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ORIGINAL RESEARCH

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The influence of verbal encouragement on heart rate, maximum oxygen uptake, and distance covered in young male adults during beep test

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Abstract

Communication and motivation from physical education teachers is an important part of physical education classes. Therefore, it is necessary to look for suitable and effective methods to maximize students' effort and performance. This study aimed to investigate the changes in aerobic performance after applying verbal encouragement (VE) to the beep test for university students. A group of 397 male students with average body mass index (BMI) 24.81 $\pm$ 5.88 and age 19.1 $\pm$ 1.3 was randomly selected for this study. Students were divided into two groups: physically active (237 PAS) and non-active students (160 NAS). These students underwent a beep test with and without VE in a counterbalancing manner. A Wilcoxon signed-rank test was employed to find differences between the distance covered, maximum oxygen uptake and maximum heart rates after verbal VE and without stimulus (WS) in a beep test. The results showed that all students improved in the distance covered after VE compared to WS in the beep test (47.3 m, 5.53%, $p < 0.0001$), NAS (34.2 m, 4.44%, $p = 0.013$) and PAS (60.2 m, 6.62%, $p < 0.0001$). All students also increased maximal heart rate (beats per minute—BPM) values after VE stimulus compared to WS in the same test (1.01 BPM, 0.51%, $p = 0.001$) and PAS (1.58 BPM, 0.80%, $p = 0.001$). Only the NAS group did not significantly improve in maximal heart rate. These findings indicate that VE ("go-go or faster-faster") applied every 60 seconds is more effective for improving endurance than without any stimulus and that VE improved performance statistically the same in both groups (NAS, PAS). Therefore, the positive effect of VE is similar to NAS and PAS.

Keywords

Physical education; Motivation; Fitness test; Endurance; Quality education

1. Introduction

Fitness testing is an integral part of physical education classes. One of the common fitness tests for measuring students' aerobic capacity is a beep test. Results from Penry [1] show high reliability and validity for maximal oxygen uptake (VO_{2max}) in beep tests in young, healthy individuals. The test is very demanding on students' internal and external motivation to finish it at their best and to get adequate results based on their abilities [2]. The question is how to raise students' motivation for their maximal effort during the execution of the test. One stimulus that practitioners could use is verbal encouragement (VE). The main aim of VE should be to motivate people and create a non-threatening and challenging environment for better effort and results [3]. The positive effect of manipulating the motivational climate in physical education lessons was already described by Morgan *et al.* [4]. It was proven that VE can increase cognitive performance in a school environment [5], and that loud auditory stimulation can achieve better performance than by effort of will alone [6]. Moreover, VE can increase performance satisfaction and mental and internal physical load [7]. Verbal instruction and encouragement are commonly used in sports environments and sports training as a motivation stimulus to achieve better results [8]. However, VE from teachers is very often missing in physical education classes. Therefore, it is essential to determine the effectiveness of this stimulus on non-athlete probands. This stimulus' effect could be quantified by maximal exercise testing, which requires participants to give a maximal effort. Some testing guidelines recommend VE as one stimulus of motivation for better results [9–11], but unfortunately, most of the studies that used the beep test in their research do not include information on whether VE was given during the test [12] and therefore it is unclear how many of them are using VE in praxis.

Some researchers investigated the effects of VE on different fitness abilities, and positive changes were found in strength [6, 13–15] and speed parameters [3–16]. Furthermore, many studies on athletes [17–19] have found just small changes after applying VE and have described that athletes and females are more self-motivated than non-athletes and males. Therefore,

they might be highly intrinsically motivated, and VE does not affect their performance as much as non-athletes' probands.

VE in endurance abilities (6-minute walk test) was used by Marinho *et al.* [20], who did not record any significant changes in performance. However, the study was conducted on elderly patients with chronic obstructive pulmonary disease and compared to a group of healthy elderly patients. Then Chitwood *et al.* [21] found significant changes during maximal oxygen uptake testing on a treadmill after encouragement in a group of calmer people, not driven, not competitive, and more patient. Similar results from maximal testing on a treadmill were described by Moffatt *et al.* [22], who suggest that VE is not effective for highly trained competitive runners, but it may be an effective motivation method for untrained non-athletes. Positive results were also reported by Edwards *et al.* [23] with untrained but active adults in speed and endurance activities (20-minute cycle on a fixed ergometer). In a similar study to ours, Neto *et al.* [24] tested 12 male high school students in a multistage 20 m shuttle run and found significant improvements in maximal oxygen uptake, distance covered, and final heart rate after using VE compared to without verbal stimulus. Research from Midgley *et al.* [25] described that studies had reported significant increases in time to exhaustion of between 8% and 18% during VO_{2max} in beep tests and that most participants perceived VE as a positive stimulus during maximal exercise testing. The frequency of VE during testing was investigated by Andreacci *et al.* [26], who described that 20 s and 60 s VE are more effective for enhancing maximal effort than without VE or when the encouragement is infrequent (180 s). The study by McCormick *et al.* [27] also shows that VE can have a beneficial effect on mental fatigue, which undermines endurance performance.

A small number of studies are focusing on the differences between physically active and non-active students, even though their motives and views for participating in physical education (PE) are different. Every stimulus from a PE teacher can influence these groups differently. Therefore, this study is unique in terms of the comparison of the effect of VE in beep tests on physically and non-physically active male university students and in terms of the selected sample size, which is significantly higher than in other similar studies. This paper aims to investigate the importance of using VE as a stimulus with students to help motivate them to make the maximum effort during physical education classes. This research examines students' responses to exercise behavior as a predictor of motivation for achieving better performance during the endurance beep test. It is hypothesized that VE during the beep test will impact endurance parameters more significantly than without stimulus (WS) in both groups (physically active and non-active). The following hypothesis is that VE positively influences more physically non-active students compared to active students.

2. Materials and Methods

The study was a single-blinded group, crossover-controlled study with the dependent heart rate, maximum oxygen uptake, and a number of shuttles completed successfully. The independent variable was the VE in the beep test.

Participants of this research were 397 male students from King Fahd University of Petroleum and Minerals who fully completed two beep tests with VE and WS. The sample size was calculated and set up based on the number of students in the university (10,000), the confidence level 95%, and the margin of error 5. The students were divided into two groups: physically active (PAS) and non-active students (NAS). A total of 237 PAS with an average body mass index (BMI) 24.9 $\pm$ 5.57, body mass 78 kg $\pm$ 15.32, height 1.77 m $\pm$ 5.42 and a calendar age 19.2 $\pm$ 1.21 was recorded. In the NAS group, there were 160 students (BMI 24.6 $\pm$ 6.17, body mass 76 kg $\pm$ 16.6, height 1.76 m $\pm$ 5.64, age 19.0 $\pm$ 1.3). The medical history was taken to deselect unhealthy or injured students from the testing. All students were asked to not be physically active 48 hours before testing and were informed about the procedure and main purpose of each test. All students underwent two measurements of their aerobic abilities with and WS in counterbalancing conditions. The procedures followed were in accordance with the ethical standards on human experimentation stated in compliance with the 1964 Helsinki Declaration and its later amendments.

2.1 Methods of Obtaining Research Data

Demographic surveys and measurements were used to collect data. The survey was administered before the testing. It was supposed to get basic demographic information about students: their name, age, body mass index, health situation, and information on how many times they were on average physically active for at least 30 minutes per week in the last five years. Based on this information, students were selected for this research, and it was recorded which students were physically active or non-active. PAS stated in the survey that they were physically active at least three or more times per week for a minimum of 30 minutes over the last 5 years [3]. The majority of students were engaged in these activities: football, swimming, and volleyball.

The beep test (multistage shuttle run test) was chosen as a reliable test for measuring aerobic capacity [28] and for its simple implementation in physical education classes. Each student underwent athletic warm-ups, which included basic athletic drills and dynamic stretching before testing. Participants perform this test two times, one time with and one time without VE. The order of attempts was regularly changed (counterbalancing) during the measurement. Each student completed two measurements in five days on Wednesday and Monday or Tuesday and Sunday, always at the same time, on a football field with artificial grass. All measurements have been done by only one and the same investigator.

The Beep test involves continuous running between two lines 20 m apart in time to record beeps. The students were standing behind one of the lines facing the second line and began running when instructed by the recording. The speed at the start was quite slow (8 km/h). The participants were running between the two lines on the signal of the recorded beeps (without knowing the number of stages and levels). After a while, the frequency of the beeps slowly increased. This continued with each beep. If the line was reached before the beep sounded, the subject had to wait until the beep sounded

before continuing. If the line was not reached before the beep sounded, the subject was given a warning and had to continue to run to the line, then turn and try to catch up with the pace within two more "beeps". The test was stopped if the subject failed to reach the line (within 2 meters) for two consecutive ends after a warning. The examiner recorded the last stage and level that were reached by the student on the beep signal, which corresponded with the distance covered during the test [29]. The rest between runs was five days.

The selected stimuli were:

1. Running without external stimuli
2. Running with VE from the examiner ("go-go or faster-faster") every 60 s during the final levels of students' run.

Based on the number of levels that students were able to achieve, their potential maximum oxygen uptake (VO_{2max}) was determined. The formula to estimate VO_{2max} in adults is VO_{2max} = 31.025 + 3.238 X − 3.248 A + 0.1536 AX, in which X = speed at the last stage in km/h and A = Age in years [30]. Students' internal load (heart rate) and distances were measured by Polar Team Pro Sport (Polar, Kempele, Finland). The system combines high-precision GPS-derived movement data, inertial sensor metrics, and integrated heart rate monitoring into a wearable tracking system. The key parameters of the system have been validated successfully by Giersch *et al.* [31]. A high degree of reliability was found between VO_{2max} measurements for all students. The average measure of the intraclass correlation coefficient (ICC)was 0.907 with a 95% confidence interval from 0.881 to 0.927 (F (392,392) = 11.358, $p < 0.001$). The Spearman correlation was run to examine the relationship between VO_{2max} and maximum heart rate There were significant correlations in measurement without stimuli r_s = 0.56, n = 397, $p < 0.001$, and with verbal encouragement r_s = 0.5, n = 397, $p < 0.001$.

2.2 Methods of Processing and Evaluation of Research Data

Data analysis was performed using the statistical program IBM SPSS Statistics 21 (IBM Corporation, Armonk, NY, USA). The standard deviation (SD) and mean were used to present the measurements' results. The Shapiro-Wilk test for normality was used on all variables. The data showed a non-normal distribution in all selected parameters. Wilcoxon signed-rank test was employed to find differences between distance covered and heart rate with and without VE in the beep test in PAS and NAS. A comparative group analysis between PAS and NAS was performed by the Mann-Whitney U Test. The level of significance was set at $p \leq 0.05$. To interpret the practical significance of the research results, the effect size (ES) was reported. McLeod [32] defined effect sizes r = 0.1 to 0.3 as small, r = 0.3 to 0.5 as medium, and r = 0.5 to 1.0 as large, with no effect for r < 0.1. The ES was calculated by the following formula: $r = Z/\sqrt{N}$ (r: effect size; *Z*: *Z* value; N: observation number).

3. Results

All students together, NAS and PAS groups achieved a significantly higher distance covered (m) and maximum oxygen uptake during the endurance beep test (Figs. 1,2,3) after applying the VE stimulus compared to WS.

All students and the PAS group also significantly increased the maximal heart rate (beats per minute—BPM) during the execution of the beep test with VE compared to WS. However, there was no significant difference in this variable between stimuli in the NAS group (Table 1). Small effect size was found in all measured variables. A between-group (NAS and PAS) comparative analysis of changes in performance did not show any statistical differences in the distance covered, the maximum heart rate, and VO_{2max}.

4. Discussion

The purpose of the study was to determine the effect of VE on physically active and non-active university students. The main findings of this research were that both groups of students significantly improved in all selected parameters (maximum heart rate, distance covered, and VO_{2max}) after applying VE compared to without VE. The exception was the non-active student group, where the maximum heart rate did not change significantly. It could happen that the NAS achieved or were close to their actual maximal heart rate in both measurements and that they used different physiological factors like oxygen intake and uptake, stroke volume, and VO_2 plateau to improve their performance [33], and also a psychological factor could affect students final performance [34]. These results confirm the first hypothesis. From the statistical comparison of changes in NAS and PAS groups, we can report no significant difference in performance, which does not correspond with the second hypothesis. VE had a similar beneficial effect for both groups of students, and therefore, the fact that students are physically active or inactive in their free time does not significantly influence the result of the stimulus, but it influences their performance when PAS performed better than NAS in terms of maximal distance covered and achieved higher VO_{2max} in both measurements with VE and WS.

A comparison of the VE impact on different participants was done by Hassel [35], who divided 20 subjects into four groups: male trained, male untrained, female trained, and female untrained, and did not find any positive changes in the Wingate test after applying VE. This result could be influenced by the duration of the Wingate test because the participants may be already motivated at the beginning of the test. The duration of the beep test is longer, and there is a greater demand for motivation. Therefore, there is more space to positively encourage the probands. Other authors [19, 22, 26, 36] mentioned in their studies that the influence of VE on endurance performance might be greater when examining non-athletes because they have limited experience of undergoing maximally all-out tests. Athletes may not need external motivation to improve their performance, and, therefore, the stimulus might not be strong enough for them. In this study on non-athletes, it is demonstrated that VE positively influences students with more experience with sports, just as NAS.

In the study of Moffatt *et al.* [22], significant improvements in VO_{2max} (4.68%) and maximum heart rate (1.68%) were found during maximal treadmill tests by the non-athlete group after applying VE. This was also confirmed in Neto's research

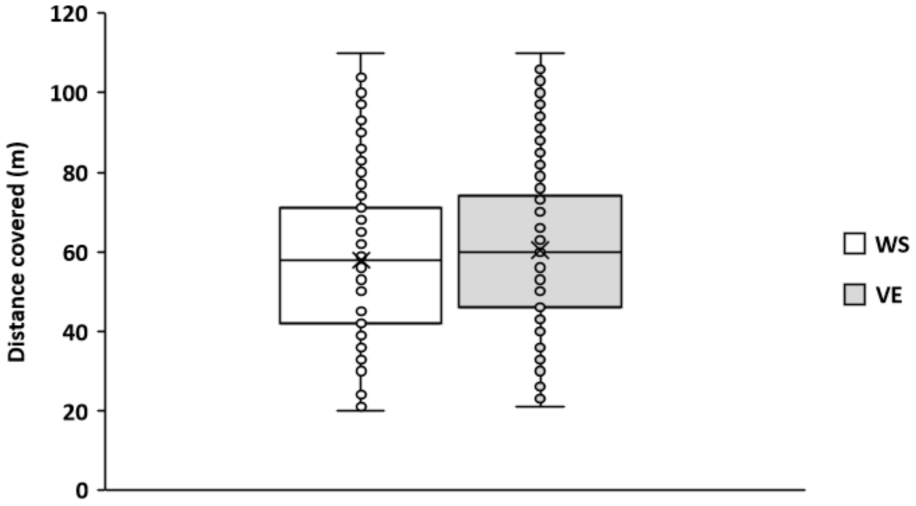

FIGURE 1. The distance covered (m) during the beep test without stimulus (WS) and with verbal encouragement (VE) in ALL students.

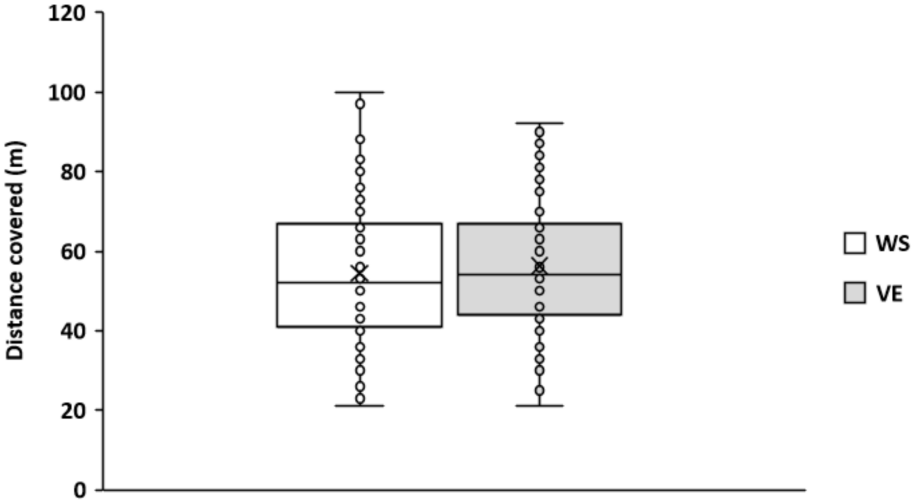

FIGURE 2. The distance covered (m) during the beep test without stimulus (WS) and with verbal encouragement (VE) in physically non-active students.

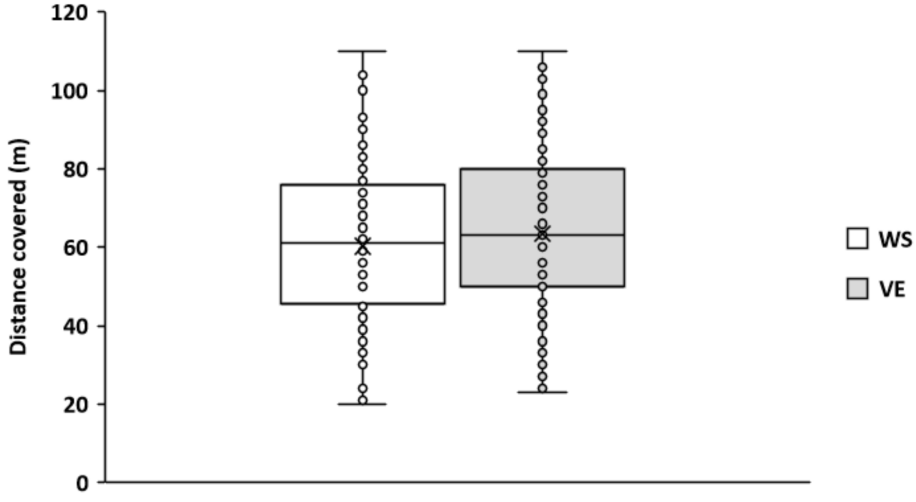

FIGURE 3. The distance covered (m) during the beep test without stimulus (WS) and with verbal encouragement (VE) in physically active students.

TABLE 1. Analysis of data for the selected fitness variables from beep tests with and without verbal encouragement (VE).

Fitness Variables	Testing WS		Testing with VE		Percentage of change (%)	*p* Value	Effect Size	*Z* Value
	Mean/Median	SD	Mean/Median	SD				
All students								
Distance covered (m)	802.3/800.0	340.90	849.6/820.0	362.00	5.57	0.0001	r = −0.17	−4.666
Maximum heart rate (BPM)	197.3/198.0	8.54	198.3/199.0	8.38	0.51	0.0010	r = −0.12	−3.438
VO_{2max} (mL/kg/min)	32.3/32.5	6.26	33.2/33.0	6.55	2.65	0.0001	r = −0.16	−4.593
Non-active students								
Distance covered (m)	736.3/680.0	305.50	770.5/720.0	315.20	4.44	0.0130	r = −0.14	−2.447
Maximum heart rate (BPM)	198.3/199.0	7.85	198.4/199.0	7.99	0.08	0.1880	r = −0.07	−1.317
VO_{2max} (mL/kg/min)	31.1/30.3	5.69	31.8/31.0	5.77	1.98	0.0140	r = −0.14	−2.453
Physically active students								
Distance covered (m)	849.0/840.0	357.00	909.2/880.0	385.00	6.62	0.0001	r = −0.18	−4.003
Maximum heart rate (BPM)	196.6/197.0	8.93	198.2/199.0	8.64	0.80	0.0010	r = −0.16	−3.435
VO_{2max} (mL/kg/min)	33.1/33.3	6.51	34.2/34.0	6.87	3.07	0.0001	r = −0.18	−3.945

SD = Standard deviation; WS = without stimulus; VE = verbal encouragement; Percentage of change = % difference between testing with VS and WS; BPM = beats per minute.

[24] on young male volunteers who significantly increased in endurance performance (VO_{2max} 5.14%, $p = 0.009$, distance covered 9.23%, $p = 0.03$, and final heart rate 3.21%, $p = 0.03$) in the 20 m shuttle run after applying VE. These values correspond with the results of this study regarding distance covered and VO_{2max}, but their studies recorded a higher increase in maximum heart rate. This could happen because of physiological limitations in mostly physically non-active students. Similar results were also achieved by Andreacci [26] in the groups of non-athlete university students who got VE during maximal testing on a treadmill at 20 and 60 seconds intervals, but the results of groups that did not get VE and which received infrequent encouragement every 180 seconds were not significantly different from the first test to the second test. VE intervals of every 60 seconds were also used by Neto [24] and in this study, so the frequency of stimuli during testing is an important factor in increasing their motivation and effort.

Generally, the physically active students achieved better results than the non-physically active students in all selected parameters. This could have happened because of the relationship between PAS and sports and their internal motivation to achieve the best results. In this case, a small stimulus can influence their performance near their peak. NAS, on the other hand, are likely to have low motivation to perform well, and VE could assist them in achieving better results and maximizing their performance and potential. This finding can help physical education teachers to understand which stimuli and how much they influence the student's motivation and effort during an endurance test.

The main limitations of the study were that students had not done maximal testing on treadmills, which would increase the validity and reliability of testing, and the measurement had been done in outside conditions. The beep test was chosen because it has many advantages from a practical point of view in a physical education environment. A large group of students can perform in a relatively small area at the same time with minimal cost and equipment compared to testing on a treadmill. Students can be more motivated during the execution of the test because they run at the same speed next to each other, so it is more competitive for them, and the teacher can better approach and encourage students anytime during the test. Lastly, the test continues at maximum effort, unlike many other tests of endurance capacity. A further limitation of this study is that the testing could have been influenced by students' exams or other university duties, which can increase stress on them during the academic year. The next limitation is that the sample size in each group was different, which could have also influenced the final results and it is also questionable

whether it is possible to attest that the VO_{2max} measured is a real maximal value. The verification phase might be a solution to the problem [37], but from a practical point of view, the beep test in this form is still used in the determination of VO_{2max} in physical education classes [38].

In future studies, it would be interesting to apply different kinds of stimuli or their combinations. The effects of goal-oriented or group competition stimuli may be used in future research. Moreover, it would be interesting to apply this kind of research just to women and compare the results with this study.

5. Conclusions

These findings demonstrate the positive effect of VE compared to testing without any verbal stimuli on the distance covered, VO_{2max}, and maximum heart rate of male university students. A comparison of physically active and non-active students showed similar improvements in both groups of students. VE positively influenced students' performance, and therefore, this stimulus could be used by physical education teachers to increase students' effort, motivation, and final results during maximal aerobic testing. The study shows the importance of using VE as a stimulus for achieving more objective results for PAS and NAS and that there is not a significant difference in response to this stimulus between these groups during the beep test.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

MP—designed the research study; performed the research; analyzed the data; wrote the manuscript; contributed to editorial changes in the manuscript; read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The procedures followed the ethical standards on human experimentation stated in compliance with the 1964 Helsinki Declaration and its later amendments. The project was approved by the ethics committee of the Deanship of Scientific Research at King Fahd University of Petroleum and Minerals in Dhahran (SB181037; 14 February 2020).

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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