UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

MEASURING THE TALK TEST AS A CONTINUOUS AS OPPOSED TO A CATEGORICAL VARIABLE

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science

Joel T. Dubiel

College of Science and Health
Clinical Exercise Physiology

December, 2014

MEASURING THE TALK TEST AS A CONTINUOUS AS OPPOSED TO A CATEGORICAL VARIABLE

By Joel T. Dubiel

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science in Clinical Exercise Physiology.

The candidate has completed the oral defense of the thesis.

Carl Foster, Ph.D.
Thesis Committee Chairperson — Date: 5/15/14

John P. Porcari, Ph.D.
Thesis Committee Member — Date: 5/15/14

Richard Mikat, Ph.D.
Thesis Committee Member — Date: 5/15/14

Thesis accepted

Steven Simpson, Ph.D.
Graduate Studies Director — Date: 6/12/14

ABSTRACT

Dubiel, J.T. Measuring the talk test as a continuous as opposed to categorical variable. MS in Clinical Exercise Physiology, December 2014, 48pp. (C. Foster)

The TT (Talk Test) has been a useful tool when prescribing exercise intensity. It has been shown to have significant relationship to the Ventilatory Threshold (VT) and Respiratory Compensation Threshold (RCT). There however have been no studies that have directly measured the perception of speech difficulty while performing the TT. The purpose of this study was to measure the perception of speech difficulty as a continuous variable (Visual Analogue Scale) and comparing it to the TT measured as a categorical variable (yes, yes/no, no). Twenty ($n = 20$) physically active volunteers participated in three incremental maximal exercise tests on an electronically braked bicycle ergometer. Exercise tests were performed in a counterbalanced order with the same protocol (25W + 25W/2 min) until fatigue. The results found that females perceived speech difficulty higher than males using the VAS with a significant difference ($p < .05$) at the Last Positive (LP), Equivocal (EQ), and Negative (NEG) stage of the TT. The main finding of the study was that perception of speech difficulty increased with exercise in a curvilinear fashion.

ACKNOWLEDGEMENTS

First, I would like to thank my thesis chair and professor, Carl Foster. Thank you very much for being patient with me. It was such a pleasure to work with a very intelligent and determined individual.

I would also like to thank John Porcari and Kristi Cadwell for everything the both of you did for us over the course of this very short year. It has been a true gift to have come through this program and meet two individuals that have such a strong passion for this field. Also thank you to Dr. Mikat for being on my thesis committee and assisting me with my statistics.

In addition I would like to thank my classmates. You guys are the best and there is no other group of individuals that I would want to spend this year with.

Finally, I would like to thank my family for being such a strong support system for me over the years when times were tough and understanding when I was unable to make it home. Most of all thank you Mom, you were always the one that was there for me over the years and you never let me give up on my dreams. Love you to the stars and back.

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

FIGURE PAGE

LIST OF APPENDICES

INTRODUCTION

In order to prescribe exercise to an individual there are four variables to consider, Frequency, Intensity, Time, and Type (F.I.T.T). The American College of Sports Medicine (ACSM, 2013) has guidelines for all four of these variables and has specific recommendations for each. However, prescribing exercise intensity can still be quite difficult. According to the *ACSM's Guidelines for Exercise Testing and Prescription*, adults should work at a moderate to vigorous work load intensity or 60-90% of their Heart Rate Reserve (HRR). This prescription for exercise intensity can be difficult to adhere to due to the wide range of percent values that it offers and the requirement for a maximal exercise test.

There are, however, alternative subjective methods of measuring exercise intensity that have become popular including the Rating of Perceived Exertion Scale (RPE) (Borg, 1998) and the Talk Test (TT).The RPE scale has been used in a variety of ways to understand exercise performance and intensity and has become accepted in the field of exercise physiology (Eston, 2012). Though the TT is not currently included in the ACSM guidelines, there is now a considerable amount of research on the TT with evidence supporting the validity of the test (Brawner et al. 2006; Cannon et al. 2004; Dehart-Beverly, Foster, Porcari, Fater, & Mikat, 2000; Foster et al. 2008; Foster et al. 2009; Jeans, E. A., Foster, C., Porcari, J. P., Gibson, M., & Doberstein, S 2011; Persinger, R., Foster, C., Gibson, M., Fater, D. W., & Porcri, J. P. 2004; Recalde et al. 2001; Rodriguez-Marroyo, J. A., Villa, G., Garcia-Lopez, J.G., & Foster, C. 2012; Voelker et al. 2001).

The TT emerged in 1937 when Professor Joseph Henry Grayson suggested to British mountaineers that they "climb no faster than you can talk" (Goode, R. C., Mertens, R., Shaiman, S., & Mertens, J, 1998). Grayson's theory sparked a substantial number of studies testing his theory, seeing if the TT is a useful method of testing prescribing intensity. Through the research on the TT, different variations and protocols have emerged testing the reliability and validity of the TT. One variation is the counting TT which was used by Loose et al. (2012) and Norman, J, Hopkins, E, & Crapo, E (2008). Loose et al. (2012) had subjects count normally at rest to as high a number as possible, until they were forced to take a breath. This number provided a target number for the subjects to count to while exercising. They then would count during exercise as high as they could. Based on the percentage for the "resting count" they were able to figure out individual exercise intensity. This same protocol was done by Norman et al. (2008). He found the counting TT to be valid when "estimating both the upper and lower exercise ranges needed to gain cardiorespiratory fitness benefits."

This theory of talking while exercising, that Professor Grayson had suggested had its skeptics who wondered how physiologic response was affected by speech production. Meckel, Y, Rotstein, A, & Inbar, O (2002) found that there were no substantial differences between talking while exercising and being silent for heart rate (HR), inspiratory time, and tidal volume. It does however lower total ventilation and oxygen uptake, and increase lactate accumulation and blood pressure.

The TT has been used as a tool to measure exercise intensity in a variety of different populations, including healthy individuals (Dehart-Beverly et al, 2000; Foster et al, 2008; Jeans et al, 2011; Persinger et al, 2004) sedentary individuals,(Foster et al,

2009) cardiac patients, (Brawner et al, 2006; Cannon et al, 2004; Voelker et al, 2002) and well-trained individuals (Recalde et al, 2002; Rodriguez-Marroyo et al, 2012). There have also been different ways to measure the validity and reliability of the TT. Foster et al. use a categorical protocol of defining the TT. When the subject is nearing the end of the stage they are asked to recite a passage. After they recite the passage the investigator asks "can you speak comfortably?" If they are able to speak comfortably they are in a positive (+) stage. If they are unsure (about speaking comfortably), then they are in the equivocal stage (+/-), and if they definitely can't speak comfortably, then they are in the negative stage (-). An alternative method that would help assess the validity and reliability of the TT would be a continuous rating of speech difficulty using a Visual Analogue Scale (VAS). The VAS has been used to measure an individual's perception of many different things, such as categories of physical fitness (Stroyer et al., 2007), fatigue (Lee, K, Hicks, G, & Nino-Murcia, G., 1991; Nijs, J, Zwinnen, K, Meeusen, R, De Geus, B, & De Meirleir, K., 2007), stress response (Ritvanen, T, Louhevaara, V, Helin, P, Halonen, T, & Hänninen, O., 2007), and exercise workload (Capodaglio, E., 2001).

The purpose of this study was to evaluate whether or not the Talk Test can be measured using a continuous rather than a categorical method. This project evaluated and compared the values of exercise intensity, heart rate, and Rating of Perceived Exertion (RPE), when the Talk Test was being performed. It was hypothesized that the two methods would be linear as the stages of the test increases and that there would be a close relationship between the (+/-) stage of the TT with ventilatory threshold (VT) and of the (-) stage of the TT with the respiratory compensation threshold (RCT).

METHODS

Subjects

The subjects for this study were 20 young adult volunteers (10 males and 10 females) from the University of Wisconsin-La Crosse. The goal was to get an even ratio of men and women for this study, within the age range of 18-24. All subjects were physically active and apparently healthy. Their descriptive characteristics are presented in table 1.

Table 1. Descriptive Characteristics of Subjects (mean $\pm$ SD)

	Males (N = 10)	Females (N = 10)
Age (yrs)	21.9 $\pm$ 1.6	21.0 $\pm$ 1.2
Height (cm)	183.1 $\pm$ 5.8	166.4 $\pm$ 4.4
Weight (kg)	78.8 $\pm$ 9.8	61.7 $\pm$ 4.3
VO_2 max (L/min)	4.0 $\pm$ 0.5	2.6 $\pm$ 0.2
VO_2 max (ml/kg)	50.8 $\pm$ 6.3	42.1 $\pm$ 3.2
VO_2 at VT (L/min)	2.6 $\pm$ 0.4	1.7 $\pm$ 0.4
VO_2 at RCT (L/min)	3.1 $\pm$ 0.3	2.2 $\pm$ 0.3
Peak Power Output (Watts)	265.5 $\pm$ 23.2	190.4 $\pm$ 18.4

Procedures

Each subject completed, in a counterbalanced order, a 1) VO_2 max test, 2) Categorical Talk Test and 3) Continuous Talk Test. All three tests were performed on an electronically braked cycle ergometer (Lode Excalibur, Groningen, NL). After performing a TT at rest, the test began at Power Output (PO) of 25 Watts (W) and increased 25W each two minutes, until the subject became fatigued. During the categorical Talk Test, subjects recited during the last 30 seconds of the stage the "Pledge of Allegiance" (a 31 word paragraph) and verbally respond on how comfortably they could talk (yes, yes/but, no) as well as identifying their RPE by pointing at a CR-10 Borg scale. The Continuous Talk Test used the same exercise protocol as the categorical; however subjects made a mark on a Visual Analogue Scale (VAS) on how comfortably they could talk rather than the principle investigator asking the question. The VAS is a 10 cm line with descriptive anchors on each end. The left end of the line represents completely comfortable speech. The right end of the line it represents unable to speak. After they finished the test, the data was analyzed by measuring the marks on the line relative of the subject's perception of how comfortably they could talk. The values that were compared and measured between the two protocols include: VT, RCT, heart rate, RPE, and VO_2 max.

RESULTS

All subjects completed all three tests. The data obtained showed that males had a higher Power Output (PO) than females in all different areas of the tests. This includes both the Gas Exchange and TT reference points, (Figure 1). As expected the PO max (227.9 ± 43.6W) during the Gas Exchange test was higher than the PO at RCT (181.6 ± 40.8W). Also the PO at RCT was higher than the PO at VT (135.7 ± 44.4W). The TT showed similar results with the PO max for the TT (233.7 ± 45.4W) was greater than the PO at TTNEG stage (185 ± 32.8W). The TT Equivocal (TTEQ) stage (160 ± 32.8W) was also higher than the TT Last Positive (TTLP) stage (133.8 ± 31.7W)

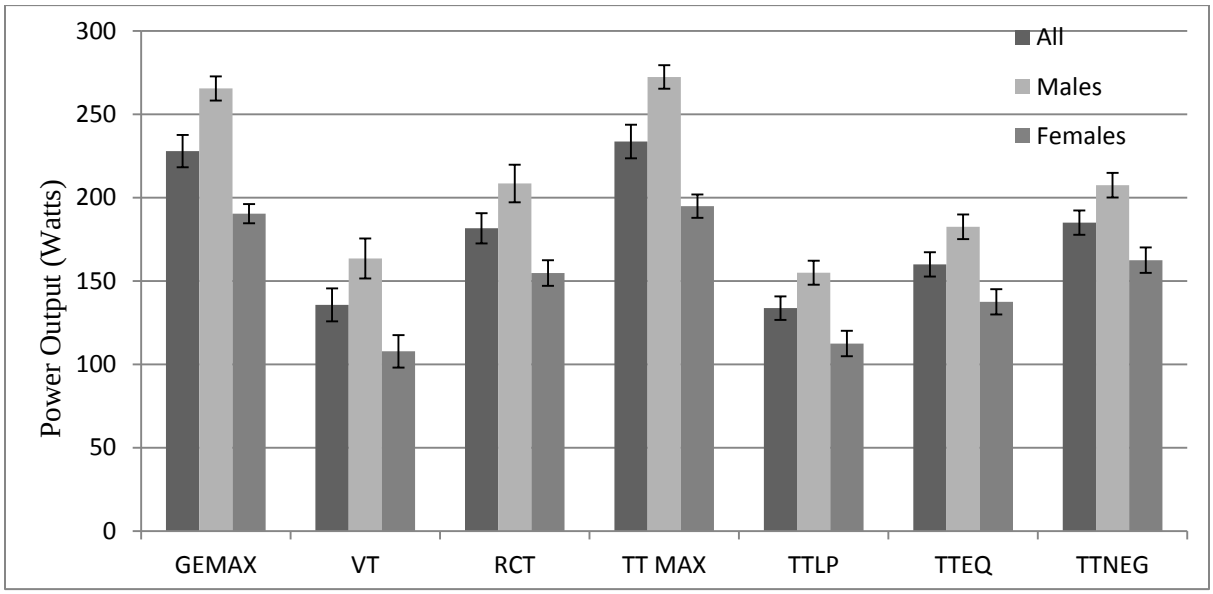

Figure 1. Comparison of Power Output for Gas Exchange and the Talk Test.

The VAS speech difficulty results are shown in Figure 2. As expected the average max score (MAX) (9.3 $\pm$ 1.1) was greater than the RCT score (6.6 $\pm$ 2.3) and the RCT score was greater than the score at VT (4.3 $\pm$ 2.3). The max score was also greater than all the sub-maximal level scores ((LP, EQ, and NEG) 3.8 $\pm$ 1.2, 5.1 $\pm$ 1.4, and 6.6 $\pm$ 1.7). Repeated measures ANOVA showed a gender difference in the VAS score relative to PO. The LP stage was 3.1 $\pm$ 0.6 vs. 4.6 $\pm$ 1.3, for men and women, respectively ($p < .05$). The EQ stage was 4.3 $\pm$ 1.1 vs. 5.8 $\pm$ 1.3 for men and women, respectively ($p < .05$). The NEG stage was 5.6 $\pm$ 1.4 vs. 7.5 $\pm$ 1.4 for men and women respectively ($p < .05$). At MAX there was no significant difference ($p > .05$) when comparing gender difference at that intensity.

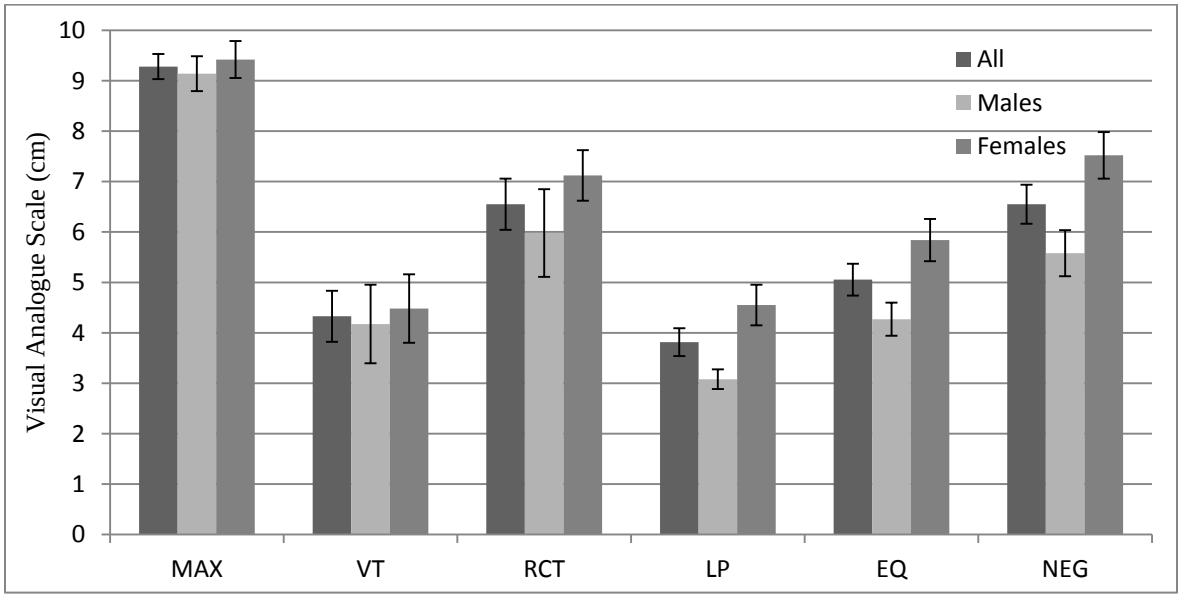

Figure 2. Comparison of the Visual Analogue Scale scores at max and sub-max levels

The comparison of RPE during the GE and TT is displayed in Figure 3. It showed expected results with the GEMAX (8.6 ± 0.9) having a greater RPE than RCT (6.0 ± 1.2) and RCT, having a greater RPE than VT (4.3 ± 1.3). The TTMAX RPE (9.2 ± .7) was greater than RPE at the sub-max levels ((TTLP, TTEQ, and TTNEG) 3.7 ± 1.0, 4.8 ± 1.2, and 6.1 ± 1.6).

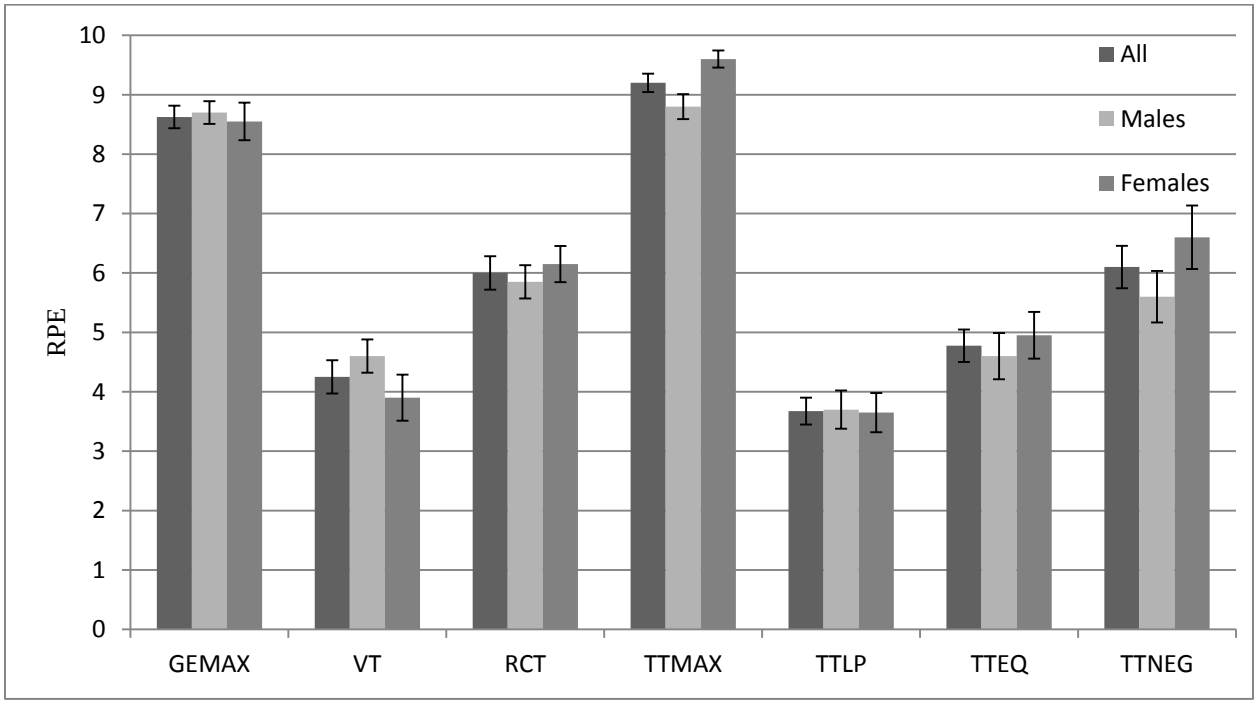

Figure 3. Comparison of Rating of Perceived Exertion between Gas Exchange and Talk Test

The percentage of the subject's heart rate reserve (%HRR) during the LP, EQ, and NEG stages of the TT was measured and compared to the RPE for the stages of the TT (Figure 4). At the LP stage %HRR was 59.9 ± 13.9% with an RPE of 3.9 ± 0.7. The EQ stage was 69.5 ± 13.9%HRR with an RPE of 5.2 ± 1.0. The NEG stage was 79.8 ± 12.2 %HRR with an RPE of 6.4 ± 1.5. The same %HRR was compared to the VAS scores for

each of the sub-maximal stages (Figure 4b). At the LP the VAS score was 3.8 ± 1.2. At the EQ the VAS score was 5.1 ± 1.4. At the NEG stage the VAS was 6.6 ± 1.7. The relationship of RPE and the VAS score are displayed in Figure 4c, showing a linear relationship.

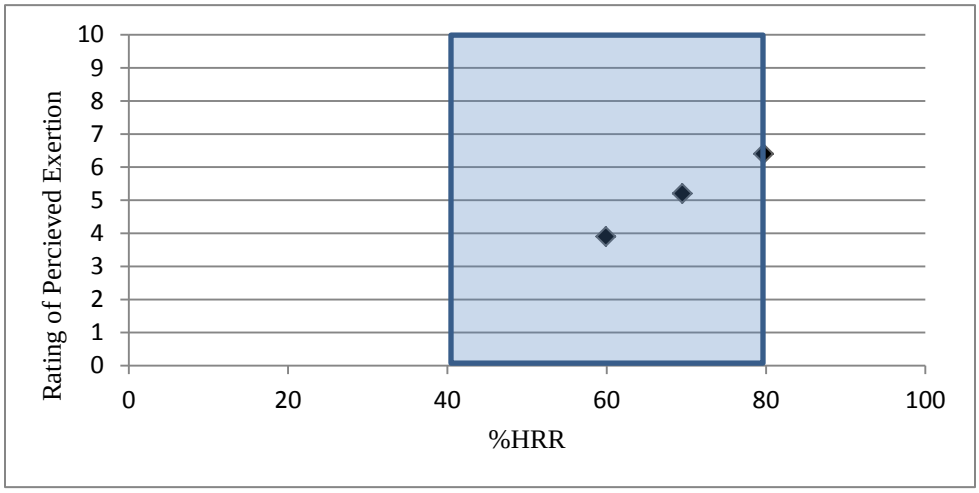

Figure 4a. % Heart Rate Reserve in comparison to Rating of Perceived Exertion

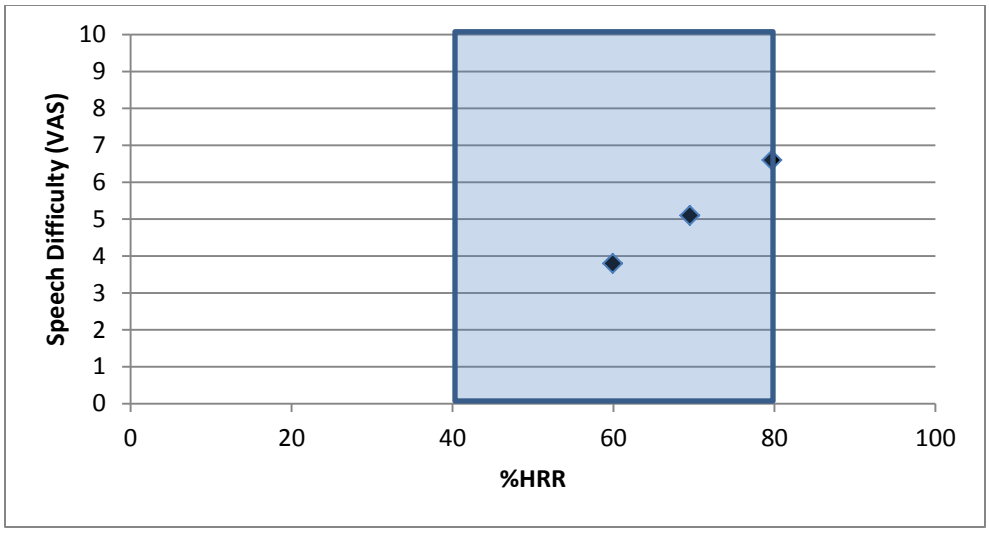

Figure 4b. % Heart Rate Reserve in comparison to Speech Difficulty (VAS)

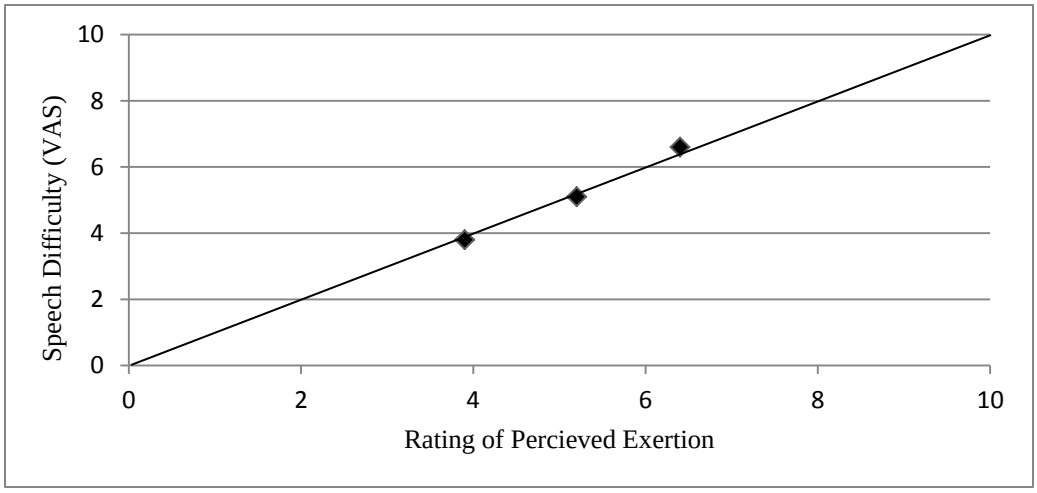

Figure 4c. The relationship between RPE and the VAS

Most strikingly the VAS for speech difficulty grew within TT categories (Figure 5). The VAS increased progressively across the + stage, reaching the EQ point at a VAS of 3.9. Between the LP and EQ point of the TT, the VAS grew from 3.9 to 5.2. Similarly, after the NEG point in the TT, the VAS for speech difficulty grew from 5.2 to 9.3 at exhaustion.

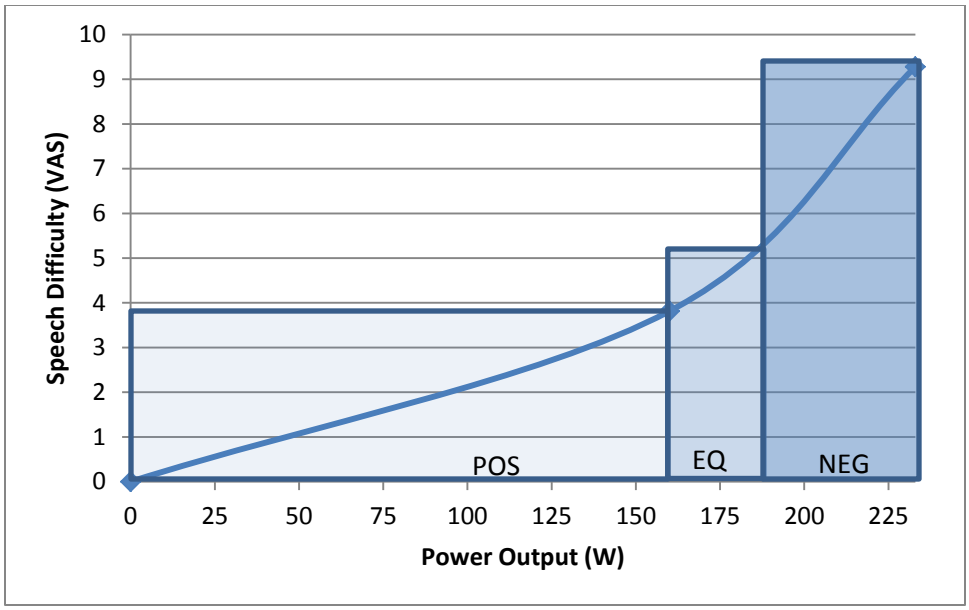

Figure 5. Comparison of the Visual Analogue Scale and Power Output vs. the Categorical Stages of the Talk Test (blocks)

DISCUSSION

The main finding of this study is that perceived speech difficulty, measured using the VAS scale increases continuously with exercise intensity. However, this leads to broad categorical responses when using the TT, which is designed for yes, maybe, no responses. The responses at perceived speech difficulty are broadly parallel to changes in RPE, and behave in a curvilinear pattern much as do lactate and pulmonary ventilation. Regardless of showing that perceived speech difficulty is actually a continuous variable, the categorical responses to the TT are still useful surrogates of continual and physiological responses such as VT and RCT.

The results from this study agree with previous data presented in our lab, (Persinger et al, 2004) which have shown that the VT has a close relationship to the LP and EQ stage of the TT. The data also agree that when a subject cannot speak comfortably (e.g. NEG stage of the TT) they were near the RCT (Rodriguez-Marroyo et al, 2012; Recalde et al, 2002).

Most research of the TT has found that the VT is more closely related to the EQ stage of the TT (Dehart-Beverly et al, 2000; Voelker et al. 2009). The VAS was used as a tool in a previous study (Capodaglio, 2001) to measure cardiorespiratory fitness in relation to the RPE scale. However there are no studies using the VAS that measure speech difficulty in subjects while performing the TT.

A primary concern with the study was the use of the VAS while exercising. Having subjects make a mark on a 10 cm line while exercising at maximal capacity

proved to be difficult in some situations. Another concern was that the population for this study was restricted to fit and healthy individuals. Further research needs to be done with the TT, while using the VAS to measure speech difficulty in different populations (sedentary, cardiac, and athletic). Another possibility for future research testing would to test the current passage (pledge of allegiance) that has been widely used in our facility (Brawner et al, 2006; Cannon et al, 2006; Dehart-Beverley et al, 2000; Foster et al, 2008; Foster et al, 2009; Jeans et al, 2010; Persinger et al, 2004; Recalde et al, 2002; Voelker et al, 2002). Despite its convenience and familiarity to most people in American culture, the 31 word length of the Pledge of Allegiance is initially too short, whereas the 101 word paragraph "Rainbow Passage" is too long. Studies that systematically evaluate the length of the speech producing stimulus, perhaps also using the VAS, is needed to better define how best to use the TT.

In summary the TT has been shown to have a close relationship with the ventilatory and respiratory compensation threshold. As we tested speech difficulty in this study using the VAS, we found that there was evidence that perceived speech difficulty is, in fact a continuous variable although its use in a categorical way still produces excellent surrogate markers of physiologic thresholds.

REFERENCES

American College of Sports Medicine, (2013). *ACSM's Guidelines for Exercise Testing and Prescription 9th edition.* Maryland: Lippincott Williams & Wilkins for the American College of Sports Medicine.

Borg, Gunnar. (1998). *Borg's perceived exertion and pain scales*. Champaign, IL: Human Kinetics.

Brawner, C. A., Vanzant, M. A., Ehrman, J. K., Foster, C., Porcari, J. P., Kelso, A. J., & Keteyian, S.J. (2006). Guiding exercise using the talk test among patients with coronary artery disease. *Journal of Cardiopulmonary Rehabilitation and Prevention*, *26*(2), 72-75.

Cannon, C., Foster, C., Porcari, J. P., Skemp-Arlt, K. M., Fater, D. W., & Backes, R. (2004). The Talk Test as a Measure of Exertional Ischemia. *American Journal Of Medicine & Sports*, *6*(2), 52-56.

Capodaglio, E. M. (2001). Comparison between the CR10 Borg's Scale and the VAS (Visual Analogue Scale) During an Arm-Cranking Exercise. *Journal Of Occupational Rehabilitation*, *11*(2), 69-74.

Dehart-Beverley, M., Foster, C., Porcari, J. P., Fater, D. W., & Mikat, R. P. (2000). Relationship Between the Talk Test and Ventilatory Threshold. *Clinical Exercise Physiology*, *2*(1), 34.

Eston, R. (2012). Use of ratings of perceived exertion in sports. *International Journal of SportsPhysiology and Performance*, *7*, 175-182

Foster, C., Porcari, J.P., Anderson, J., Paulson, M., Smaczny, D., Webber, H., Doberstein, S.T., & Udermann, B. (2008). The talk test as a marker of exercise training intensity. *Journal of Cardiopulmonary Rehabilitation and Prevention*, 28, 24-30.

Foster, C., Porcari, J. P., Gibson, M., Wright, G., Greany, J., Talati, N., & Recalde, P. (2009). Translation of Submaximal Exercise Test Responses to Exercise Prescription Using the Talk Test. *Journal of Strength & Conditioning Research (Lippincott Williams & Wilkins)*, *23*(9), 2425-2429.

Goode, R. C., Mertens, R., Shaiman, S., & Mertens, J. (1998). Voice, breathing, and the control of exercise intensity. *Advances in Experimental Medicine and Biology*, 450, 223-229.

Jeans, E. A., Foster, C., Porcari, J. P., Gibson, M., & Doberstein, S. (2011). Translation of Exercise Testing to Exercise Prescription using the Talk Test. *Journal Of Strength & Conditioning Research (Lippincott Williams & Wilkins)*, *25*(3), 590-596.

Loose, B. D., Christiansen, A. M., Smolczyk, J. E., Roberts, K. L., Budziszewska, A., Hollatz, C. G., & Norman, J. F. (2012). Consistency of the Counting Talk Test for Exercise Prescription. *Journal of Strength & Conditioning Research (Lippincott Williams & Wilkins)*, *26*(6), 1701-1707.

Meckel, Y., Rotstein, A., & Inbar, O. (2002). The effects of speech production on physiologic responses during submaximal exercise. *Medicine and science in sports and exercise*, *34*(8), 1337-1343.

Nijs, J., Zwinnen, K., Meeusen, R., De Geus, B., & De Meirleir, K. (2007). Comparison of two exercise testing protocols in patients with chronic fatigue syndrome. *Journal of Rehabilitation Research & Development*, *44*(4), 553-559.

Norman, J., Hopkins, E., & Crapo, E. (2008). Validity of the counting talk test in comparison with standard methods of estimating exercise intensity in young healthy adults. *Journal of Cardiopulmonary Rehabilitation And Prevention*, *28*(3), 199-202. doi:10.1097/01.HCR.0000320072.89093.0d

Persinger, R., Foster, C., Gibson, M., Fater, D. W., & Porcri, J. P. (2004). Consistency of the Talk Test for Exercise Prescription. *Medicine & Science In Sports & Exercise*, *36*(9), 1632-1636.

Ritvanen, T., Louhevaara, V., Helin, P., Halonen, T., & Hänninen, O. (2007). Effects of Aerobic Fitness on the Physiological Stress Responses at Work. *International Journal of Occupational Medicine & Environmental Health*, *20*(1), 1-8. doi:10.2478/v10001-007-0005-5

Rodriguez-Marroyo J. A., Villa, J. G., Garcia-Lopez, J., & Foster, C. (2012). Relationship between the Talk Test and Ventilatory Thresholds in Well-Trained Cyclists. *Journal of Strength & Conditioning Research (Lippincott Williams & Wilkins)*, *27*(7), 1942-1949.

Recalde, P. T., Foster, C., Skemp-Arlt, K. M., Fater, D. C. W., Neese, C. A., Dodge, C., & Porcari, J.P. (2002) The 'talk test' as a simple marker of ventilatory threshold. *South Africa Sports Medicine*, (9) 5-8.

StrØyer, J., Jensen, L., Avlund, K., Essendrop, M., Warming, S., & Schibye, B. (2007). Validity and Reliability of Self-Assessed Physical Fitness using Visual Analogue Scales. *Perceptual & Motor Skills*, *104*(2), 519-533. doi:10.2466/PMS.104.2519-533

Voelker, S. A., Foster, C., Porcari, J. P., Skemp, K. M., Brice, G., & Backes, R. (2002). Relationship Between the Talk Test and Ventilatory Threshold in Cardiac Patients. *Clinical Exercise Physiology*, *4*(2), 120.

APPENDIX A

INFORMED CONSENT

Protocol Title:	Measuring the Talk Test as Continuous as opposed to Categorical Data
Principle Investigator:	Joel Dubiel 1118 Pine St. La Crosse, Wi 54601 763-354-4408
Emergency Contact:	Joel Dubiel 763-354-4408

- **Purpose and Procedures:**
  - The intention of this study is to measure and evaluate the Talk Test using a Continuous protocol and compare the values to a Categorical Protocol (e.g., different ways of evaluating the Talk Test).
  - My participation in this study will involve three exercise tests, one being a VO_2 max test, which can cause fatigue.
  - During the VO_2 max test I will wear a headgear and scuba type mouth piece to analyze my breathing as well as wear a polar heart monitor.
  - During the Categorical and Continuous protocols it will only be required that I wear a polar heart monitor.
  - The total time requirement is 45 minutes for each test on different days with at least 48 hours in between tests
  - Testing will take place in Mitchell Hall room 225 in the Human Performance Laboratory .
- **Potential Risks:**
  - I may experience discomfort and fatigue while performing the exercise tests.
  - I may experience muscle soreness from the exercise that is to be performed on the cycle ergometer.
  - Individuals trained in CPR, First Aid, and Advanced Cardiac Life Support will be in the Human Performance Laboratory and will take the necessary steps if there are any problems that may occur. If problems do arise established protocols will be followed and the test will be terminated.
  - The potential risk for any serious or life threatening complications to occur in a healthy individual like myself is minimal. This includes a cardiovascular event, which could lead to heart attack, stroke and/or sudden death.
- **Rights and Confidentiality:**
  - My involvement in this study is voluntary and I can choose to discontinue my participation at any time without penalty.
  - I can also refuse to answer any questions that I do not feel comfortable sharing without penalty.
  - The results derived from this study may be presented at professional meetings and maybe published in scientific literature. However only grouped data will be presented.
  - All information will be confidential and will be ensured by the use of numerical codes. No identifying information will be connected to my data.
  - To ensure the confidentiality, all information will be kept in files that are safe and secure and only accessible to the principle investigator.

Questions concerning study procedures shall be directed to Joel Dubiel (763-354-4408) or or the study advisor Dr. Carl Foster, Research Director of the CEP program, UW-L (608-785-8687). Questions concerning the protection of human subjects shall be directed to the UW-La Crosse Institutional Review Board for the Protection of Human Subjects, (608-785-8124 or irb@uwlax.edu).

Participant_____ Date_____

Researcher_____ Date_____

APPENDIX B

RATING OF PERCEIVED EXERTION

Borg's Rating of Perceived Exertion Scale

0	No Effort (Standing At Rest)
0.5	Very, Very Easy
1	Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	
7	Very Hard
8	
9	Very, Very Hard (Nearly Maximal)
10	Maximal Effort

APPENDIX C

VISUAL ANALOGUE SCALE


Completely Comfortable
Unable to Talk

APPENDIX D

PLEDGE OF ALLEGIANCE

"Pledge of Allegiance"

"I pledge allegiance to the flag of the United States of America and to the Republic for which it stands, one Nation under God, indivisible with liberty and justice for all."

APPENDIX E

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Introduction

In order to prescribe exercise to an individual there should be four variables to consider, Frequency, Intensity, Time, and Type (F.I.T.T). The American College of Sports Medicine (ACSM, 2013) has guidelines for all four of these variables and has specific recommendations for each. However, prescribing the intensity for an individual can be quite difficult. According to the *ACSM's Guidelines for Exercise Testing and Prescription*, adults should work at a moderate to vigorous work load intensity or 60-90% of their Heart Rate Reserve (HRR). This prescription for exercise intensity can be a difficult process to prescribe due to the wide range of percent values that it offers, the requirement for an exercise test done by a trained professional and/or the presence of a physician and the need for maximal exertion. These limitations can cause some individuals to shy away from an exercise test or to exercise above or below their recommended exercise intensity.

Rating of Perceived Exertion

There are alternatives to measure exercise intensity that don't involve the help of trained medical professionals that a person can do on their own. One alternative is Borg's Rating of Perceived Exertion Scale (RPE), which helps measure the individual's perception of how hard they believe they are working (Borg 1998). There are at least 3 versions of the Borg scale that use a different range of categorical values. Borg & Kaijser (2006) compared the relationship between all 3 Borg scales and how they compared to each other with two different workloads. The original Borg scale ranges from 6-20. According to Borg (1998) this range 6-20 is supposed to correspond with Heart Rate

(HR) in a linear progression from 60 – 200 beats per min (bpm). The Category Ratio (CR) – 10 scale and Categorical Ratio –100 scale measures the magnitude estimation according to Borg & Kaijser (2006). In the study Borg & Kaijser found that the CR scales were very similar compared to the original Borg scale. In all of the scales they found a linear progression with HR and RPE. The RPE is valid for monitoring, prescribing and regulating exercise intensity according to Eston (2012). However Eston (2012) mentions that the ACSM has recently suggested that the RPE scale an invalid measure of primarily prescribing exercise intensity. Though the RPE scale is still accepted in the majority of organizations and in the field of exercise physiology there are other subjective measures that can help determine an individual's exercise intensity. One of those methods is the Talk Test (TT).

The Talk Test

The TT emerged in 1937 when Professor Joseph Henry Grayson suggested to British climbers that they "climb no faster than you can talk" (Goode, R. C., Mertens, R., Shaiman, S., & Mertens, J, 1998). Grayson's theory sparked a substantial amount of research testing his theory, seeing if the TT is a useful method of testing exercise intensity. The typical protocol for the TT has been quite simple. The individual performs a graded exercise test in incremental stages, usually two minutes in length. During the last 30 seconds of each interval the subject will either recite a passage or answer a question based on a recorded interview questionnaire. The principal investigator will ask the subject if they "can speak comfortably" and the subject will respond with one of three possible answers. If the subject feels as if they can speak comfortably they will answer the question with a positive remark such as "yes". If the subject feels unsure whether or

not they can speak comfortably, they will usually give a hesitant answer such as "yeah/but". Then when the subject feels and knows that there speech capability is too uncomfortable to recite the passage or answer the question, they will usually respond with a negative remark such as "no". Through the research of the TT, different variations and protocols have emerged testing the reliability and validity of it. Though the TT may not be included in the ACSM guidelines, there is now a considerable amount of research on the TT with evidence supporting the validity of the test (Brawner et al. 2006; Cannon et al. 2004; Dehart-Beverly, Foster, Porcari, Fater, & Mikat, 2000; Foster et al. 2009; Jeans, E. A., Foster, C., Porcari, J. P., Gibson, M., & Doberstein, S 2011; Persinger, R., Foster, C., Gibson, M., Fater, D. W., & Porcri, J. P. 2004; Quinn, T. & Coons, B. 2011; Recalde et al. 2001; Rodriguez-Marroyo, J. A., Villa, G., Garcia-Lopez, J.G., & Foster, C. 2012; Voelker et al. 2001). Through the research completed, it can be found that the TT is an effective means of experience of exercise prescription for healthy individuals, sedentary individuals, cardiac patients, and athletes.

Talk Test with Healthy Individuals

Dehart-Beverley et al. (2000) used twenty-eight healthy subjects who exercised regularly. The purpose of this study was to find whether or not the TT can be used as a simple replacement to measure Ventilatory Threshold (VT). Each subject performed two maximal tests. Through the research it was found that when a subject was able to speak comfortably or at a positive stage (LP), or if they were at an equivocal stage (+/-), they were most likely near or at their VT. Those who were unable to speak comfortably were clearly above their VT. Dehart-Beverly et al. listed some possible limitations that could have caused for a skew in the data such as the interval time being too long at two minute

stages and that the passage that the study used (The Rainbow passage) was 101-words and might have been too long as well.

Another study that tested the consistency of the TT in healthy subjects was performed by Persinger et al. (2004). Persinger et al. studied the TT and how it is correlated in different modes of exercise. The study used a cycle ergometer and treadmill to test the different modes of training and how they correlate with each other using the TT. Each subject was to perform four maximal exercise tests, two on the treadmill and two on the cycle ergometer. It was found in both modes of training that the LP and the equivocal (+/-) stage were found to be close to or at the VT when performing the TT.

Another study that was completed using healthy individuals for the TT was Jeans et al. (2011) that tested the translation of the TT to exercise prescription. The purpose of the study was to see how much of the absolute training intensity needed to be decreased during an incremental exercise test, so that a subject was able to speak comfortably. Each subject performed 6 exercise tests for this study. The first two were maximal exercise tests, one that measured maximal oxygen uptake using an open circuit spirometer, and the other was a maximal exercise test using the TT. The following three training bouts were performed based on the results of maximal exercise tests. These three tests used a 40 minute protocol on the treadmill that tested each subject at their equivocal stage, last positive stage (LP), and the stage before the last positive (LP-1) stage. The last test consisted of a second maximal exercise test, which used the TT. The study had found that during all three training bouts the subjects heart rate were within range based on the ACSM guidelines throughout the 40 minutes. However during the equivocal stage, during the last 10 minutes subjects felt as if they could not speak comfortably. This study

helps show that if individual wants to train to an extent where they are able to speak comfortably for 40 minutes; they must train at the LP stage.

Quinn and Coons (2011) had used fifteen healthy subjects to test the validity and reliability of the TT, and to see if there is a relationship between VT and a lactate threshold (LT). Using the similar protocol as Dehart-Beverley et al. (2000) they found similar results. The research had found that the VT values were lower in the TT compared to the LT values, which were closer to the (LP-1) and (+/-) stages. There was also evidence to suggest that when the TT was being performed both VT values and LT values exceeded the limits when the subject was at a negative stage (-). However both the VT values and LT values were within range of the ACSM guidelines for exercise prescription.

Talk Test with Sedentary Individuals

There have been many studies that have used healthy individuals as their subjects for measuring the different variations of the TT. One study used sedentary individuals to see how they would correspond to the TT and if there was any correlation between them and healthy individuals. Foster et al. (2009) used sedentary individuals to determine the amount of reduction in absolute exercise intensity in an incremental exercise, which would allow the subjects to speak comfortably. It was found that to be able to speak comfortably the exercise intensity had to be decreased to the previous stage that comfortable speech was last recorded in order to finish a 20 minute exercise bout (LP-1). This still showed a steady-state exercise response that recorded a HR range and MET range that was within the ACSM guidelines.

Talk Test with Cardiac Patients

Another population that the TT has been used to measure an appropriate exercise prescription is patients with cardiovascular disease. Voelker et al. (2001) used the same protocol as Dehart-Beverley et al. (2000) by having the patients perform two maximal exercise tests. The first test was an incremental exercise test completed on the treadmill that measured gas exchange and was performed until the subject was fatigued or until there were noticeable symptoms or ECG changes that required for the test to be terminated. The second test was performed using the same protocol but with the TT being performed. The results were very similar to the results found in subjects from a healthy population. When an individual could not speak comfortably, they were beyond their VT. When a subject was exercising at the recommended guidelines of the ACSM based on heart rate, it was found that the subject was at the LP stage or the equivocal stage with speech compatibility.

Brawner et al. (2006) used cardiac patients with stable Coronary Artery Disease (CAD). The purpose of this study was to measure the TT using two different speech provoking strategies among patients that qualified for CAD. This was based on age $\geq$ 18 years, history of myocardial infraction, coronary revascularization, or a positive coronary angiogram and normal sinus rhythm. Subjects were first required to perform a maximal incremental exercise test that went to the subject's peak exertion. They then were required to perform one of the two speech provoking protocols. One of the speech protocols used the talk test on the treadmill, where the patient would recite the "Pledge of Allegiance" during the last 30 seconds of the exercise stage. The other protocol had the patients walk in an indoor track and verbally respond to 12 minutes of standardized

questions through a portable audio cassette player. The study found that when subjects were exercising below their VT, they were at a point when they could still talk comfortably. There was also evidence that showed when the majority of patients were exercising above their VT they were unable to speak comfortably. The correlation between the two protocols showed similar results and both were within the guidelines of prescribing exercise intensity to cardiac patients based on the subjects HR and RPE.

Another study with cardiac patients was conducted by Cannon et al. (2006) that focused on patients with myocardial ischemia. The purpose of this study was to focus on if the TT was effective at measuring the relationship of electrocardiographic evidence for myocardial revascularization in cardiac patients. The study recruited 19 subjects that qualified for the study based on electrocardiographic evidence for myocardial ischemia. There were also some subjects in the study that had showed evidence of CAD. The protocol for this study was similar to Voelker et al. (2001) and Dehart-Beverley et al. (2000) by having the subjects perform a graded exercise test and recite the "Pledge of Allegiance" during the last 30 seconds of the exercise stage. The study showed similar results as compared to previous studies involving the TT. When the subject was able to speak comfortably there was no electrocardiographic evidence of myocardial ischemia.

A more recent study done by Zanettini et al. (2012) tested the validity of the TT for exercise prescription after myocardial revascularization. The study recruited 50 individuals who either had a coronary artery bypass graft or a percutaneous coronary intervention. They then had them perform three repetitions of the TT at different intensities on different days. During these 3 TT sessions a different physiotherapist operator was assigned every time in order to assess reliability in administering a

workload. Each physiotherapist operator was assigned randomly and all were blinded to the previous results from other tests. Subjects were required to cycle at different workloads and recite a passage about religious freedom from the Italian Constitution. The workload increased every 3 minutes and subjects would be asked if they were able to "speak comfortably" after reciting the passage. It was found that the reliability of assessing the TT with both the patients and physiotherapists was acceptable and that at the LP stage at which the individual was able to speak comfortably was an appropriate exercise intensity workload for a patient with recent myocardial revascularization.

Talk Test with Athletes

The TT has been measured in various populations to help measure the reliability and validity of determining an appropriate exercise intensity to work at. It has been measured with healthy and sedentary individuals as well as cardiac patients. There is however complications in prescribing exercise when it comes to athletes. Recalde et al. (2001) explains in his study that "recent evidence has suggested that athletes have difficulty matching the training prescriptions prepared by coaches… particularly training intensity." Recalde et al. (2001) and Rodriguez-Marroyo et al. (2012) used well-trained individuals or elite cyclists in their study to test the efficacy of the TT. Unsurprisingly they found that when the individual was at the equivocal stage or at the negative stage of the test they were at or above their VT. Both of these studies help provide evidence that the TT could be used as a surrogate to measure VT and help prescribe exercise intensity. The negative stage of the TT was well correlated with the respiratory compensation threshold (RCT).

Variations of determining Exercise Prescription

With the TT being as popular as it is, there has been an evolution of different methods of the TT that allows for individuals to measure their exercise intensity. One of those methods is the Counting Talk Test (CTT) that uses the same idea as the standardized TT but in the sense of using a numerical system. The CTT first measures an individual's capability to be able to count as high as they can while at rest, before they have to take a breath. Then based on the numerical value that the subject received, the individual would be given a range to achieve while exercising. Loose et al. (2012) and Norman, Hopkins, E & Crapo (2008) both performed studies that measured the validity of the TT. Norman et al. (2008) found that the CTT was an effective way at measuring a lower and upper exercise intensity range rather than just maximal intensity range. Loose et al. (2012) had measured the CTT while using different modes of training with the subjects. The study had found the CTT had been consistent with all the modes of training tested and that the results fit into the ACSM recommendations for physical activity.

Another method to determine exercise intensity is the theory that when you are able to "hear your breathing" while exercising you are at or near your VT. Goode et al. (1998) conducted a study that had 19 subjects perform exercise tests both on a cycle ergometer and indoor track. Exercising, the subjects were asked to raise their hand when they first noticed that they could hear themselves breathing. After this had happened they were asked to maintain the same exercise intensity for a short duration until the exercise test was finished. It was found that when the subjects could hear themselves breathe, while cycling or jogging they were at or near their VT. This also correlated with the

subjects HR, which was within the 60 to 90% HRR of the ASCM recommendations for moderate to vigorous activity.

With the idea that talking while exercising might decrease ventilation, there have been studies done that measure how speech production affects physiologic responses during exercise. Meckel, Rotstein, & Inbar, (2002) performed a study that measured the different physiologic responses while speaking during submaximal exercise. The study consisted of 14 healthy subjects and had them perform a $V0_2$ max test. After the test on a separate day they were required to perform 3 consecutive exercise tests with constant exercise bouts at 65, 75, and 85% of their max VO_2 test. After this protocol was finished they were required to do the same thing, however speech production was provoked. While exercising the subjects were required to read a passage at constant pace that was facilitated by the use of a metronome. It was found that when speaking during exercise there was a reduction in minute ventilation, oxygen uptake, and elevation in lactic acid. There however was no difference in HR, inspiration time, and in tidal volume whether the subject was talking or being silent.

The Visual Analogue Scale

Through the studies that have been done to measure exercise intensity using the TT, there is evidence to show that the method is reliable and valid with a variety of populations. There are also other variations of the TT and methods used to determine an individual's exercise intensity, however there is no recognition of it in the ACSM as being a primary source when determining exercise intensity. The RPE scale has been used in most of the studies focusing on the TT as to help determine how "hard" an

individual is working. The Visual Analogue Scale (VAS) is also a tool to measure how "hard" an individual believes they are working.

One study that measures the comparison between Borg's RPE scale and the VAS is performed by Capodaglio (2001) that used an arm-cranking exercise. The study recruited 15 young healthy subjects that had them perform an incremental arm cranking exercise until complete fatigue. The subjects were required to use both the CR-10 RPE scale as well as the VAS in random order to evaluate arm fatigue and cardiorespiratory fatigue. The results that were found were that CR-10 RPE scale had created a positively accelerating increase corresponding to workload, while the VAS had created more of a linear increase with workload. Through these findings it was concluded that both scales were accepted to be an appropriate way to measure exercise intensity and that they actually corresponded very well with each other.

Nijs, Zwinnen, Meeusen, De Geus, & De Meirleir (2007) conducted a study to compare the exercise protocols in patients with chronic fatigue syndrome. They used the VAS scale for their subjects, so that they were able to rate their perception of how severe their symptoms were that corresponded with chronic fatigue syndrome. Another study that used the VAS was Ritvanen, Louhevaara, Helin, Halonen, & Hänninen (2007) that measured the Effects of Aerobic Fitness on Physiological Stress Responses at Work. The study's purpose was to evaluate whether or not aerobic fitness had any effect on stress. The study recruited 27 healthy individuals, who were all high school teachers. The VAS was used in order to gain a better understanding on how stressed each individual teacher feels. StrØyer et al. (2007) used the VAS to measure the validity and reliability of self-assessed physical fitness. The study recruited 935 individuals that had a background in

healthcare and asked them to give a self-assessment using the VAS in five components of physical fitness. The components consisted of endurance, muscular strength, aerobic fitness, flexibility, and balance. The subjects had used a VAS with verbal and illustrative anchors to measure their self-assessment of physical fitness. The findings of the research concluded that aerobic fitness, muscle strength and flexibility can be self-assessed with moderate reliability and good validity using the VAS.

Summary

These studies are specifically important to our study because it suggests that the TT is an effective method for measuring an individual's exercise intensity. It's suggested that with Borg's RPE scale the VAS can be another tool for measuring the validity and reliability of the TT. By completing our proposed study, we hope to find whether or not the TT can be measured in a continuous method rather than a categorical method. In addition, will evaluate what effects will occur with the changes in exercise intensity as each method is used.

REFERENCES

American College of Sports Medicine, (2013). *ACSM's Guidelines for Exercise Testing and Prescription 9th edition.* Maryland: Lippincott Williams & Wilkins for the American College of Sports Medicine.

Borg, Gunnar. (1998). *Borg's perceived exertion and pain scales*. Champaign, IL: Human Kinetics.

Brawner, C. A., Vanzant, M. A., Ehrman, J. K., Foster, C., Porcari, J. P., Kelso, A. J., & Keteyian, S. J. (2006). Guiding exercise using the talk test among patients with coronary artery disease. *Journal of Cardiopulmonary Rehabilitation and Prevention*, *26*(2), 72-75.

Cannon, C., Foster, C., Porcari, J. P., Skemp-Arlt, K. M., Fater, D. W., & Backes, R. (2004). The Talk Test as a Measure of Exertional Ischemia. *American Journal Of Medicine & Sports*, *6*(2), 52-56.

Capodaglio, E. M. (2001). Comparison between the CR10 Borg's Scale and the VAS (Visual Analogue Scale) During an Arm-Cranking Exercise. *Journal Of Occupational Rehabilitation*, *11*(2), 69-74.

Dehart-Beverley, M., Foster, C., Porcari, J. P., Fater, D. W., & Mikat, R. P. (2000). Relationship Between the Talk Test and Ventilatory Threshold. *Clinical Exercise Physiology*, *2*(1), 34.

Eston, R. (2012). Use of ratings of perceived exertion in sports. *International Journal of Sports Physiology and Performance*, *7*, 175-182

Foster, C., Porcari, J.P., Anderson, J., Paulson, M., Smaczny, D., Webber, H., Doberstein, S.T., & Udermann, B. (2008). The talk test as a marker of exercise training intensity. *Journal of Cardiopulmonary Rehabilitation and Prevention*, 28, 24-30.

Foster, C., Porcari, J. P., Gibson, M., Wright, G., Greany, J., Talati, N., & Recalde, P. (2009). Translation of Submaximal Exercise Test Responses to Exercise Prescription Using the Talk Test. *Journal of Strength & Conditioning Research (Lippincott Williams & Wilkins)*, *23*(9), 2425-2429.

Goode, R. C., Mertens, R., Shaiman, S., & Mertens, J. (1998). Voice, breathing, and the control of exercise intensity. *Advances in Experimental Medicine and Biology*, 450, 223-229.

Jeans, E. A., Foster, C., Porcari, J. P., Gibson, M., & Doberstein, S. (2011). Translation of Exercise Testing to Exercise Prescription using the Talk Test. *Journal Of Strength & Conditioning Research (Lippincott Williams & Wilkins), 25*(3), 590-596.

Loose, B. D., Christiansen, A. M., Smolczyk, J. E., Roberts, K. L., Budziszewska, A., Hollatz, C. G., & Norman, J. F. (2012). Consistency of the Counting Talk Test for Exercise Prescription. *Journal of Strength & Conditioning Research (Lippincott Williams & Wilkins), 26*(6), 1701-1707.

Meckel, Y., Rotstein, A., & Inbar, O. (2002). The effects of speech production on physiologic responses during submaximal exercise. *Medicine and science in sports and exercise, 34*(8), 1337-1343.

Nijs, J., Zwinnen, K., Meeusen, R., De Geus, B., & De Meirleir, K. (2007). Comparison of two exercise testing protocols in patients with chronic fatigue syndrome. *Journal of Rehabilitation Research & Development, 44*(4), 553-559.

Norman, J., Hopkins, E., & Crapo, E. (2008). Validity of the counting talk test in comparison with standard methods of estimating exercise intensity in young healthy adults. *Journal of Cardiopulmonary Rehabilitation And Prevention, 28*(3), 199-202. doi:10.1097/01.HCR.0000320072.89093.0d

Persinger, R., Foster, C., Gibson, M., Fater, D. W., & Porcri, J. P. (2004). Consistency of the Talk Test for Exercise Prescription. *Medicine & Science In Sports & Exercise, 36*(9), 1632-1636.

Ritvanen, T., Louhevaara, V., Helin, P., Halonen, T., & Hänninen, O. (2007). Effects of Aerobic Fitness on the Physiological Stress Responses at Work. *International Journal of Occupational Medicine & Environmental Health, 20*(1), 1-8. doi:10.2478/v10001-007-0005-5

Rodriguez-Marroyo J. A., Villa, J. G., Garcia-Lopez, J., & Foster, C. (2012). Relationship between the Talk Test and Ventilatory Thresholds in Well-Trained Cyclists. *Journal of Strength & Conditioning Research (Lippincott Williams & Wilkins), 27*(7), 1942-1949.

Recalde, P. T., Foster, C., Skemp-Arlt, K. M., Fater, D. C. W., Neese, C. A., Dodge, C., & Porcari, J. P. (2002) The 'talk test' as a simple marker of ventilatory threshold. *South Africa Sports Medicine,* (9) 5-8.

StrØyer, J., Jensen, L., Avlund, K., Essendrop, M., Warming, S., & Schibye, B. (2007). Validity and Reliability of Self-Assessed Physical Fitness using Visual Analogue Scales. *Perceptual & Motor Skills, 104*(2), 519-533. doi:10.2466/PMS.104.2519-533

Voelker, S. A., Foster, C., Porcari, J. P., Skemp, K. M., Brice, G., & Backes, R. (2002). Relationship Between the Talk Test and Ventilatory Threshold in Cardiac Patients. *Clinical Exercise Physiology*, *4*(2), 120.