

No Feedback (NFB) Trial Each subject performed the NFB bout as the first test. During the NFB exercise bout, the treadmill’s electronic panel was set to display MET (Metabolic Equivalent of the Task) in order to prevent the subject from seeing a scrolling visual display of the time elapsed or distance travelled during the test. The investigator was positioned behind the treadmill to prevent interaction and potential distraction of the subject. The only communication between the investigator and the subject occurred when RPE (0-10 scale) was obtained at the 5 and 20 minute time points. Measurements of heart rate and treadmill speed were recorded every five minutes. The total distance travelled was recorded by the investigator after 20 minutes of exercise and the test was terminated after an appropriate cool-down period (heart rate below 120 bpm). Only the investigator had access to the total distance travelled; the subject had no knowledge of this information.

Feedback (FB) Trial The exercise test with feedback was performed during the subject’s second visit to the laboratory. During the FB trial, the treadmill’s panel was set to display the distance setting. This provided the subject with continuous visual feedback regarding the distance during the exercise bout. In addition, the investigator informed the subject of time elapsed at five minute intervals. The time feedback was not presented in a manner to provide verbal encouragement. Heart rate, treadmill speed, RPE and total distance travelled were obtained in the same manner as during the NFB trial.

Statistical Analyses

The data obtained from this experiment were analyzed using SPSS 16.0 for Windows (SPSS, Inc, Chicago, IL). All means are expressed as mean ± standard deviation. Heart rate and treadmill speed were analyzed using a 2-factor (group × time) analysis of variance with repeated measures on the within (time) factor. Each dependent variable was compared between groups (NFB and FB) and over time. Bonferroni adjustments for multiple comparisons were conducted to discriminate between means when ANOVA yielded significant results. Paired sample t-tests were used to compare distance travelled and RPE between the NFB and FB exercise bouts. Statistical significance was established at $p < 0.05$ for all statistical analysis.

RESULTS

Subject characteristics are presented in Table 1. The sample consisted of 29 college-aged young adults (14 men; 15 women). Percent body fat ranged from 7.0 to 30.5% in the men and 16.1 to 26.3% in the women. The average duration between the two exercise bouts was 7.8 ± 3.9 days.

Table 1. Subject characteristics. Men = 14, Women = 15

Characteristic	**mean ± s.d.**	**range**	**mean ± s.d.**	**range**
Age (yrs)	20.5 ± 1.0	19.0 - 26.0	21.1 ± 2.6	19.0 - 29.0
Height (cm)	177.0 ± 7.9	160.0 - 186.7	162.3 ± 4.6	157.5 - 169.5
Body mass (kg)	86.3 ± 22.6	58.1 - 130.5	57.9 ± 6.1	49.6 - 71.0
Body Fat (%)	16.4 ± 8.3	7.0 - 30.5	20.9 ± 4.5	11.6 - 26.3

When provided with FB, subjects covered a longer distance on the treadmill when compared to the NFB trial (1.94 ± 0.45 vs. 1.81± 0.48 miles, $p = 0.004$). This pattern also remained when the data was examined relative to gender; men (2.12 ± 0.50 vs. 1.95± 0.55 miles, $p = 0.011$), women (1.76 ± 0.34 vs. 1.66± 0.37 miles, $p = 0.015$). Mean heart rate , treadmill speed, and RPE values were not statistically different ($p > 0.05$) between the FB and NFB trials (Table 2). However, a large percentage of the subjects demonstrated a higher heart rate and/or treadmill speed during the FB trial when compared to the NFB trial at the 20 min time point (Table 3).

Table 2. Physiological and perceptual responses during exercise.

Characteristic	Time (min)			
	5	10	15	20
Heart rate (b/min)				
FB	159.3 ± 23.2	165.2 ± 19.0	166.3 ± 20.0	169.3 ± 21.2
NFB	152.7 ± 23.6	161.8 ± 25.1	162.9 ± 25.4	161.0 ± 25.7
Speed (mph)				
FB	6.0 ± 1.3	5.8 ± 1.5	5.9 ± 1.5	6.0 ± 1.9
NFB	5.5 ± 1.6	5.6 ± 1.5	5.5 ± 1.4	5.3 ± 1.5
RPE				
FB	3.2 ± 1.5	NR	NR	4.9 ± 1.7
NFB	3.2 ± 1.3	NR	NR	4.7 ± 1.7

All values are mean ± SD; FB = with feedback; NFB = without feedback; NR = not recorded; RPE = ratings of perceived exertion

Table 3. Percentage of subjects that demonstrated a heart rate (HR) and/or treadmill speed (TS) increase during the feedback vs. without feedback trial.

Variable	Time (min)			
	5	10	15	20
HR (b/min)	59%	48%	48%	74%
TS (mph)	59%	52%	66%	69%

DISCUSSION

The purpose of this study was to determine whether external feedback influenced the exercise performance of recreationally-active young adults. It was hypothesized that external feedback would improve exercise performance in this group because of their unfamiliarity with developing a pacing strategy. As anticipated, the principal finding was that the subjects travelled a longer distance when they were provided with external feedback during the exercise bout.

Previously, it has been shown that some athletes can develop an effective pacing strategy before exercise begins that is unaffected by external feedback (Albertus *et al.,* 2005; Mauger *et al.,* 2009). Albertus *et al.* (2005) discovered that fifteen well-trained cyclists could produce similar time trial times despite being given incorrect distance feedback. Mauger *et al.* (2009) reported that a group of trained cyclists that were distance blinded and received no feedback were able to develop a similar pacing strategy as those that knew distance and had feedback during the time trial. Collectively, the studies suggest that athletes may have the ability to develop a successful pacing strategy based simply on prior experience even when external feedback is inaccurately presented or absent. Hampson *et al.* (2001) has suggested that individuals become better at pacing their events with practice, suggesting that performance is dependent on experience. The subjects used presently were not involved with organized athletics or competitive training. According to the theory of teleoanticipation, an initial pacing strategy cannot be set if the exercise endpoint is not known (Ulmer, 1996). Our subjects were informed that the exercise bout would last for twenty minutes and were instructed to cover as much distance as possible during that time. However, they most likely were unable to develop an appropriate pacing strategy prior to exercise because of their lack of regular exercise participation. Without the ability to develop a pacing strategy, the subjects would have had to rely upon sensory feedback to regulate exercise intensity. The data show that during the NFB trial, the subjects may have selected a running speed that ensured their ability to finish the twenty-minute exercise bout without premature fatigue. Conversely, during the FB trial when time elapsed was provided, the subjects were better able to regulate and adjust exercise intensity during the testing session. Along with the difference in mean distance travelled between trials, this is supported by the fact that for a large percentage of the subjects HR was higher and treadmill speed was faster (74% and 69%, respectively) during the FB trial when compared to the NFB trial at the 20 min assessment point.

One limitation was that in order to protect the purpose of the study we were unable to counterbalance the testing sessions. According to the testing protocol, all subjects initially completed the NFB trial which was followed by the FB trial approximately one week later. As previously discussed, athletes have been shown to be able to develop a pre-exercise pacing strategy based upon their prior training and athletic experience (Albertus *et al.,* 2005; Eston *et a*l., 2007). It is possible that the experience gained during the NFB trial may have had some impact on the subsequent FB exercise test (i.e., testing effect). However, the magnitude of that impact and whether an untrained individual can formulate a pacing strategy based upon a single exercise experience is unknown and worthy of further investigation. To correct for this design limitation, future studies should include a separate control group where those subjects perform two NFB trials with the same pre-exercise instructions as those used presently. In consideration of the present research design limitation and relatively small sample size, these findings should be viewed as preliminary. Further analysis is required to validate the results of the current study.

In conclusion, our findings suggest that recreationally-active young adults perform better when provided with external feedback. Without acquiring the previous training experience necessary to formulate an appropriate pacing strategy, our subjects most likely relied more upon external feedback to self-select the pace of exercise. As such, we suggest coaches and personal trainers continuously provide novice athletes or "new-beginners" with regular external feedback during training to ensure the highest level of performance is attained during practice sessions until adequate levels of experience has been gained over time.

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