ORIGINAL RESEARCH ARTICLE

The 'Talk Test' as a simple marker of ventilatory threshold

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Abstract

Objective. Endurance training prescriptions are often based on laboratory measurements of physiological reference points, such as the ventilatory threshold (VT). This study evaluated the relationship between a simple surrogate of the VT, the Talk Test (TT), and objective measures of VT in well-trained individuals.

Design. This was a comparative study of the oxygen consumption (VO_2) in reference to TT, VT and respiratory compensation threshold (RCT). Well-trained adults (N = 16) completed a habituation session, and two maximal exercise tests. One test used gas analysis to identify VT and RCT. During a second, identical protocol (during which we assumed an identical metabolic response), at the end of each exercise stage, subjects read a standard paragraph and reported their ability to speak comfortably. The VO_2 at VT, RCT, and the last positive, equivocal, and negative stage of the TT were compared.

Setting. A university-based research laboratory.

Results. There were no significant ($P < 0.05$) differences between the VO_2 at VT (2.79 ± 0.68 l/min) and either the last positive (2.46 ± 0.78 l/min) or equivocal (2.79 ± 0.86 l/min) stages of the TT or between RCT (3.38 ± 0.81 l/min) and the negative stage of TT (3.42 ± 0.84 l/min).

Conclusions. When subjects can speak comfortably they are exercising at intensities below VT. Subjects clearly unable to speak comfortably were exercising at or beyond RCT.

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Introduction

In order for athletes to achieve their competitive goals, they must train at an appropriately high intensity to provoke maximal training adaptations.[2,5,11,13,17,20,24] However, they must also train easily enough on recovery days to allow regeneration prior to the next hard training bout.[13] Recent evidence has suggested that athletes have difficulty matching the training prescriptions prepared by professional coaches, particularly the training intensity.[16] Athletes typically train at too high an intensity on coach-designated 'recovery' days, and at too low an intensity on coach-designated 'hard' days. This suggests, perhaps, that strategies for monitoring and controlling training intensity need to be augmented. The discontinuity of linearity in either lactate accumulation or the ventilatory pattern during incremental exercise represents a marker that has proved to be convenient for controlling the intensity of exercise training.[1,3,8,17,20,21,24,25] Training prescriptions based on these discontinuities are well tolerated and are widely used for controlling the training of endurance athletes. In particular, identifying the heart rate associated with the lactate threshold (LT) or ventilatory threshold (VT) provides an easy-to-administer approach to controlling training. Although the power output at the LT and/or VT change significantly with improvement in conditioning, there is apparently little change in heart rate or rating of perceived exertion (RPE).[7] Therefore, a single well-done training prescription based on physiological thresholds may be quite stable.

However, evaluating LT is often confusing due to the many criteria that have been used, including fixed lactate concentrations of 2.0 mmol/l, 2.5 mmol/l, and 4.0 mmol/l.[9] Relative criteria have also been used, such as the breakpoint of the lactate intensity curve, 1 mmol/l above resting concentration, 1 mmol/l above the exercise baseline, or maximal lactate steady state, and surrogates of power output based on attempts to define the maximal lactate steady state.[1,9,10,25] Although each of these methods has been shown to have high levels of validity and reliability, their very number often proves to be more confusing than helpful.

VT, which has relatively more consistent diagnostic criteria than blood lactate-based strategies, has been shown to be well correlated with LT,[8,19] although there is controversy regarding whether VT and LT are really measuring the same thing.[17] Nevertheless, VT is well related to endurance performance,[22,23] is well documented as an effective intensity for exercise training,[6,17] and is convertible to easy-to-monitor techniques such as heart rate or perceived exertion.

The Talk Test (TT) or the ability to converse comfortably during exercise, has been suggested as a marker for gauging exercise intensity for many years.[3] Since high levels of ventilatory control are necessary for comfortable speech, the TT represents a reasonably common-sense surrogate of the VT. In non-athletic individuals, the TT has been shown to be associated with exercise intensities within conventional 60 - 90% maximal heart rate guidelines,[3] and has been shown to be highly correlated with VT in healthy students,[8] healthy adults,[23] and patients with stable cardiovascular disease.[25] Presuming that reasonably tight control of exercise training intensity in more athletic individuals is desirable,[2,13,14,24] the TT would appear to be a potentially attractive tool, because of its simplicity. Accordingly, the purpose of this study was to extend our previous observations by evaluating the relationship between the TT and VT in well-trained individuals.

Materials and methods

Subjects

Sixteen well-trained individuals volunteered to participate in this study. On average (± standard deviation (SD)) they were 22.8 (± 8.2) years old, 68.3 (± 13.7) kg in weight, and 172.5 (± 9.5) cm tall. All were regular exercisers who participated in a minimum of 6 hours of endurance exercise per week. About half of the subjects were active in recreational level sports and trained systematically (runners or triathletes), while the remainder exercised as part of a personal fitness programme. All subjects provided informed consent, and the protocol was approved by the University of Wisconsin-La Crosse Ethics Committee.

Methods

Each subject reported to the lab three times, including a habituation session, an oxygen consumption (VO_2) peak/VT session and a TT session. Exercise was performed either on the mill (N = 10) or cycle ergometer (N = 6) according to the training habits of the subject. Testing sessions were separated by a minimum of 48 hours. Subjects were asked to maintain a constant dietary pattern and to avoid heavy exercise and stimulants for 24 hours prior to testing. None of the subjects were smokers.

The habituation session was intended to make the subjects comfortable with the respiratory apparatus and (for runners) with treadmill running, and to allow an estimation of reasonable starting velocities. During the first testing session, each subject was required to perform maximal incremental exercise with continuous measurement of respiratory gas exchange using open circuit spirometry (Quinton Q-Plex, Seattle, WA, USA, with calibration gases verified by micro-Scholander). The VT and respiratory compensation threshold (RCT) were identified using the V slope technique.[22] The initial workload was individualised based on results from the habituation session to a velocity associated with a Rating of Perceived Exertion (RPE) of 2 (e.g. 'easy') on the category ratio (0 - 10) RPE scale. For treadmill running, the increments between the 3-minute stages included an increase in velocity of 0.22 m/s until a RPE of 4 (e.g. 'somewhat hard') had been reached. Thereafter, the incline of the treadmill belt was increased 2% every 3-minute stage, until the subject became fatigued. For cycle ergometry, exercise was performed on an electrically braked ergometer (Lode, Groningen, The Netherlands) with a freely chosen pedal cadence in the range of 60 - 80 rpm. Exercise was begun at 30 and 40 Watts and incremented by 30 and 40 W per 3-minute stage for females and males, respectively.

On another day, an identical exercise protocol was completed without use of the respiratory apparatus. We made the assumption that the pattern of increase in metabolic variables was identical to the test during which respiratory metabolism was measured. Given the well-established reliability of the metabolic and haemodynamic response to incremental exercise, we felt that this was a conservative assumption. In order to provide a standardised stimulus for the TT, subjects were asked to recite the 'Pledge of Allegiance' during the last 30 seconds of each stage. This is a 31-word paragraph that is widely familiar to most people in American culture. Additionally, a cue card was available to prompt the subjects should they not know this paragraph from memory. Immediately following recitation of the standard paragraph, the subject was asked 'can you still speak comfortably?', to which they had the option of answering 'yes' (positive), 'I'm not sure' (equivocal), or 'no' (negative). This strategy for classifying stages of the TT is similar to other studies from our laboratory.[8,23,24] The last stage at which the subject could still unequivocally speak comfortably was taken as the last positive stage of the TT. The first time the subject was not entirely certain about speaking comfortably was taken as the equivocal stage, and the first time that s/he definitely could not speak comfortably was taken as the first negative stage.

Statistical analysis

Repeated measure analysis of variance (ANOVA) was used to evaluate differences between temporally matched responses of VT, RCT, and the three indices of the TT. When significant ($P < 0.05$) differences were found, a least significant difference (LSD) *post hoc* test was used. Product moment correlations were used to support conclusions drawn from the primary ANOVA analysis.

Results

The characteristics of the subjects are presented in Table I. Although the subjects were not high-level competitive athletes, their well-trained status is reflected by their high VO_2 peak relative to age and gender-predicted values.

TABLE I. Mean (± SD) characteristics of the subjects during exercise

Variable	Men (N = 9)	Women (N = 7)	Total (N = 16)
VO_2 peak (l/min)	4.00 ± 0.67	2.78 ± 0.37	3.47 ± 0.83
VO_2 peak (ml/kg/min)	54.1 ± 10.9	46.6 ± 5.6	50.8 ± 9.5
% of Predicted VO_2 peak	118.2 ± 13.3	114.4 ± 13.3	115.4 ± 12.9
Maximum HR (bpm)	188 ± 14	193 ± 6	190 ± 12
VT (% of VO_2 peak)	78 ± 9	81 ± 3	80 ± 7
RCT (% of VO_2 peak)	97 ± 2	97 ± 5	97 ± 2

VO_2 = oxygen consumption; HR = heart rate; VT = ventilatory threshold; RCT = respiratory compensation threshold; bpm = beats per minute.

There was no significant ($P < 0.05$) difference between the VO_2 at VT (2.79 ± 0.68 l/min), the last positive (2.46 ± 0.78 l/min), and equivocal (2.79 ± 0.86 l/min) stages of the TT (Fig. 1). The VO_2 at the negative stage of the TT (3.42 ± 0.84 l/min) and the RCT (3.38 ± 0.81 l/min) were significantly different from all other indices, but not from each other. The VO_2 at VT was well correlated with the VO_2 at the last positive ($R^2 = 0.85$), equivocal ($R^2 = 0.91$) and negative ($R^2 = 0.97$) stages of the TT (Fig. 2), the data for the VT versus equivocal stage of the TT fitting very close to the line of identity. The VO_2 at the RCT was well correlated with the VO_2 at the last positive ($R^2 = 0.84$), equivocal ($R^2 = 0.87$) and negative ($R^2 = 0.99$) stages of the TT, with the data for the RCT versus negative stage of the TT fitting very close to the line of identity (Fig. 3).

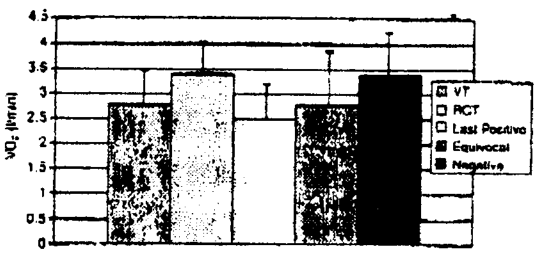

Fig. 1. Mean (± SD) values for VO_2 at the VT and RCT in relation to the VO_2 at the various stages of the TT. Note that the last positive and equivocal stages of the TT are both very similar to the VT.

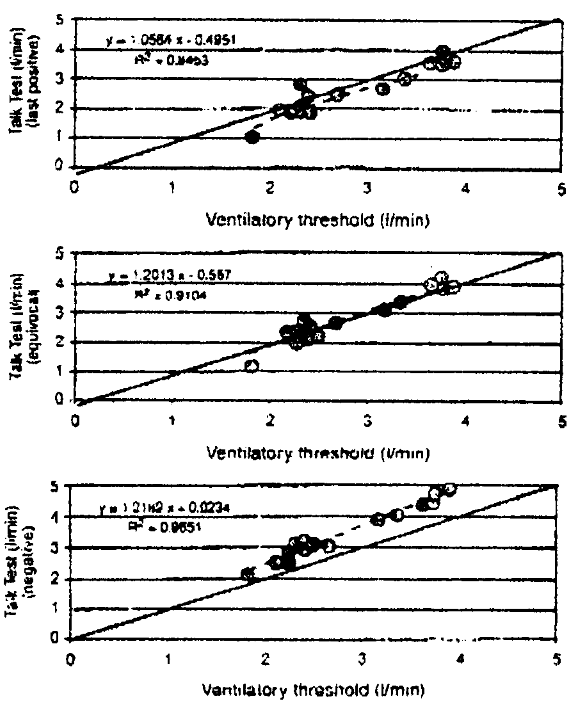

Fig. 2. Comparison of the VO_2 during the TT with the VO_2 at the VT. Note that the equivocal stage of TT is very similar to VT, while the last positive stage is somewhat lower and the negative stage is significantly greater, although the correlation is high for all three relationships.

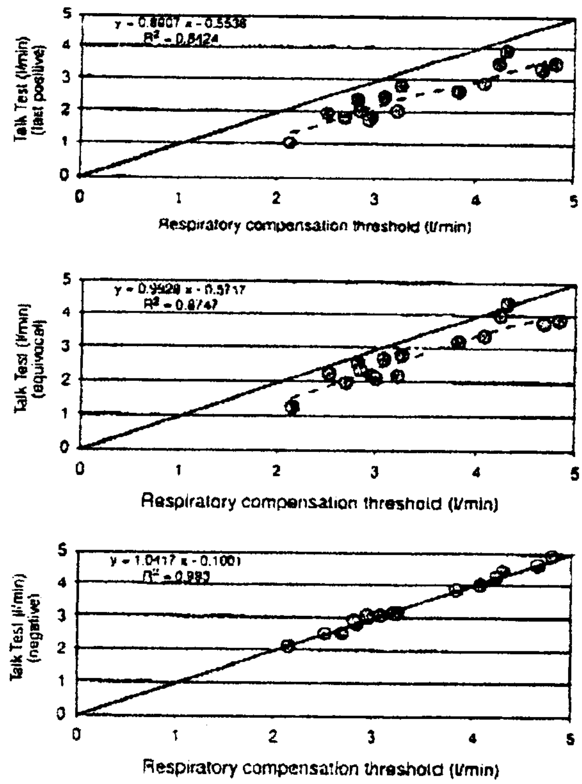

Fig. 3. Comparison of the VO_2 during the TT with the VO_2 at the RCT. Note that the negative stage of TT is very similar to the RCT, while the last positive and equivocal stages are significantly less, although the correlation is high for all three relationships.

Discussion

The results in this group of well-trained subjects demonstrated that the TT can be used as a representation of exercise intensities around VT and RCT, which is similar to our findings with moderately active university students,[8] sedentary adults,[13] and patients with stable cardiovascular disease.[28] Analyses of the data led to the following conclusions. First, the ability to speak comfortably (last positive stage of TT) is consistently observed at exercise intensities below VT. Second, the first sign of uncertainty in the ability to speak comfortably (equivocal stage of TT) is representative of exercise intensities very close to the VT. Third, the exercise intensity associated with a clear inability to produce comfortable speech (negative stage of TT) is representative of the RCT.

The present data, along with prior studies from our laboratory,[8,23,28] demonstrate consistent findings with regard to the last positive and negative stage of the TT in relation to VT. The last positive stage is consistently below VT and the negative stage is consistently beyond VT. The equivocal stage of the TT is not as consistent, sometimes measured significantly beyond VT, but still reinforces the pattern of increased difficulty in speaking due to the increase in ventilation.

In the 1960s, Hollman[18] and Wasserman and McIlroy[27] independently demonstrated a relationship between alterations in gas exchange at VT and an initial increase in arterial lactate values (i.e. LT). Results from a number of studies[9] suggest that changes in lactate accumulation and changes in ventilatory pattern occur at approximately the same exercise intensity. However, other data have demonstrated that LT and VT can differ under certain conditions and should not be used interchangeably.[4] Uncoordinated shifts in LT and VT have been seen after endurance training,[17] glycogen depletion,[19] and in patients with McArdle's syndrome.[16] Nevertheless, both LT and VT are known to be effective predictors of prolonged endurance performance and both have been shown to be useful prescriptively.

There were some technical issues which might have influenced the interpretation of our results. The methodology required two testing sessions to obtain information regarding VO_2 at VT, RCT and TT, as it was impractical to perform the TT while wearing the respiratory apparatus. In order to address this issue, the heart rate during the two tests at the same exercise stage were compared, and demonstrated a high correlation (r = 0.98) and a narrow scatter around the line of identity. These data suggest that the requirement of performing two exercise procedures did not introduce a bias into the present results. Secondly, the measurements of TT were limited to the last 30 seconds of each 3-minute stage. Although many individuals experience the inability to speak as a loss of ability to carry on a conversation during exercise training, we felt that the requirement to recite a standard paragraph at frequent intervals was more likely to be a consistent method for provoking speech than inducing a conversation. Others have applied strategies for provoking a more conversational pattern of speech,[3] with results substantially similar to those obtained using our approach. We have also used a longer (~100-word) paragraph as a provocative tool, with results similar to the 31-word paragraph used in the present trial.[8,23] Lastly, although the subjects in this study were quite well-trained, they were not high-level athletes. It may be that extrapolation of the present results to the training of serious athletes is not justified. However, the consistency of our results across various populations[8,21,23] suggests that the relationship between the TT and ventilatory markers of exercise intensity is somewhat generalisable.

Conclusions

In summary, the present study has compared the TT as a surrogate of the VT as a strategy for controlling endurance training intensity. The results support our hypothesis, that the VT and equivocal stage of TT occur at a similar VO_2 during incremental exercise. We interpret these data as suggesting that the TT may be used as a simple and non-invasive method by which to gauge exercise intensity during endurance training that is substantially comparable to the VT. Accordingly, it seems reasonable to suggest that the use of the TT may provide an adjunctive technique for controlling the intensity of training in well-trained individuals.

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