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The effect of competition and opponent gender on the performance of a graded exercise test

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THE EFFECT OF COMPETITION AND OPPONENT GENDER ON THE PERFORMANCE OF A GRADED EXERCISE TEST

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by

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CERTIFICATE OF APPROVAL

MASTER OF SCIENCE THESIS

This is to certify that the Thesis of

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submitted in partial fulfillment of the requirements for the degree of Master of Science in the Department of Exercise and Sport Sciences at Ithaca College has been approved.

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ABSTRACT

Although competition is the basis for athletics throughout the world, there has been little research conducted examining the effect of competition on physical performance. Even more so there is little research in the area of inter-gender competition and physical performance. This is possibly due to the physical and strength differences between females and males, and the fact they do not usually compete in athletics directly. The purpose of this study was to determine the effects of competition and opponent gender on the physiological responses during a treadmill graded exercise test (GXT). Twenty-eight subjects (14 males; 14 females) performed three treadmill GXTs on three different days. The control group (7 males; 7 females) performed three GXTs alone and the experimental group (7 males; 7 females) performed trial one alone, a second trial versus a male, and a third trial versus a female. Prior to testing, participants completed the Physical Self Efficacy Scale (PSE), the Sports Attitude Inventory (SAI), and the Jenkins Activity Survey (JAS). A 2 x 2 x 3 ANOVA (group x gender x competition type) with repeated measures on the last factor was used to analyze the dependent variables. No significant interactions ($p < 0.05$) were found in time to exhaustion or respiratory exchange ratio (RER). For maximal oxygen consumption ($\dot{V}O_2$ max), a significant gender x group interaction was noted with a post-hoc Tukey HSD revealing control males having significantly higher $\dot{V}O_2$ max values than both control and experimental females. A significant difference was also found between genders for $\dot{V}O_2$ max, and comparing means showed males having a significantly higher $\dot{V}O_2$ max than females. A significant

main effect for competition type was seen for RER, with a post-hoc Tukey HSD indicating RER was significantly greater for all subjects (control and experimental combined) on trial 2 and trial 3 than on trial 1. The analysis of psychological variables using a 2 x 2 ANOVA indicated no significant differences in scores between genders, groups, or a gender x group interaction in the PSE or SAI. Analysis of the JAS indicated that overall female subjects scored significantly higher on competitiveness than male subjects. In conclusion, these results indicated that athletes competing versus a male or a female did not improve performance on multiple trials of graded exercise tests. This finding signifies performance on a graded exercise test will not improve across three trials and that inducing a competitive environment will not alter the exercise test results for either gender.

DEDICATION

This thesis is dedicated to my parents, Thom and Charlene,

for their constant support and encouragement

throughout this project and my life.

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Chapter 1

INTRODUCTION

Competition stems back to primitive people fighting for survival and is evident today in business, leisure, and sport. People often pursue competition for the enjoyment and excitement they derive from it. Generally, competition encourages individuals to perform to the best of his or her capability (Bell, 1975). Competition is the basis for participation in athletics, and can be defined as a desire to achieve some goal in relation to a standard of excellence (Bell, 1975). These goals can be set by the individuals, coaches, parents, or teammates and drive the athlete to attempt to perform better on a task. Competition can surface in the form of internal (against previous personal records or goals), or external competition (compete against others).

Men are generally expected to be more avid competitors than women. Gill (1988) found that males appear more competitive and "win-orientated" (i.e., win the competition without concern of performance) while females appear more "goal-orientated" (i.e., set goals to achieve such as time or distance, can include goal of winning). Studies regarding the impact of competition on female performance are not in agreement. Some show that females perform better under competitive situations (Gill, Gross, Huddleston, & Shifflett, 1984; Palmer & Bennett, 1998; Peretti, 1971), while others show a decrease in performance (White, 1991).

To date only one study has been conducted on the effects of competition on a graded exercise test (GXT) performance. Wilmore (1968) studied healthy, college-aged

males competing during a cycle ergometer GXT. The results showed a significant increase in mean work output and riding time during competition, with no significant increase in HR or $\dot{V}O_2$ max. Wilmore attributed this increase in performance without a concurrent increase in physiological measures to a learning effect across trials, and also that maximal values are absolute and are not improved with additional work in excess of what is needed to achieve those maximal values. A possible limitation in the Wilmore study was that using a cycle ergometer for the test might have restricted the subjects' ability to increase their $\dot{V}O_2$ max even during competition. A cycle ergometer often produces a high degree of local muscular fatigue that may limit a subject's ability to fully tax their central circulatory system. Conversely, the use of a treadmill for a GXT is believed to produce central fatigue prior to local muscular fatigue (Faulkner, Donald, Elk & Conway, 1971; Hermansen, Ekblom & Saltin, 1970).

Many studies involving competition give subjects competitive directions (e.g., "you want to get the highest score you can") but do not involve direct competition or inter-gender competition (Giannini, Weinberg, & Jackson, 1988; Palmer & Bennett, 1998; Peretti, 1971; White, 1991). Some studies use simulated competition like a time trial (Foster, Green, Snyder, & Thompson, 1993; Passelergue Robert, & Lac, 1995; Triplett, 1897, as cited in Cox, 1990). Of the studies that include competition between males and females, most focus on mental tasks (Palmer & Bennett, 1998, Peretti, 1971) or simple motor tasks (Gill, Gross, Huddleston, & Shifflet, 1984; White, 1991). There appears to be a gap in the literature regarding head-to-head competition between genders

on performance of stressful physical tasks. This may be related to the physical differences between males and females that might give one gender an advantage over the other. Although males would still have an advantage due to larger muscle mass, a treadmill GXT can to some extent control for size differences by measuring performance in terms of bodyweight, while simultaneously minimizing local muscular fatigue.

The number of females competing in athletics is increasing every year, and they are playing sports that used to be deemed "male sports," such as football, rugby and hockey. More and more events such as road races, marathons and triathlons have both genders competing simultaneously. Therefore, the purpose of this study was to examine the effects of competition and opponent gender on physiological responses and performance during a treadmill GXT.

Statement of Purpose

The purpose of this study was to examine the effects of competition with a member of the opposite or same gender, on time to exhaustion, respiratory exchange ratio (RER), and $\dot{V}O_2$ max during a treadmill GXT in subjects' aged 18-44 years of age, and to consider any connection between subjects' performance and psychological profiles through scores on the JAS, the SAI, and the PSE.

Null Hypotheses

1. Competition, whether against the same or the opposite gender, will have no effect on time to exhaustion, maximum respiratory exchange ratio, or $\dot{V}O_2$ max in subjects' aged 18-44.
2. Scores on the JAS, the SAI, and the PSE will not differ between subjects', and will have no effect on time to exhaustion, maximum respiratory exchange ratio, or $\dot{V}O_2$ max for subjects' aged 18-44.

Scope of the Problem

The most effective method for achieving exceptional performances is foremost in all athletes and coaches minds. There is limited literature regarding performance when genders compete against each other. To determine if the most effective method may involve training with or competing against a member of the opposite gender, a controlled study examining this is warranted. The results of this study may initiate an in-depth look at the gender-based segregation that typically occurs during athletic training, practices, and competitions. In addition, the literature indicates that subjects often do not achieve a "true" $\dot{V}O_2$ max during a GXT and this may be due to psychological limitations (Butts, Jensen, & Lui, 1982; Chitwood, Moffatt, Burke, Luchino, & Jordan, 1997; Moffatt, Chitwood, & Biggerstaff, 1994; Noakes, 1988; Wilmore, 1968), which conceivably could be overcome through the use of competition to invoke exceptional performance. An accurate measure of $\dot{V}O_2$ max can assist in developing a precise exercise prescription

(ACSM, 1998; Powers & Howley, 1994) and significantly correlates with athletic performance (Chen, 1991; Custer & Chaloupka, 1977; Lambert, 1990; Saltin and Åstrand, 1967; Wiswell, Jazue, Marcell, Hawkins, Tarpenning, Constantino, & Hyslop, 2000).

Assumptions of Study

1. The subjects for this investigation followed the pre-test instructions for three GXTs.
2. The subjects were be equally prepared and motivated for each test day.
3. The subjects did not change lifestyle, sleep patterns, diet, or exercise routine from the time the study began until the testing was complete.
4. The subjects had prior experience on a treadmill and were therefore capable of running on a treadmill without any difficulty that would have influenced the results.
5. The environment that was produced in the laboratory simulated competition.

Definition of Terms

1. Maximal oxygen consumption ($\dot{V}O_2$ max): The maximum amount of oxygen the body can take in, transport, and utilize for energy production, measured in milliliters of oxygen, per kilogram of body weight, per minute. Determined during the GXT as the greatest $\dot{V}O_2$ measurement attained.
2. Graded exercise test (GXT): A treadmill test used to measure $\dot{V}O_2$ max. The GXT protocol in this study uses a speed chosen by the subject, and percent grade increases 2 percent every three minutes until volitional exhaustion.
3. Rating of Perceived Exertion (RPE): A subjective scale from 6-20, which is used to determine perceived level of exercise difficulty (Borg, 1972).

4. Volitional Exhaustion: When the subject can no longer continue the protocol of the GXT due to fatigue and requests to stop the test, signaled by grabbing onto the handrail of the treadmill.
5. Achievement Motivation: The tendency for a subject to have a motive to achieve success or a motive to avoid failure (Cox, 1990; Cratty, 1989), which is being measured on the SAI (Willis, 1982).
6. Self-Efficacy: An individual's feelings of effectiveness, perception of abilities, or self-confidence (Cratty, 1989), which is being measured on the PSE (Ryckman, Robbins, Thornton, & Cantrell, 1982)

Delimitations

1. Experimental subjects were 14 males and 14 females between the ages of 18 and 44 years of age, from the Ithaca community.
2. Subjects had participated in some form of competitive athletics for a minimum of three years, in either high school, collegiate, or recreation.
3. Subjects were currently exercising a minimum of three days a week, for at least 45 minutes a day.
4. Testing took place in the Exercise Physiology Laboratory at Ithaca College and used a motor driven treadmill.
5. Subjects had experienced and demonstrated the capacity for running on a treadmill.

Limitations

1. The results may only be applicable to adults who are currently engaging in regular physical activity and are between the ages of 18-44 years.
2. The results of this study may not be applicable when other modes of exercise or protocols of graded exercise testing are used.
3. The results may be different when using non-experienced subjects, those unfamiliar with treadmill running or unfamiliar with competitive environments.

Chapter 2

REVIEW OF LITERATURE

Introduction

To offer a background understanding of the effects of competition and gender on graded exercise test performance (GXT), this review will examine the following topics: (a) importance and measurement of $\dot{V}O_2$ max, (b) selected factors that influence performance, (c) effect of competition on performance, (d) gender and competition, and (e) summary.

Importance and Measurement of $\dot{V}O_2$ Max

An individual who exercises regularly is generally exercising for a specific desired outcome. Desired outcomes may include improving fitness, athletic potential, and performance. For any of these benefits to occur it is usually recommended to exercise in the range of 50-85% of $\dot{V}O_2$ max, or 60-90% of their maximum heart rate (HR max) (ACSM, 1998). Generally, the average person does not know their $\dot{V}O_2$ max or HR max to determine an appropriate training intensity.

A GXT is the most commonly used method to determine $\dot{V}O_2$ max. This test involves a series of increasing workloads until the subject can no longer increase oxygen consumption (ACSM, 1998; Maud & Foster, 1995; Plowman & Smith, 1997). Once $\dot{V}O_2$ max is established, an exercise prescription can be developed specifically for the individual with a high degree of accuracy and potential effectiveness. The results of a

GXT are used to evaluate cardiorespiratory fitness, which in turn can be used for detecting disease, estimating athletic potential, or for clinical and research purposes (ACSM, 1998).

Athletes are required to perform at intense levels almost every day and efficient cardiovascular and respiratory systems are critical to performance and success. Most athletes begin with pre-season conditioning to help achieve an "aerobic base." It is generally believed that a person who is well-trained is less prone to injury (Kibler & Chandler, 1994) and is capable of training more efficiently because they will not fatigue as quickly. In season, an athlete with a higher $\dot{V}O_2$ max often has distinct advantage, and to compete successfully in events that last longer than 20 minutes a high $\dot{V}O_2$ max is almost required (Powers & Howley, 1994).

Relationship Between $\dot{V}O_2$ max and Performance

Several authors have found a strong connection between $\dot{V}O_2$ max and performance. Saltin and Åstrand (1967) performed GXTs on male and female athletes from the Swedish National team and their findings showed that the best athletes (i.e., World champions, Swedish champions, and Olympic game participants) produced the greatest $\dot{V}O_2$ max scores. Custer and Chaloupka (1977) found a significant positive correlation between $\dot{V}O_2$ max and the performance of 6, 9, and 12-minute runs in colleged-age females. Lambert (1990) determined that calculating a percentage of $\dot{V}O_2$ max at a given intensity (268.2 $m \cdot min^{-1}$) had the highest correlation ($r = .525$-$.722$) with

performance times during cross-country competition. In 1991, Chen found that $\dot{V}O_2$ max had a significant correlation with a 1.5-mile run (r = -.90) and a 3.0-mile run (r = -.84) for females and with a 3.0-mile run for males (r = -.65). Of running economy, $\dot{V}O_2$ max, body composition, and ventilatory threshold, $\dot{V}O_2$ max was the most important variable for predicting running performance in females. Wiswell et al. (2000) found that among masters runers, $\dot{V}O_2$ max was a significant predictor of run times in a 5 km (-0.643, -0.656), 10 km (-0.661, -0.680) and marathon (-0.594, -0.680) run for males and females respectively. Therefore, the accurate measurement of $\dot{V}O_2$ max is extremely useful in predicting athletic performance, especially in females.

Noakes (1988) determined that a true measure of athletic potential is the maximum speed or workload that is attained during the GXT. If one achieves a higher workload, it would predict a higher athletic potential. Although $\dot{V}O_2$ max testing is beneficial for endurance athletes to predict performance, it is not the only factor that predicts performance. Therefore, many physiological tests would need to be done to fully evaluate the work capacity of endurance athletes. Regardless, a $\dot{V}O_2$ max test will give an athlete a baseline to help coaches plan their exercise training program (Powers & Howley, 1994).

Plateau Phenomenon

The most widely accepted criterion for achieving $\dot{V}O_2$ max during a GXT is a plateau in $\dot{V}O_2$ during the final stages of the test. A plateau is determined as no further

rise in $\dot{V}O_2$ with increasing workload. However, 50% of all subjects never reach a plateau and this has created controversy in maximum exercise testing. Cumming and Borysyk (1971) found that although the subjects met the maximum test criteria for blood lactate, respiratory exchange ratio and heart rate, fewer than 43% of their subjects aged 40-65 years of age reached a plateau in $\dot{V}O_2$ during the GXT. Cunningham, MacFarlane Van Waterschoot, Paterson, Lefcoe and Sangal (1977) did a similar study but used 66 ten-year-old boys as subjects. They found that 62% of the young boys never reached a plateau in $\dot{V}O_2$, when a plateau was described as a difference of less then 2.1 $ml \cdot kg^{-1} \cdot min^{-1}$ between the last two stages. Noakes (1988) wrote that when subjects do not reach a plateau in $\dot{V}O_2$ it is due to a lack of sufficient motivation to exercise until central limitation causes them to stop. The lack of a plateau in $\dot{V}O_2$ during a GXT may result in an underestimation of an athlete's maximum potential and a related insufficient prescription of training intensity.

Selected Factors That Influence Performance

Motivation

When an individual competes with others or attempts to achieve a set standard of excellence, they are motivated by personality factors, social variables, and cognitions (Roberts, 1992). Noakes (1988) believed that subjects were often not sufficiently motivated to reach an exercise intensity that would result in central limitation and a plateau in $\dot{V}O_2$. Motivation is affected by internal factors, such as need achievement,

expectation of success and self-efficacy, and also external factors, such as verbal encouragement, an audience, and perception of competition. All of these factors affect performance in a competitive setting.

Need achievement is based on the idea that people will either have a motive to achieve success (high n Ach) or a motive to avoid failure (low n Ach). Individuals with a motive to achieve success will be more likely to enter into a competitive situation and be intrinsically motivated to perform well. They will work at a higher intensity, and choose tasks that will test their abilities (Cox, 1990; Cratty, 1989). On the other hand, a person with a motive to avoid failure will try to avoid competition, and choose tasks that are extremely difficult, so that success is unlikely for most people. As a situation becomes more challenging and has higher risks, an athlete who has a motive to achieve success will rise to the occasion, and an athlete who wants to avoid failure will try to avoid situations with a high probability of failure (Henschen & Straub, 1995). In a competitive situation, performance of subjects with high n Ach will be enhanced, but for subjects with low n Ach performance will decrease (Cox, 1990).

In a study by Scalan and Ragan (1978), subjects who were either extreme low or high n Ach, performed a novel ring peg task in a non-competitive setting, and were spontaneously placed into competition with a confederate. Upon completion of the competition, they were asked which environment (competitive or non-competitive) they would choose to perform in if given a choice. Ninety-six percent of the high n Ach

subjects choose competition while only 58% of the low n Ach subjects choose competition. Thomassen & Halvari (1996) looked at the influence of the motive to achieve success, and the motive to avoid failure, on involvement in sport competition. They used the question "In which sports are you active in your spare time?" to determine whether the students were involved in competitive sport, recreational sport, no sport, or both. They then used the Achievement Motives Scale to determine the individuals motive to achieve success and the motive to avoid failure. The results showed a positive correlation between the involvement in sports and the motive to achieve success, as well as a positive correlation between the motive to avoid failure and the lack of involvement in sports.

Expectation of Success

During competition, an individual's expectation of how they will perform can greatly impact the outcome. The self-fulfilling prophecy states that a person's expectations of how they believe they will perform, is usually fulfilled. If they believe they will perform poorly, or will lose, it will come true. On the other hand, if they believe they will perform at an exceptional level and win, they will win (Cox, 1990).

In 1972, Nelson and Furst studied college-aged males in an arm wrestling contest. The subjects were tested for arm strength and were asked to rank how they believe their classmates performed on the same arm strength test. Opponents were then matched in an arm-wrestling contest where both contestants thought the weaker of the two (by the

strength measurements) to be the stronger of the two (based on classmates rankings). The weaker subject won 10 of 12 contests, displaying that the expectation of winning could greatly influence actual moderate strength handicaps.

Intertwined with expectation of success is self-efficacy, which can be defined as an individual's feelings of effectiveness, perception of abilities, or self-confidence. A person's self-efficacy will impact how they perform during competition. Usually high feelings of self-efficacy result in good performance, while people with lower confidence tend to perform poorly (Cratty, 1989). Gould, Weiss, and Weinberg (1981) studied Big Ten wrestlers and found that the more successful wrestlers were more confident and believed they were close to their maximum potential, compared to the less successful wrestlers. Treasure, Monson, and Lox (1996) found that for 13-18 year old wrestlers the higher the level of self-efficacy, the better they performed. Weiss, Klint, and Wiese (1989) also found that gymnasts between the ages of 7 and 18 who had higher self-efficacy were more successful.

Verbal Encouragement

Although $\dot{V}O_2$ max testing is important for research, subjects do not enjoy the experience because it is uncomfortable to exert oneself maximally. To collect accurate $\dot{V}O_2$ max measurements, it is critical for the subjects to work until complete exhaustion. Many researchers have mentioned that motivation may be a limiting factor in the performance of $\dot{V}O_2$ max testing and have tried to create environments to help subjects

overcome any psychological limitations and attempt to reach a "true" maximum. (Butts, Jensen, & Lui, 1982; Chitwood, Moffatt, Burke, Luchino, & Jordan, 1997; Moffatt, Chitwood, & Biggerstaff, 1994; Wilmore, 1968).

Butts et al. (1982) studied the effect of verbal encouragement on the performance of a GXT in intercollegiate cross-country runners. Subjects completed one test with little interaction with the experimenter, and one test with vigorous verbal encouragement to keep going as long as possible. The researchers found no difference in $\dot{V}O_2$, RER, or V_E between trials, but heart rates and time to exhaustion were higher with verbal encouragement. Moffatt et al. (1994) performed a similar study but included sedentary individuals as well as competitive distance runners. In the competitive runner sample, $\dot{V}O_2$ max and RER were unchanged between trials, while the untrained subjects improved $\dot{V}O_2$ max with verbal encouragement. Both groups had increased max HR and time to exhaustion when verbally encouraged by the experimenter. Chitwood et al. (1997) also studied the effects of encouragement, but the groups were made of Type A and Type B personalities. Their results showed a significant increase in $\dot{V}O_2$ max, RER and treadmill time when the Type B personalities were given encouragement, while the Type A personalities only showed an increase in RER with encouragement. The authors explained the difference were due to Type B personalities needing more external motivation than Type A personalities during high intensity exercise.

Audience

Audiences can either positively or negatively impact the performance of a subject, depending on the experience of the subject, the type of task, and the type of audience. The audience can either be a passive group of onlookers, or a coactive audience, which involves other participants who do not interact with the subject or each other. Generally the less experienced performer will have a decreased performance in front of an audience, while the performance of a highly skilled athlete will be enhanced or unaffected. The presence of an audience generally improves performance on a simple speed or power task, but decreases performance on an intricate, fine-control task (Cox, 1990; Cratty, 1989).

Smith, Burwitz, and Jakeman (1988) performed a study on the effects of audience on performance of three motor performance tests (visual motor test, ergometer power test, and serial reaction time test). After a five-week habituation to three motor performance tasks, during which they had a plateau in performance, 27 male students performed the same tasks under an audience condition. With an audience they had significant increases in HR prior to all three tasks, as well as significant increases in performance on all three tasks. On the other hand, Paulus and Cornelius (1974) found that the subjects with the highest skill level had the largest decrease in performance when required to spontaneously demonstrate gymnastics skills in front of spectators. Michaels, Blommel, Brokato, Linkous and Rowe (1982) also found that good pool players

improved accuracy by about 9% when being observed, while poor pool players decreased accuracy by around 9% with observers.

Effect of Competition on Performance

Triplett (1897) performed one of the initial studies on competition in sport and how it affects performance. He found that cyclists who were paced, timed, and racing against another competitor who was also paced and timed, performed significantly better than when they were unpaced, or just paced (as cited in Cox, 1990). Passelergue et al. (1995) found competitors had significantly better performances during a sanctioned competition when compared to a simulated weight lifting competition. Foster, Green, Snyder, & Thompson (1993) studied well-trained, sub-elite and elite athletes during a 5 km time trial on a racing bicycle attached to a windload simulator versus a cycle ergometer GXT. They found that the time trial produced a significantly higher $\dot{V}O_2$ max, HR max, blood lactate concentration, and pulmonary ventilation than the GXT. Giannini, Weinberg, and Jackson (1988) found that subjects performed significantly better on a one-on-one offensive basketball task when given a competitive goal, than subjects who were told to "do your best" without feedback in post-test trials. These studies demonstrated the positive effects of entering into competition. The desire to outperform others or attain a personal best generally results in a greater performance.

Gender and Competition

Males and females interact frequently on a daily basis, whether at work, at the gym, or in the home. Generally males are considered to be competitive and aggressive,

while females are less competitive and passive. Cashdan (1998) used diaries of college-aged men and women to determine why each gender competes, with whom they compete, and how the competition is displayed. The researchers found that each gender is most likely to compete with a member of the same gender, but women usually compete for attention and academics while males compete for success in academics or sports. In accordance with general beliefs, males are more likely to use physical aggression, and younger men are more competitive than older men.

Gill et al. (1984) matched subjects with either a person of the same or opposite gender for a competitive pegboard task. The researchers found that although males had overall faster times during non-competition, females had overall faster times during competition. In other words, with competition, females improved performance time by a greater percentage than males. Females won eight of ten opposite gender competitions leading the researchers to conclude opposite gender competition may not be detrimental to females' performance. They also found individuals in the same-gender competition improved performance more than individuals in opposite gender competition. During a color-word interference task (a Stroop test), with either competitive or non-competitive instructions (but performing alone), females had a significant improvement with competitive instructions, and a faster time regardless of the situation (Peretti, 1971). Palmer and Bennett (1998) found similar results using a Stroop test and a receptive attention task. Men performed better than women in non-competition for both tasks, but the women performed better in competition. Males competing versus males had the

highest score on a pursuit rotor apparatus test, but the females performed better when competing against a member of the opposite gender. Regardless of opponent gender, performance was significantly better during competition than in non-competitive settings (Freishlag, 1973).

Taylor (1978) measured reaction time, movement time, and response time of college-aged males and females on a choice response time task and the opponent's sex did not cause a significant difference in performance. It was noted that the experimental group (competing group) did have a significant improvement in performance in all areas, while the control group (not competing) did not. Johnson (1975) found no difference in performance of a colored card-sorting task when competing against the same or opposite gender for 8-20 year olds.

It is not often that males and females actually compete in a sanctioned athletic event. There are two documented events that have pitted a man versus a woman: on September 20, 1973 Billie Jean King defeated Bobby Riggs in a tennis match, and on October 9, 1999 Margaret McGregor defeated Loi Chow in a boxing match. Although these were sanctioned events the match-ups were less than equal. Billie Jean King was 29 years of age when she faced the 55 year-old Bobby Riggs. Just weeks before the match Riggs had easily defeated Margaret Court, a three time Wimbledon champion, in an exhibition match. Margaret McGregor had a 3-0 record when she challenged the 0-2 Chow who had been out of boxing for 4 years while pursuing a career as a jockey. A number of exhibition boxing and kickboxing matches between sexes have taken place

dating back to 1952. It should also be noted that many competitions such as the triathlons, marathons, road races, and cycling competitions often have males and females racing simultaneously. While it is not "head-to-head" competition, they are racing the same courses at the same time. In the recent Ironman Australia, the first place female, Lori Bowden, had one of the four closest women-versus-men winning time gaps in history of Ironman racing, just 29.9 minutes behind the men's champion. Bowden also holds the closest time a woman has come to winning an Ironman competition at 24.5 minutes behind the top male finisher. During the race in Australia her marathon run time was faster than all but the top two men finishers.

White (1991) used a time-on-target task, where subjects tried to keep a hand held stylus on a rotating light. Subjects completed the task competitively, non-competitively, or cooperatively and males had a significantly higher score in all situations. Competitive males had the highest score while competitive women had the lowest score.

When comparing males and females, Gackenback (1982) found that in collegiate swimmers, males had a higher systolic blood pressure prior to competition, even though they reported lower feelings of anxiety and hostility than females prior to competition. The females actually had a decrease in blood pressure before competition compared to before a practice. Therefore, the physiological effect of competition may also differ by gender.

Summary

In conclusion, it appears from the review of literature, that although GXT is designed to measure $\dot{V}O_2$ max, many subjects do not reach an oxygen consumption plateau. This may be due to insufficient motivation, undesirable environment, or a lack of expectations that prevents them from exercising to this level. This underestimation of $\dot{V}O_2$ max may lead to inaccurate interpretation of fitness level and athletic potential. Competition generally produces an increase in performance when compared to noncompetitive or cooperative environment. Performance in a competitive setting is dependent on expectation of success, need achievement motivation, and gender. Yet, the effect of opposite gender competition is somewhat inconclusive. In some cases females improve performance when competing with males, and other times performance decreases. The studies involving competition between genders have focused on mental tasks or simple motor task. Athletic events that placed a male versus a female were often unequal and centered toward media profit rather than establishing equality between men and women. Little research has been completed on competition between males and females using a strenuous physical performance scenario. Therefore, further investigation is needed to assess the impact of gender and competition on performance.

Chapter 3

METHODS

The purpose of this study was to examine the effects of competition and opponent gender on physiological responses and performance during a treadmill GXT. This chapter will review the methods and procedures used during this study and will include the following sections: (a) recruitment of subjects (b) initial assessment of subjects, (c) GXT protocol, (d) procedure for pairing, (e) experimental design, (f) statistical analysis, and (g) summary.

Recruitment of Subjects

Thirty-one subjects (males=15, females=16) between the ages of 18-44 years were recruited from the Ithaca, NY community. Flyers were posted in the surrounding area at fitness centers, sporting goods stores, and the Ithaca College and Cornell University campuses. To be eligible, subjects needed to be currently exercising a minimum of 45 minutes, 3 days a week, and had participated in at least three years of competitive athletics in high school or college. Subjects were asked to abstain from heavy activity such as a hard practice or workout on the day prior to as well as the day of the testing. They were also asked to refrain from eating, ingesting caffeine or nicotine a minimum of 3 hours before the testing.

Potential subjects reported to the Ithaca College Wellness Clinic for trial 1 (T1) and completed a health history form (Appendix A) and a 24-hour lifestyle history (Appendix B) to evaluate their ability to participate in the study. Any volunteer with

more than one risk factor for coronary heart disease (i.e., hypertension, smoker, high cholesterol, obese, family history of coronary heart disease) according to the ACSM's Guidelines for Exercise Testing and Prescription (ACSM, 2000) was eliminated from the sample.

Initial Assessment of Subjects

Individuals who met study criteria and did not have a 24-hour lifestyle history violation (e.g., ate <3 hours before) were informed they would be completing three exercise tests but were not informed of impending competition with another subject. This was to prevent any anticipatory preparation or emotional response by the subjects. Any questions concerning the study were answered and informed consent was then obtained from all subjects using a form approved by the Ithaca College Human Subjects Research Committee (Appendix C). Subjects then completed the Sports Attitude Inventory (SAI) (Appendix D), the Physical Self-Efficacy Scale (PSE) (Appendix E), and the Jenkins Activity Survey (JAS) (Appendix F). The SAI is used to determine level of achievement motivation and competitiveness and literature indicates that high motive to achieve success will lead subjects to enter into competition and perform well, and a high motive to avoid failure will lead subjects to avoid competition and perform poorly. The PSE is used to determine confidence in ability and the literature shows that subject with high self-efficacy will perform well in competition and can overcome moderate ability deficits. The JAS is used to determine type A versus type B behavior, with literature indicating type A subjects are more competitive than type B subjects. Each instrument,

scoring details, reliability, validity, and normative data can be found in the respective appendix.

GXT Protocol

Upon completion of the psychological questionnaires, resting heart rate and blood pressure were taken and each subject was weighed in shorts and a t-shirt on a calibrated balance scale. A heart rate monitor (Polar, Woodbury, NY) was then placed on the subject and they were escorted to the Exercise Physiology Laboratory. Rating of perceived exertion (RPE) using a 6-20 scale (Borg, 1972) and hand signals to be used during the GXT were explained, and then a description of the protocol was given to the subjects. A 5-minute warm-up on the treadmill at each subject's self-selected pace with 0% grade was completed. Each subject was asked what speed best matches the maximum speed they could maintain for around 20 minutes and this was used as the testing speed. Following the warm-up, the treadmill was stopped and each subject was fitted with headgear (Hans Rudolph, Kansas City, MO), a Hans Rudolph 2700 series large 2-way non-rebreathing valve, and nose clip. The experimenter gave standardized verbal instructions prior to and during the test.

Subjects performed a maximal test on a motorized treadmill (Precor C962i, Bothell, WA) using a continuous running protocol (McConnell & Clark, 1988). The treadmill was set at 0% grade, the belt was started, and the subject was directed to step onto the belt. The speed increase button was immediately held until the speed reached the previously determined testing speed. The test had an increase of 2% in grade every 3

minutes until volitional exhaustion. This was signaled when the subject grabbed onto the handrail, and the test was stopped. This protocol was adapted from McConnell & Clark's (1988) study that evaluated different protocols for runners.

Heart rate (HR) was recorded at the end of every minute, and RPE was obtained one and a half minutes into each 3-minute stage. A ParVo Medics True Max 2400 Metabolic Measurement System (Salt Lake City, UT) was used to measure $\dot{V}O_2$, time to exhaustion (TE), and respiratory exchange ratio (RER). Measurements of $\dot{V}O_2$ and RER were taken every 15 seconds and $\dot{V}O_2$ max and maximum RER were determined by averaging the four values for the last minute of the GXT. The metabolic cart was calibrated using a 3-liter syringe and known gases approximating expired ventilation values (16% O_2, 4% CO_2) prior to the start of each GXT.

Procedure for Pairing

Subjects began the experiment by completing T1 in the presence of the researcher and an assistant. As soon as two subjects had a time to exhaustion (TE) within 1.5 minutes of each other, they were paired and placed in the experimental (E) group, and continued with the remaining trials. If more than two subjects had similar TE, it was attempted to also match $\dot{V}O_2$ max and/or testing speed. This pairing could be with a male or with a female competitor. Time to exhaustion was determined from the time the subject reached their testing speed until they signaled to end the test by grabbing the handrail of the treadmill. The E subjects completed trial 2 (T2) and trial 3 (T3) in the presence of another subject, as well as the researcher and assistant. After the second trial,

subjects were paired again for a third trial with a subject of opposite gender of their competition in the second trial, using the same criteria for pairing as previously mentioned. This allowed one trial to be completed with a member of the opposite gender while another trial was completed with a member of the same gender. Subjects who were unable to be paired with another subject became control (C) subjects. The C subjects then completed T2 and T3 in the presence of the researcher and an assistant. All subjects completed three exercise tests each separated by at least two days, but not longer than three weeks to complete all trials. A total of 15 subjects (7 males; 8 females) were initially in the C group, and 16 subjects (8 males; 8 females) were initially in the E group. One female subject was eliminated from the control group for exceeding the three-week limit for completing all trials, and one female and one male subject were eliminated from the experimental group for not completing all three trials, bringing each group to 14 subjects (7 males; 7 females).

Experimental Design

For the control group, T2 and T3 were identical to T1 except the only questionnaire completed was a 24-hour lifestyle history. The same was true for E subjects, but during T2 and T3 a second subject was present in the laboratory on an adjacent treadmill. The order of the two trials (opposite gender or same gender competitor first) was randomized among the subjects. Subjects were told their competitor had similar results during T1 and that they should try to compete with that person for the better performance time. Just prior to the beginning of each E test, the

subjects were again told that they had similar results during T1 and then were told, "I want to see who quits first." In all tests for C and for T1 for E, the subjects were verbally encouraged, from a list of possible phrases (Appendix G). During T2 and T3 for E, in addition to the list of phrases, subjects were also encouraged with the phrases, "come on, don't let them beat you," "you don't want to be the one who quits first" and "don't give up." During T2 and T3 for E, subjects were urged to continue even after the competitor stopped.

Statistical Analysis

Data were statistically analyzed using SPSS Version 10.0 software. A 2 x 2 x 3 ANOVA (group x gender x trial) with repeated measures on the last factor was used to analyze the dependent variables. Dependent variables included $\dot{V}O_2$ max, TE, and RER. Separate 2 x 2 ANOVAs (gender x group) were computed for the measurements of the JAS, the PSE, and the SAI. Significant F-values were further analyzed using a Tukey HSD post-hoc procedure. Level of significance was set at $\alpha = 0.05$. Descriptive statistics including mean and standard error of the mean were calculated on all dependent variables.

Summary

Twenty-eight subjects (males=14, females=14) between the ages of 18-44 years were recruited to complete three GXT's. The control subjects completed all three trials alone, while the experimental subjects completed T1 alone, and a second and third trial

versus a male and female competitor. The dependent variables of $\dot{V}O_2$ max, TE, and RER, were analyzed using a 2 x 2 x 3 ANOVA (group x gender x trial) with repeated measures on trial. Psychological measures were evaluated using the JAS, the PSE and the SAI, and were statistically analyzed using a 2 x 2 ANOVA (gender x group).

Chapter 4

RESULTS

The results of this study, examining the effect competition between genders has on performance, are described in this chapter. The raw data, subject demographics, and pairing information from the study can be found in Appendix H. Within this chapter, data are organized by variables into three sections: 1) Demographic data, 2) Physical and performance variables and, 3) Psychological variables.

Demographic Data

Initially 31 subjects were recruited for the study, but three subjects were eliminated for not meeting all criteria of the study. Subject #6 and subject #14 were eliminated from the analyses due to not completing T3. Subject #24 was eliminated from analyses due to having greater than three weeks elapse before completion of all trials. The number #13 was never assigned to a subject. Table 1 displays the pairing of the experimental subjects for competitive trials. The average difference between TE used for pairing competitors is 0.73 ± 0.32 minutes during T2 and 0.75 ± 0.62 minutes during T3. A summary of the subjects' demographic data can be seen in Table 2.

Physiological and Performance Variables

$\dot{V}O_2$ max

$\dot{V}O_2$ max is the maximum amount of oxygen that a person can consume from the environment, transport to the necessary tissues, and utilize for energy production. Means and SEM for $\dot{V}O_2$ max for all conditions can be seen in Table 3. Table 4 summarizes the

Table 1

Summary of Competition Pairs for the Experimental Group

		Competitor	
Gender	Subject	Trial 2	Trial 3
m	1	5 (0.77)	8 (0.95)
m	2	6 (0.90)	10 (0.35)
m	5	1 (0.77)	27 (0.71)
f	7	11 (0.90)	19 (0.23)
f	8	1 (0.95)	10 (1.37)
f	10	2 (0.35)	8 (1.37)
m	11	21 (0.30)	7 (0.90)
f	15	26 (0.60)	22 (0.17)
f	19	21 (0.37)	7 (0.23)
m	21	11 (0.30)	19 (0.37)
f	22	28 (0.85)	15 (0.17)
m	26	28 (1.24)	15 (0.60)
f	27	5 (0.71)	14 (0.82)
m	28	26 (1.24)	22 (0.85)

Note. Difference in TE used for pairing is listed in parentheses (e.g., subject 1 and 5 had a difference in TE of 0.77 minutes to pair for T2.)

Table 2

Mean and Standard Deviation of Demographic Data by Gender, Group, and Total Subjects

		Male			Female		
		Control (n=7)	Experimental (n=7)	Total (n=14)	Control (n=7)	Experimental (n=7)	Total (n=14)
Age (years)	Mean	31.3	27.7	29.5	33.6	22.3	27.9
	SD	9.8	8.6	9.0	10.0	2.9	9.2
Weight (pounds)	Mean	161.9	166.7	164.3	142.9	139.7	141.3
	SD	20.8	18.7	19.2	28.7	20.9	24.2
Height (inches)	Mean	70.6	69.6	70.1	64.9	66.7	65.8
	SD	2.1	2.6	2.3	2.3	2.5	2.5
Years in competition	Mean	14.1	14.0	14.1	9.1	6.0	7.6
	SD	7.4	7.7	7.2	5.7	2.8	4.6

Table 3

Mean and Standard Error of the Mean (SEM) for $\dot{V}O_2$ max ($ml \cdot kg^{-1} \cdot min^{-1}$) across Three Trials

	Control					
	Male (n=7)			Female (n=7)		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
Mean	65.93	63.36	64.91	40.64	39.53	39.62
SEM	2.64	2.63	2.97	2.09	1.80	1.60

	Experimental					
	Male (n=7)			Female (n=7)		
		Gender of Competition			Gender of Competition	
	Trial 1	Male	Female	Trial 1	Male	Female
Mean	54.37	52.31	52.86	47.56	48.57	47.82
SEM	2.78	2.21	1.76	0.70	1.26	1.14

Note. For the control group all trials were completed alone. For the experimental group trial 1 was alone, trial 2 was versus a male, and trial 3 was versus a female.

Table 4

Summary of 2 x 2 x 3 ANOVA for $\dot{V}O_2$ max

Source	SS	df	MS	F	p
Gender	4727.438	1	4727.438	56.228	0.000*
Group	64.299	1	64.299	0.765	0.391
Gender x Group	2019.021	1	2019.021	24.014	0.000*
Error	2017.826	24	84.076		
Trial	20.560	2	10.280	2.965	0.061
Trial x Gender	18.277	2	9.139	2.636	0.082
Trial x Group	6.364	2	3.182	0.918	0.406
Trial x Gender x Group	3.342	2	1.671	0.482	0.621
Residual	166.423	48	3.467		

Note. *indicates significant difference ($p<0.05$)

results of the ANOVA for $\dot{V}O_2$ max. The 2 x 2 x 3 ANOVA (group x gender x trial) showed a significant gender x group interaction (F=24.014, p= .000). Using a Tukey HSD post-hoc procedure, it was found that the control group males had a significantly higher $\dot{V}O_2$ max than the experimental group males (64.73 $\pm$ 2.71 vs. 53.18 $\pm$ 2.18 $ml \cdot kg^{-1} \cdot min^{-1}$, respectively), while the control group females had a significantly lower $\dot{V}O_2$ max than the experimental females (39.93 $\pm$ 1.81 vs. 47.98 $\pm$ 0.82 $ml \cdot kg^{-1} \cdot min^{-1}$, respectively). When evaluating gender differences within the control and experimental groups, it was found that in the control group, males had a significantly higher $\dot{V}O_2$ max than females, however no significant difference was found between males and females in the experimental group. Table 5 contains a summary of the post-hoc analysis. No significant differences were found for trial indicating that competition did not have an affect on $\dot{V}O_2$ max. Figure 1 shows the change in $\dot{V}O_2$ max for all subjects across the three trials.

RER

RER, the respiratory exchange ratio is the ratio of $\dot{V}CO_2$ produced to $\dot{V}O_2$ consumed. The means and SEM for maximum RER achieved during the exercise tests can be seen in Table 6. Table 7 shows the ANOVA summary for maximum RER. The 2 x 2 x 3 ANOVA (gender x group x trial) showed no significant interactions. A significant main effect was found for trial (F=6.36, p=0.003). A post-hoc Tukey HSD showed that mean RER was significantly higher for all subjects (control and experimental combined) during T2 and T3, when compared to T1 (critical difference = 0.0205). The

Table 5

Differences Between Means for $\dot{V}O_2$ max for Analysis of Significant Gender x Group Interaction

			Control		Experimental	
		Mean	Male	Female	Male	Female
Control	Male	64.73	-	-	-	-
	Female	39.93	24.81*	-	-	-
Experimental	Male	53.18	11.56*	-13.25*	-	-
	Female	47.98	16.75*	-8.06*	5.20	-

* indicates a significant difference ($p<.05$) using a Tukey HSD procedure (minimum critical difference =7.80)

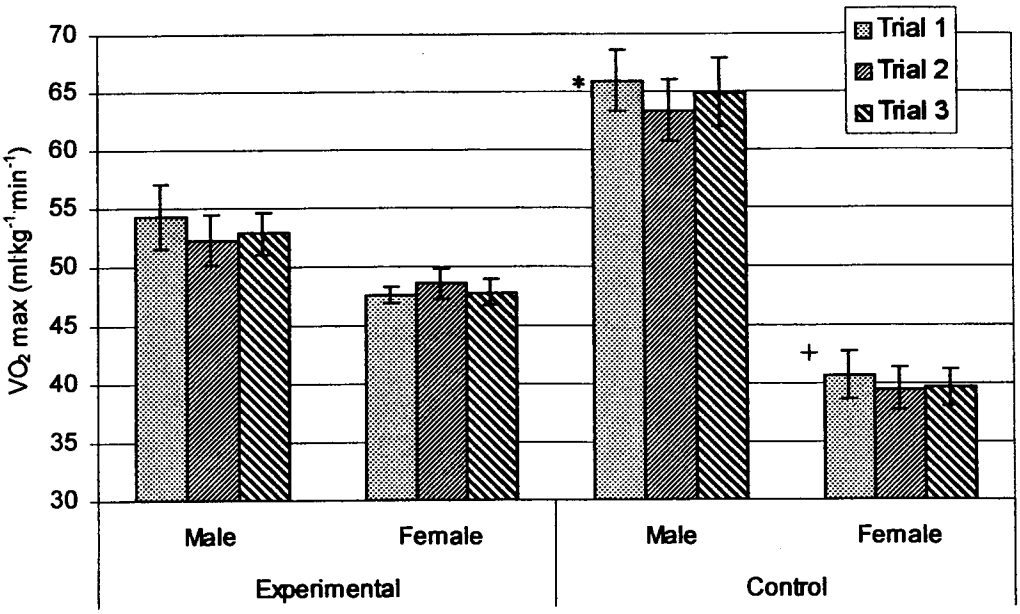

Figure 1. Comparison of mean (± SEM) for $\dot{V}O_2$ max across three trials for the experimental and control subjects (experimental: n=7 males, 7 females; control: n=7 males, 7 females). For the experimental group, trial 2 was versus a male competitor and trial 3 was versus a female competitor.

* Indicates the male control group was significantly higher ($p<0.05$) than all other groups

+ Indicates the female control group was significantly lower ($p<0.05$) than all other groups

Table 6

Mean and Standard Error of the Mean (SEM) for RER across Three Trials

	Control					
	Male (n=7)			Female (n=7)		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
Mean	1.09	1.12	1.12	1.07	1.10	1.08
SEM	0.012	0.015	0.013	0.020	0.020	0.025

	Experimental					
	Male (n=7)			Female (n=7)		
		Gender of Competition			Gender of Competition	
	Trial 1	Male	Female	Trial 1	Male	Female
Mean	1.11	1.12	1.13	1.08	1.10	1.13
SEM	0.017	0.015	0.027	0.014	0.021	0.021

Note. For the control group all trials were completed alone. For the experimental group trial 1 was alone, trial 2 was versus a male, and trial 3 was versus a female.

Table 7

Summary of the 2 x 2 x 3 ANOVA for RER

Source	SS	df	MS	F	p
Gender	0.01030	1	0.01030	1.815	0.191
Group	0.00414	1	0.00414	0.730	0.401
Gender x Group	0.00027	1	0.00027	0.047	0.830
Error	0.13600	24	0.00567		
Trial	0.01282	2	0.00641	6.636	0.003*
Trial x Gender	0.00006	2	0.00003	0.033	0.967
Trial x Group	0.00302	2	0.00151	1.562	0.220
Trial x Gender x Group	0.00215	2	0.00108	1.113	0.337
Residual	0.04635	48	0.00097		

Note. *indicates significant difference ($p<0.05$)

mean RER for T1 was 1.09 $\pm$ .008, and the means for T2 and T3 were 1.11$\pm$ .009 and 1.12 $\pm$ .011 respectively. Neither gender nor group had an affect on maximum RER. Figure 2 shows maximum RER for the control group, the experimental group, and all subjects combined.

Time to Exhaustion

The third physiological variable examined in this study was time to exhaustion (TE). Time to exhaustion was determined from the time the subject reached their testing speed until they signaled to end the test, measured in minutes. Means and SEM for TE in all conditions can be seen in Table 8. Table 9 shows the ANOVA summary for TE. The 2 x 2 x 3 ANOVA (gender x group x trial) displayed no significant interactions, indicating competition did not affect TE. There were no significant main effects found for trials, gender, or group indicating time to exhaustion was similar for males and females, control and experimental, and across the three trials. Figure 3 represents the TE scores for all subjects across the three trials.

Psychological Variables

To examine factors that could impact the competitiveness of subjects, three psychological scales were administered in this study: the PSE, the JAS, and the SAI. The results for these variables are discussed below.

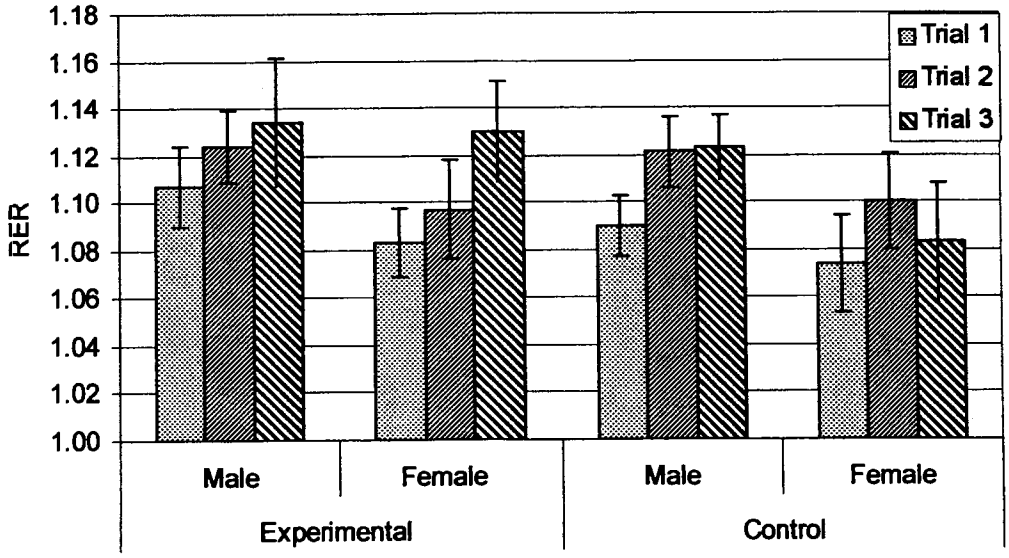

Figure 2. Mean (± SEM) RER across three trials for the experimental and control subjects (experimental: n=7 males, 7 females; control: n=7 males, 7 females). For the experimental group, trial 2 was versus a male competitor and trial 3 was versus a female competitor. A significant main effect was found for trials indicating RER was significantly higher during T2 and T3 compared to T1.

Table 8

Means and Standard Error of the Mean (SEM) for Time to Exhaustion (minutes) Across Three Trials

	Control					
	Male (n=7)			Female (n=7)		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
Mean	13.81	14.28	14.57	11.64	11.60	11.41
SEM	0.66	0.76	0.93	1.22	1.01	1.07

	Experimental					
	Male (n=7)			Female (n=7)		
		Gender of Competition			Gender of Competition	
	Trial 1	Male	Female	Trial 1	Male	Female
Mean	11.89	11.69	11.49	11.76	12.68	12.50
SEM	0.83	0.78	0.56	1.01	0.74	0.86

Note. For the control group all trials were completed alone. For the experimental group trial 1 was alone, trial 2 was versus a male, and trial 3 was versus a female.

Table 9

Summary of the 2 x 2 x 3 ANOVA for Time to Exhaustion

Source	SS	df	MS	F	p
Gender	21.869	1	21.869	1.468	0.237
Group	16.333	1	16.333	1.097	0.305
Gender x Group	57.107	1	57.107	3.834	0.062
Error	357.449	24	14.894		
Trial	1.275	2	0.637	0.792	0.459
Trial x Gender	0.348	2	0.174	0.216	0.806
Trial x Group	0.210	2	0.100	0.125	0.883
Trial x Gender x Group	4.377	2	2.188	2.720	0.076
Residual	38.624	48	0.805		

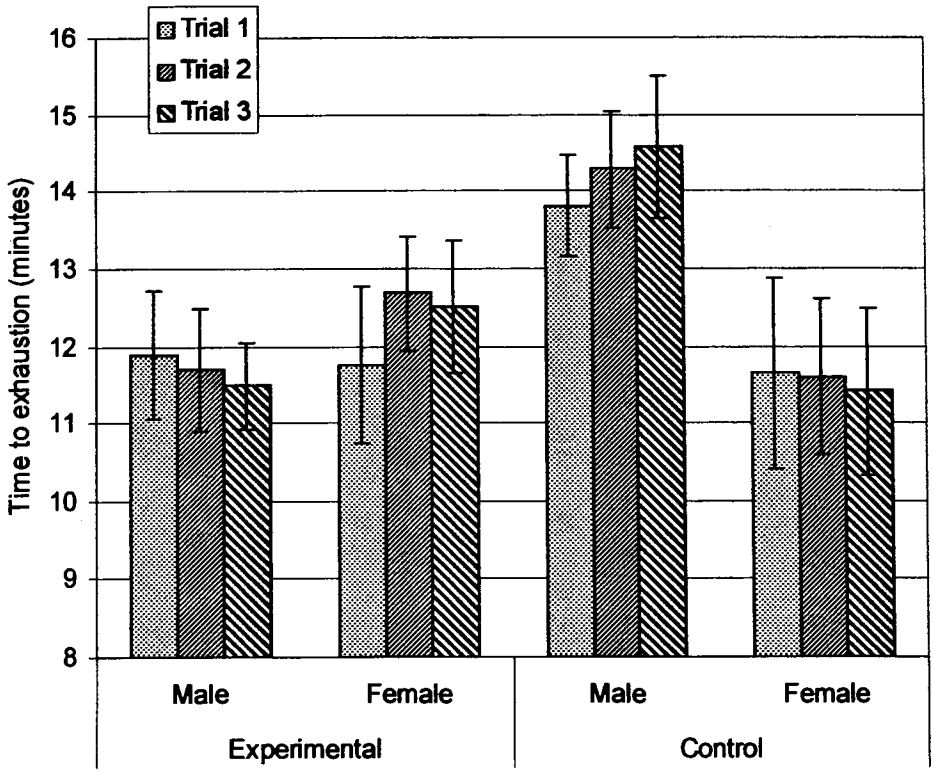

Figure 3. Mean (± SEM) for TE across three trials in experimental and control groups. For the experimental group, trial 2 was versus a male competitor and trial 3 was versus a female competitor. No significant interaction or main effect was found for TE.

Physical Self-Efficacy Scale (PSE)

The PSE scale is a tool used to measure self-efficacy or feelings of effectiveness, perception of abilities, or self-confidence. The scale uses 22, 6-point Likert items, with a possible score range from 22 to 132, with higher scores representing a high sense of physical self-efficacy. Table 10 displays the means and SEM for the PSE. Table 11 illustrates the 2 x 2 ANOVA (gender x group) for the PSE, showing no significant differences between genders or groups. The results indicated that subjects were similar in self-efficacy.

Jenkins Activity Survey (JAS)

The JAS is a scale comprised of four subscales: Type A Personality scale, Speed and Impatience scale, Involvement scale, and Hard-Driving and Competitive scale. Table 12 shows the mean and SEM for each component of the JAS. Table 13 illustrates the 2 x 2 ANOVA (gender x group) for the JAS, showing no significant differences in the Impatience scale, Involvement scale, and Type A Personality scale between genders or groups indicating the subjects were similar in these areas. However, a significant main effect for gender was found in the Hard-Driving and Competitive scale ($F=5.454$, $p=0.028$). Females were found to have a significantly higher score on the Hard-Driving and Competitive scale than the males (7.34 ± 2.38 vs. -0.47 ± 2.48 respectively).

Table 10

Means and Standard Error of the Mean (SEM) for the Physical Self-Efficacy Scale (PSE) for All Subject Groups

	Male			Female		
	Control (n=7)	Experimental (n=7)	Total (n=14)	Control (n=7)	Experimental (n=7)	Total (n=14)
Mean	90.71	101.00	95.86	94.29	93.00	93.64
SEM	4.13	4.72	3.33	3.91	4.67	2.93

Table 11

Summary of the 2 x 2 ANOVA of the Physical Self-Efficacy Scale (PSE)

Source	SS	df	MS	F	p
Gender	34.321	1	34.321	0.257	0.617
Group	141.750	1	141.750	1.060	0.313
Gender x Group	234.321	1	234.321	1.753	0.198
Residual	3208.857	24	133.702		

Table 12

Means and Standard Error of the Mean (SEM) for the Four Subscales of the Jenkins Activity Survey (JAS) According to Gender, Group and Total Subjects

		Male			Female		
		Control (n=7)	Experimental (n=7)	Total (n=14)	Control (n=7)	Experimental (n=7)	Total (n=14)
Personality	Mean	-1.03	-3.86	-2.44	2.29	6.19	4.24
	SEM	4.12	4.36	2.91	3.54	1.02	1.85
Impatience	Mean	-1.09	-5.11	-3.10	2.40	-1.64	0.38
	SEM	2.34	2.51	1.74	3.05	2.12	1.87
Involvement	Mean	6.71	4.51	5.61	6.99	5.77	6.38
	SEM	2.71	4.14	2.40	1.98	2.35	1.49
Competitive	Mean	1.80	-2.74	-0.47*	3.54	11.13	7.34*
	SEM	4.08	2.90	2.48	3.69	2.47	2.38

* indicates that females were found to be significantly more competitive than their male counterparts ($p < .05$)

Table 13

Summary of the 2 x 2 ANOVA for the Four Subscales of the Jenkins Activity Survey (JAS)

Component	Source	SS	df	MS	F	p
Personality Type	Gender	312.223	1	312.223	3.600	0.070
	Group	2.009	1	2.009	0.023	0.880
	Gender x Group	79.229	1	79.229	0.913	0.349
	Residual	2081.709	24	86.738		
Impatience	Gender	84.703	1	84.703	1.895	0.181
	Group	114.009	1	114.009	2.551	0.123
	Gender x Group	0.000	1	0.000	0.000	0.998
	Residual	1072.694	24	44.696		
Involvement	Gender	4.089	1	4.089	0.069	0.795
	Group	20.400	1	20.400	0.343	0.563
	Gender x Group	1.700	1	1.700	0.029	0.867
	Residual	1425.700	24	59.404		
Competitiveness	Gender	426.660	1	426.660	5.456	0.028*
	Group	16.203	1	16.203	0.207	0.653
	Gender x Group	257.429	1	257.429	3.292	0.082
	Residual	1876.749	24	78.198		

Note. *indicates significant difference ($p<0.05$)

Sports Attitude Inventory (SAI)

The SAI is a tool used to measure competitiveness and achievement motivation (motive to achieve success and motive to avoid failure). Achievement motivation affects the subjects' likelihood to enter into a competitive situation and the degree to which they would excel in that situation. The scale uses 40, 5-point Likert items, with 12 items related to competitiveness, 17 for motive to achieve success, and 11 for motive to avoid failure. Table 14 shows the means and SEM for the SAI while Table 15 shows the 2 x 2 ANOVA (gender x group) analyses of the SAI. The 2 x 2 ANOVA demonstrated no significant interactions between genders and groups, and no main effect for gender or group indicating the subjects were similar in their competitiveness, motive to achieve success, and motive to avoid failure.

Summary

These data revealed a significant interaction between gender and group for $\dot{V}O_2$ max with the control males having a significantly higher $\dot{V}O_2$ max than experimental females and experimental males, and the control females also had a significantly lower $\dot{V}O_2$ max than experimental males and experimental females, indicating that the pairing procedure created an experimental group with average $\dot{V}O_2$ max values, while the control group subjects were the above average males and below average females. A significant main effect in maximum RER was found for trials with T1 being significantly lower than T2 and T3, indicating that maximum RER tended to increase with practice. There also was a

Table 14

Means and Standard Error of the Mean (SEM) for the Three Components of the Sports Attitude Inventory (SAI) According to Gender, Group and Total Subjects

		Male			Female		
		Control (n=7)	Experimental (n=7)	Total (n=14)	Control (n=7)	Experimental (n=7)	Total (n=14)
Competitive	Mean	47.57	46.71	47.14	46.14	46.43	46.29
	SEM	1.65	1.77	1.17	1.22	2.35	1.27
Success	Mean	69.14	65.29	67.21	65.00	70.71	67.86
	SEM	3.31	2.78	2.15	2.33	1.54	1.56
Failure	Mean	34.71	32.71	33.71	32.86	34.86	33.86
	SEM	0.94	1.84	1.03	2.25	1.06	1.23

Table 15

Summary of the 2 x 2 ANOVA for the Three Components of the Sports Attitude Inventory (SAI)

Component	Source	SS	df	MS	F	p
Competitivenss	Gender	5.143	1	5.143	0.229	0.637
	Group	0.571	1	0.571	0.025	0.875
	Gender x Group	2.286	1	2.286	0.102	0.753
	Residual	539.714	24	22.488		
Motive to achieve success	Gender	2.893	1	2.893	0.062	0.805
	Group	6.036	1	6.036	0.130	0.722
	Gender x Group	160.321	1	160.321	3.455	0.075
	Residual	1113.714	24	46.405		
Motive to avoid failure	Gender	0.143	1	0.143	0.008	0.930
	Group	0.000	1	0.000	0.000	1.000
	Gender x Group	28.000	1	28.000	1.532	0.228
	Residual	438.571	24	18.274		

significant main effect found between genders on the JAS Hard-Driving and Competitiveness scale, with females scoring higher in competitiveness than males.

Chapter 5

DISCUSSION

The primary purpose of this study was to evaluate the effect of competition between genders on physiological and performance variables during a GXT. The majority of previous exercise-related literature focuses on the effect of verbal encouragement or personality type on GXT performance (Butts et al., 1982; Chitwood et al., 1997; Moffatt et al., 1994). Another body of work examined the effect of competition between genders on simple motor (Freishlag, 1973; Gill et al., 1984; Taylor, 1978; White, 1991) or cognitive tasks (Johnson, 1975; Palmer & Bennett, 1998; Peretti, 1997). Only one previous study discussed the effect of competition on performance during a cycle ergometer GXT, but used only male subjects (Wilmore, 1968).

Physiological Measures

Although competition might be expected to improve performance, it did not have an effect on the selected measures of performance in the current study. There was no difference in $\dot{V}O_2$ max or time to exhaustion in subjects that were competing. One explanation is that the subjects of this study reached their observed max during trial 1 and were therefore physically unable to increase performance during subsequent trials with competition. Butts et al. (1982) found that intercollegiate cross-country runners had no increase in $\dot{V}O_2$ max during a second trial treadmill GXT with vigorous verbal encouragement. Moffatt et al. (1994) also found that competitive distance runners were unable to increase $\dot{V}O_2$ max during a second trial treadmill GXT with verbal

encouragement. Chitwood et al. (1997) studied the performance of Type A and Type B personalities during GXTs and found Type A personalities were unable to increase $\dot{V}O_2$ max during a second trial with verbal encouragement, while Type B personalities showed improvement in $\dot{V}O_2$ max and TE. The present study partially concurs with the results of Wilmore (1968) who used college-aged males competing during a cycle ergometer GXT. His subjects also had no increase in $\dot{V}O_2$ max during a second trial that involved competition with another subject, but Wilmore's subjects did have an increase in mean work output and riding time during competition, while the subjects in the present study did not increase TE. These studies lead to the conclusion that subjects are able to exert themselves further to an observed maximum during an initial GXT, and the external motivator of competition provided by the researchers was unable to increase $\dot{V}O_2$ maximum on a subsequent GXT.

While competition-induced improvement in performance was not seen in this study, there were small but significant differences noted in RER between baseline and subsequent trials for all subjects. The variable RER is the ratio of $\dot{V}CO_2$ produced to $\dot{V}O_2$ consumed and can be used as criteria for attainment of a true maximum GXT. Depending on the author, the RER used to reflect a true maximum test ranges from 1.0 to 1.15 (Chitwood et. al., 1997; Cumming & Borysyk, 1972; Issekutz, Birkhead, & Rodahl, 1962; Moffatt et. al., 1994). In this study, the grand mean for maximum RER was 1.09 ± 0.008 during trial 1 (baseline measurements), and $1.11 \pm 0.009$for trial 2 (experimental: competition versus a male; control: alone) and 1.12 ± 0.011 for trial 3 (experimental:

competition versus female; control: alone). With improvements occurring in all subjects, it is likely that a learning effect enabled a small improvement in RER over three trials. These results are similar to Chitwood et al. (1997) who found no significant increases in $\dot{V}O_2$ max for subjects with Type A personalities, but found a significant increase in RER with verbal encouragement during a GXT. On the contrary, Moffatt et al. (1994) and Butts et al. (1982) found no significant increases in RER for competitive runners or sedentary individuals during a GXT using verbal encouragement. Cumming and Borysyk (1972) found that RER does not always correlate well with other criteria for attaining maximum effort, and there can be a variable degree of overventilation occurring that is not related to other physiological changes. In summary, the change in RER over the trials was small and could be related to variable overventilation, therefore the physiological significance of this event is uncertain.

While unrelated to competition, a significant group difference was found in $\dot{V}O_2$ max between the males and females in the control group, while it was not found between the males and females in the experimental group. This is most likely related to the pairing procedure used in the present study. In an attempt to pair subjects, the experimental group was comprised of subjects with similar performances in TE and $\dot{V}O_2$ max, while the control group was comprised of subjects with performances that were too high or too low to be paired with another subject. This pairing procedure created an environment with higher than average $\dot{V}O_2$ max performances for experimental females and average $\dot{V}O_2$ max performances for experimental males. This in turn made the

control females significantly lower than all other groups, and control males significantly higher than all other groups.

Competition Versus Opposite Gender

While genders are separated during most types of athletic competition, many events allow males and females to compete simultaneously (e.g., marathons, triathlons, road races, cycling, etc). Due to the lack of research into physically stressful inter-gender competition it is unclear how males and females would perform when competing against each other. The previous literature on inter-gender competition studied simple motor tasks or cognitive tasks, and produced conflicting results. The present study found no change in performance for males or females during competition, regardless of the gender of the competitor. These results are similar to Johnson's (1975) findings on a colored card-sorting task that saw no difference in performance regardless of opponent gender. Taylor (1978) also found that opponent gender did not affect reaction time, movement time, and response time when competing on a choice response time task. Although some literature does support an improvement in female performance when competing versus a male, it did not occur in the current study (Gill et al., 1984, Freishlag, 1973, Palmer and Bennett, 1998, Peretti, 1971).

Competition and Performance

Regardless of gender, the current study did not see an improvement in performance with competition, when compared to the control group. This is in contrast to studies in the literature that found significant improvements during competition.

Foster et al. (1993) found that a cycle time trial produced a significantly higher $\dot{V}O_2$ max, HR max, blood lactate concentration, and pulmonary ventilation in well-trained sub-elite, and elite, athletes than during a maximum exercise test. Passelergue et al. (1995) also found subjects performed significantly better in a sanctioned competition than a simulated weight-lifting competition. Taylor (1978) found that the experimental group (competing group) did have a significant improvement on choice response time task, while the control group (not competing) did not. Triplett as far back as 1897, found that cyclists had significantly better performances while being paced, timed and against another competitor, when compared to being just paced or unpaced. These studies showed an improvement in performance with competition and lead to questioning if the present study simulated competition adequately.

Although the environment was intended to elicit the feeling of competition, it is possible the subject did not perceive the situation as competitive. Although perception of competition was not measured in the present study, in discussion with subjects following the experimental trials, multiple subjects noted they did not feel in direct competition with their competitor. Reasons mentioned by the subjects were: they could not see the other subject due to the headgear, they did not know the competitor or have a connection to the competitor, they knew they were not at the same treadmill speed, it was a task to unfamiliar in which to compete. For a situation to be perceived as competitive, the opponents must have a felt rivalry or a felt exclusivity of goals, therefore is highly dependent upon the subject's perception of the opponent and the social environment

(Butt, 1987). When an athlete achieves peak performance, it is sometimes because they react with "fight instincts" as if they were in danger, often occurring when they are defending their ego or their pride during competition (Clarkson, 1999). In the present study, subjects were often not matched on speed, possibly allowing subjects to feel they could stop earlier than their competitor and still have a better performance. In other words, the results of this study may have been limited by creating a less-than-maximal competitive environment. Any future studies should attempt to match subjects based on both $\dot{V}O_2$ max and treadmill speed.

Psychological Measures

A particularly interesting result from the present study was the significant difference found between genders on the competitiveness scale of the JAS. Generally men are considered to be more avid competitors, more aggressive, and are "win-oriented," while females are considered more passive and are "goal-oriented" (Gill, 1988). However in this study, the JAS Hard-driving and competitiveness scale found that the females had a significantly higher mean score than the males. It is also interesting to note the experimental females had the highest mean score with 11.13 (range= 1.6 – 21.4) while the experimental males had the lowest score of –2.74 (range= -9.8 – 8.4). Although these scores indicate the female subjects rated their competitiveness significantly higher than the male subjects, there was not a gender difference in performance during the competitive trials.

It is of importance to understand that scores on the competitiveness subscale of the JAS are derived from a linear transformation with a mean of 0.0 with a standard deviation of 10.0 in the normative population. Therefore the means of the females (7.34) and males (-0.47) fall within one standard deviation of the mean for the normative data for the JAS Hard-driving and competitiveness scale, indicating these athletic subjects had a somewhat neutral competitive drive. This occurred despite the fact that all the subjects had taken part in competitive athletics in the past. Competition neutrality is also indicated on the SAI-competitiveness scores. Both male and female subjects scored within one standard deviation of the mean for the normative data for the SAI-competitiveness score. The correlation between the JAS Hard-driving and competitiveness scale and the SAI-competitiveness scale is r=0.51. It is noteworthy to document that there is a strong correlation between scores on the JAS Hard-driving and competitiveness scale and change in TE for E males from T1 to T2 (r=0.63) and T1 to T3 (r=0.84). This is also true for the SAI-competitiveness scale and change in TE for E males from T1 to T2 (r=0.78) and T1 to T3 (r=0.57). The neutral scores on competitiveness could account in part for the lack of increase in TE and possibly $\dot{V}O_2$ max when these subjects were placed in a competitive situation.

While it is possible the subjects may not have perceived the trials as competitive, or may not have had a competitive drive, review of the data indicates they may have been intrinsically motivated to improve on the performance of T1. Intrinsic motivation is described as behavior that is not dependent on any external rewards (Corsini, 1994). An

athlete who is intrinsically motivated finds encouragement that stems from performing the task itself; there is not a need for outside reward to facilitate the athlete's motivation (Cratty, 1989). In all of the 14 competitions in this study, a subject had "won" their competition, but still had not reached their baseline TE. In 12 of 14 such trials the "winning" competitor continued and exceeded their baseline performance even though their competitor had stopped. Table 15 shows the TE for the 10 subjects who "won" one or both of their competitions. It would appear that most participants in this study were intrinsically motivated to perform and competition was not the driving force.

Given the results of this study, when using a treadmill GXT as a method to determine $\dot{V}O_2$ max, RER and TE, a tester could assume that athletes with a neutral competitive drive are generally able to exert themselves maximally without outside intervention. These findings are in line with previous studies in the literature that test athlete's performance on GXTs. Being accustomed to training at high intensity levels, and performing at a maximum intensity during competition, likely enables athletes to elicit a true maximal intensity during an initial GXT. This evidence suggests that a single GXT can be used to develop appropriate training guidelines, and training with the opposite gender would not be beneficial or detrimental to performance.

Summary

This study showed very little impact of competition or gender on selected performance variables of a treadmill GXT. No significant improvement was found in

Table 16

Comparison of TE in Trials that the Subject "Won" and the TE their Competitor Achieved

	Time to Exhaustion		
Subject	Trial 1	Trial 2	Trial 3
2	14.65	(11.70) 15.00	lost
5	10.37	(10.00) 10.60	(10.37) 11.23
7	12.90	(10.27) 11.88*	lost
8	12.95	(12.37) 12.42*	lost
10	15.00	(13.50) 16.65	(13.57) 15.90
15	10.75	(9.78) 10.88	lost
19	13.13	(13.02) 13.50	(12.72) 13.87
21	13.00	(12.42) 13.78	lost
22	10.92	(10.25) 12.38	(9.13) 11.97
28	10.07	(9.73) 10.28	lost

* indicates the subject "won" the trial but did not exceed their T1 performance

Note. Number listed in parentheses is their competitors TE for that trial (e.g., Subject 2 had a TE of 14.65 on T1, during T2 the competitor stopped at 11.70, but Subject 2 exceed T1 TE by going to 15.00) Four subjects "lost" both competitive trials.

$\dot{V}O_2$ max, RER, or TE when competing regardless of gender. It should be cautioned that the pairing procedure did essentially place higher aerobic capacity females versus average capacity males, and did not adequately test higher aerobic capacity males or lower capacity females in competition. Competition is difficult to simulate and its importance to participants is hard to gauge. Future studies involving competition must be carefully designed to simulate actual competition as best as possible. A slight increase in RER was noted for all subjects but the physiological significance could not be determined by this study. Psychologically, males are often deemed the more competitive sex (Cashdan, 1998), but this study indicated that the females scored significantly higher on the JAS Hard-Driving and Competitiveness scale. In general, the scores from the JAS Hard-Driving and Competitiveness scale and the SAI indicated a neutral competitive drive for all subjects. The lack of improvement in performance with competition could be attributed to the neutral scores of the subjects.

Chapter 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to examine the effect of competition and gender on performance during a treadmill graded exercise test (GXT). Twenty-eight subjects (n=14 males, n=14 females) between the ages of 18-44 years, with a history of participating in competitive athletics completed three treadmill GXTs. All subjects completed trial 1 in the presence of the researcher and an assistant. Based upon time to exhaustion, subjects were paired with another subject (male or female) for the completion of trial 2. For trial 3, subjects were paired a second time with a subject of the opposite gender of their competitor for trial 2. Trials 2 and 3 were designed as a competition with subjects on side-by-side treadmills, completing the GXT simultaneously. Using a speed that was comparable to the subject's training intensity, the protocol for the GXT started with a 0% grade and increased 2% in grade every 3 minutes until volitional exhaustion.

Performance was measured through relative $\dot{V}O_2$ max, RER, and time to exhaustion. Open circuit spirometry was used to determine $\dot{V}O_2$ max and RER, while time to exhaustion was determined from when the subject reached their testing speed until stopping the test by grabbing the handrail. An average of four $\dot{V}O_2$ measurements and an average of four RER measurements during the final minute of the exercise test were used to determine $\dot{V}O_2$ max and maximum RER, respectively. Self-efficacy, achievement motivation, competitiveness, and personality type were also measured using

the Physical Self Efficacy Scale (PSE), the Jenkins Activity Survey (JAS) and the Sports Attitude Inventory (SAI).

A 2 x 2 x 3 ANOVA (group x gender x trial) with repeated measures on trial revealed no significant interactions ($p>0.05$) in time to exhaustion or RER. However, a significant gender x group interaction was found for $\dot{V}O_2$ max A post-hoc Tukey HSD revealed that control males had significantly higher $\dot{V}O_2$ max values than the experimental males and control females had significantly lower $\dot{V}O_2$ max measures experimental females. At the same time when comparing the genders, the control males and control females were significantly different, while the experimental male and females were not. This is most likely attributed to the pairing procedure that was used for the experimental design. A significant main effect was seen for RER with a post-hoc Tukey HSD showing all subjects (control and experimental combined) increased maximum RER from trial 1 to trial 2 and also trial 1 to trial 3.

The analysis of psychological variables using a 2 x 2 ANOVA (gender x group) indicated no significant differences in scores between genders, groups, nor a gender x group interaction in the PSE or SAI. Analysis of the JAS showed significant differences between genders on the competitiveness scale. Comparison of means indicated that overall, female subjects scored higher on competitiveness than male subjects.

Conclusions

Based upon the analysis of data collected in the present study the following conclusions can be made:

1. Even though males typically have a significantly higher $\dot{V}O_2$ max than females when measured during a treadmill GXT, the pairing procedures created an experimental group with above average females and average males, who were not significantly different in $\dot{V}O_2$ max.
2. $\dot{V}O_2$ max may be maximized on the first trial for well-motivated, athletic subjects.
3. Three trials of a treadmill GXT progressively elicit slightly higher RER though the significance of this event is unclear.
4. Females scored higher than males on the competitiveness scale of the JAS, but did not differ on the competitiveness scale of the SAI, although both scales indicated the subjects in this study had neutral competitive drive.
5. Competition versus subjects of the same or opposite gender resulted in no significant changes in treadmill GXT performance as represented by $\dot{V}O_2$ max, time to exhaustion, or RER for males or females.

Recommendations for Further Study

Based upon the results collected in the present study, the following recommendations are made:

1. A study should be performed using a well-trained confederate as the competitor, thereby facilitating a maximum effort on each trial by the competing subject.
2. A study should be performed that matches experimental subjects on treadmill speed to give competitors the feeling of doing equal performance.
3. A study should be performed that provides a reward for "winning" the competition and also for how much one improves performance on subsequent trials. This will motivate those subjects who may be extrinsically motivated rather than intrinsically motivated.
4. A study should be performed utilizing members of the same athletic team where the athletes already compete for positions on the team, such as basketball team or track and field team.
5. A study should be performed using subjects who measure high on the competitiveness scale of the JAS or the SAI, rather than subjects with neutral competitive scores.
6. A study should be performed using a control group more comparable to the experimental group on time to exhaustion, $\dot{V}O_2$ max, and treadmill speed.

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Appendix A

HEALTH HISTORY FORM

Date ___/___/___

Name (please print)_____

Number _____

Birthday ___/___/___ Gender: □ male □female

Height _____inches Weight _____lbs

Do you have a family history (grandparents, parents, siblings) of any of the following?

- □ Heart disease
- □ Stroke
- □ High Blood Pressure
- □ High Cholesterol
- □ Diabetes
- □ Other

If any are checked please specify who and/or what: _____

_____

Do you have any of the following?

- □ Heart disease
- □ High blood pressure
- □ High cholesterol
- □ Asthma
- □ Diabetes
- □ Heart murmur
- □ Skipped or rapid beats, or irregular rhythms
- □ Lung Disease
- □ Cancer
- □ Any major injuries (requiring surgery, or extended time off)

If any are checked please explain:_____

_____

Have you recently experienced any of the following symptoms/conditions?

- ☐ Chest pain
- ☐ Dizziness/Lightheadedness
- ☐ Fainting
- ☐ Heart palpitations
- ☐ Injury
- ☐ Loss of consciousness
- ☐ Shortness of breath

If any are checked please explain:_____
_____

Do you smoke? ☐ yes ☐no ☐quit
How much do (did) you smoke? _____ packs/day
How long have you smoked? _____
If you quit, when_____

Do you currently take any medications? ☐ yes ☐no
If yes, what medications: _____
_____

What does your exercise program currently consist of? _____
_____

Are you currently involved in competitive athletics? ☐ yes ☐no
If yes, what activity? _____
_____

How many years have you participated in competitive athletics? _____

What competitive athletics have you participated in? _____
_____

Do you enjoy having verbal encouragement while competing? ☐ yes ☐no

Have you ever completed a graded exercise test (stress test) on a treadmill? ☐ yes ☐no
If yes, when? _____
If yes, for what purpose? _____

Appendix B

24-HOUR HEALTH HISTORY

Date: ___/___/___ Time: _____ am/pm

Name: _____

How much sleep did you get last night? _____ hours

How much sleep do you normally get? _____ hours

How long has it been since your last meal or snack? _____hours

When did you last:

Have a cup of coffee or tea? _____

Smoke a cigarette, cigar, or pipe? _____

Take drugs (including asprin)? _____

Drink alcohol? _____

Give blood? _____

Have an illness? _____

Suffer from respiratory problems? _____

What sort of physical activity did you perform yesterday? _____

_____

What sort of physical exercise did you perform today? _____

_____

Appendix C

INFORMED CONSENT FORM

1. Purpose of the Study

The purpose of this study is to examine changes in the performance of a graded exercise test (GXT) over multiple trials. A GXT is a treadmill test used to measure maximal oxygen consumption. A set speed is used, and percent grade increase every three minutes. Maximal oxygen consumption is the maximum amount of oxygen the body can take in, transport and utilize for energy.

2. Benefits of the Study

The results obtained from this study can be used to assess your cardiovascular fitness, maximum heart rate, and assist in developing your training program.

3. What You Will Be Asked to Do

You will be asked to complete a health history form to evaluate any risk factors for heart disease. Then you will complete three questionnaires: the Sports Attitudes Inventory to determine your achievement motivation and competitiveness, the Physical Self Efficacy Scale to determine your confidence in your abilities, and the Jenkins Activity Survey to determine your personality type. You will perform three GXT's on a motor driven treadmill. Each test will take approximately 1 hour. You will be given a 5-minute warm-up at a speed chosen by you. You will determine a comfortable but fast speed for the treadmill and it will remain constant through out the test. The elevation of the treadmill will increase by 2% every three minutes, until you are unable to maintain the intensity; at this point the test will be stopped. To determine your VO_2 max, you will be required to wear a mouthpiece (similar to a scuba diving mouthpiece) attached to headgear, and a nose clip. This will allow all of your expired air to be analyzed. You will also wear a Polar heart rate monitor to assess your heart rate during the test.

4. Risks

This study poses certain risks that may occur during the test. This includes abnormal blood pressure, increased heart rate, abnormal heartbeat, dizziness, fainting, stomach discomfort, muscle cramps, muscle injury, and in rare instances stroke, heart attack or death. Through preliminary screening and evaluation of health history, every attempt has been made to minimize these risks. The great majority of GXT's in healthy adults are conducted with no adverse effects, particularly with well-trained individuals like you. In the event that a subject may need medical attention, I am certified in CPR and First Aid and an emergency plan is in place in the laboratory.

_____
Initial Here

5. If You Would Like More Information about the Study

If any questions arise concerning the procedures, risks, or benefits, before, during or after the test please contact Jennifer Moore at (607) 274-1301 or jmoore3@ic3.ithaca.edu or Dr. Gary Sforzo at 274-3359.

6. Withdrawal from the Study

All participation in this study is purely voluntary. You have the ability to withdrawal from the study at any time. If any questions should arise before or after you agree to participate in the study I will be happy to answer them. If you choose to withdrawal from the study please contact me so that I can take the necessary steps to debrief you.

7. How the Data will be Maintained in Confidence

All information gathered from the questionnaires and graded exercise tests throughout this study will remain confidential. Information from this study will never be presented in a manner that will enable you to be identified. All subjects will be given numbers to be used as the identification method throughout the study and data analysis.

I have read the above and I understand its contents. I agree to participate in the study. I acknowledge that I am 18 years of age or older.

_____
Print or Type Name

_____
Signature Date

_____
Witness

Appendix D

_____
Number

SPORTS ATTITUDE INVENTORY

This questionnaire is designed to assess your reactions to situations that often arise in sports settings. Please answer the questions as honestly as possible; there are no right or wrong answers. If you are not currently on a team, or competing, think back to a time when you were. Place your answer in the space to the left of the question.

Please use the following scale to indicate your agreement or disagreement:

A = Strongly agree
B = Agree
C = Neither agree or disagree
D = Disagree
E = Strongly disagree

____ 1. I have the ability to get my teammates "fired up" to compete.

____ 2. Before competition I don't worry too much about what is going to happen.

____ 3. Teammates respect the way I work at my sport.

____ 4. The night before a contest, I don't find it difficult to sleep.

____ 5. Recognition from the coach makes a hard practice seem worthwhile.

____ 6. I do not enjoy being a team leader.

____ 7. It is hard work rather than luck that leads to success

____ 8. I often take a poor performance harder than I should.

____ 9. Winning gives me great satisfaction.

____ 10. Others do not see me as a tough competitor

____ 11. I would be willing to work all year around in order to be a success in my sport.

____ 12. I am nervous and fidgety right before competition.

____ 13. I enjoy thinking about my past successes in sports.

____ 14. I don't seem to be as tough as most of my teammates.

____ 15. I seem to perform better when spectators are present.

____ 16. Teammates respect my leadership ability.

____ 17. I admire athletes who are willing to put in extra practice time to improve their skills.

____ 18. I seem to compete best against highly skilled opponents.
____ 19. I work hard at my sport in the hope of gaining recognition.
____ 20. After competing poorly, I find it difficult to sleep.
____ 21. I am not pleased with my athletic ability.
____ 22. Sometimes when I compete poorly it bothers me for several days.
____ 23. Making a big play or executing a skill perfectly gives me a thrill.
____ 24. Teammates admire my persistence and determination.
____ 25. I usually feel butterflies in my stomach just before competition.
____ 26. My goal is to become outstanding in my sport.
____ 27. In head-to-head competition with someone of my own ability level, I lose more often than I win.
____ 28. I get excited just talking to someone about a contest.
____ 29. I try hard to be the best.
____ 30. During competition, if I "blow it," it takes a while for me to shake it off.
____ 31. I like to forget my sport in the off-season.
____ 32. I enjoy having people see me perform.
____ 33. I try to get other athletes to train hard.
____ 34. When I compete, I get so caught up in the contest that I temporarily lose contact with reality.
____ 35. I enjoy an assignment which others find difficult.
____ 36. Being a good athlete is not important to me.
____ 37. I enjoy making suggestions that will help a teammate's performance.
____ 38. When I make a mistake, it bothers me the rest of the contest.
____ 39. I have a very strong desire to be successful in my sport.
____ 40. It is hard for me to stay calm before competition.

That is the end of this questionnaire; if you do not have any questions, please return it to the researcher.

Sports Attitude Inventory Scoring

Items 1, 3, 6, 10, 14, 16, 18, 21, 24, 27, 33, and 37 comprise the competitiveness scale, with possible scores range from 12-60 and higher scores representing a high degree of competitiveness. Items 5, 7, 9, 11, 13, 15, 17, 19, 23, 26, 28, 29, 31, 32, 35, 36, and 39 comprise the motive to achieve success scale, with possible scores ranging from 17-85 and higher scores representing a high motive to achieve success. Items 2, 4, 8, 12, 20, 22, 25, 30, 34, 38, and 40 comprise the motive to avoid failure, with possible scores ranging from 11-55 and a high score representing a high motive to avoid failure (Willis, 1982).

Items 1, 3, 5, 7-9, 11-13, 15-20, 22-26, 28-35, 37-40 should be scored with A=5, B=4, C=3, D=2, and E=1. Items 2, 4, 6, 10, 21, 27, and 36 should be scored in the opposite direction with A=1, B=2, etc. The scores are added to give the total score on each subscale. Normative data of 251 females gives a mean of 41.43 (SD=6.20) for competitiveness, 66.99 (SD=7.90) for motive to achieve success, and 34.23 (SD=7.09) for motive to avoid failure. Normative data of 741 males gives a mean of 43.54 (SD=5.77) for competitiveness, 69.77 (SD=6.85) for motive to achieve success, and 33.39 (SD=6.91) for motive to avoid failure (Willis, 1982).

Test-retest reliability for the SAI is 0.75, 0.69, and 0.71 for the competitiveness, motive to achieve success, and motive to avoid failure subscales, respectively (Willis, 1982). Correlation between the competitiveness scale and motive to achieve success scale to the Self Motivation Inventory was found to be .41 and .63 ($p<.01$), respectively establishing sufficient construct validity (Willis & Layne, 1988). The motive to avoid failure subscale is more accurately compared to the Sport Competition Anxiety Test with a correlation of .65 ($p<.01$) also establishing sufficient construct validity (Willis, 1982).

Appendix E

_____
Number

PHYSICAL SELF-EFFICACY SCALE

This questionnaire is a series of attitude statements about you. I am interested in the extent to which you agree or disagree with these. Please read each statement carefully. Then indicate the extent to which you agree or disagree by indicating the appropriate number. If you find that the numbers to be used in answering do not adequately indicate your opinion, please use the one that is closest to the way you feel. The numbers and their meanings are indicated below:

If you agree strongly --------- 1
If you agree somewhat ------ 2
If you agree slightly --------- 3
If you disagree slightly ------ 4
If you disagree somewhat --- 5
If you disagree strongly ----- 6

____ 1. I have excellent reflexes.

____ 2. I am not agile and graceful.

____ 3. I am rarely embarrassed by my voice.

____ 4. My physique is rather strong.

____ 5. Sometimes I don't hold up well under stress.

____ 6. I can't run fast.

____ 7. I have physical defects that sometimes bother me.

____ 8. I don't feel in control when I take tests involving physical dexterity.

____ 9. I am never intimidated by the thought of a sexual encounter.

____10. People think negative things about me because of my posture.

____11. I am not hesitant about disagreeing with people bigger than me.

____12. I have poor muscle tone.

____13. I take little pride in my ability in sports.

____14. Athletic people usually do not receive more attention than me.

____15. I am sometimes envious of those better looking than myself.

____16. Sometimes my laugh embarrasses me.

____17. I am not concerned with the impression my physique makes on others.

____18. Sometimes I feel uncomfortable shaking hands because my hands are clammy.

____19. My speed has helped me out of some tight spots.

____20. I find that I am not accident-prone.

____21. I have strong grip.

____22. Because of my agility I have been able to do things that many others could not do.

Physical Self-Efficacy Scale Scoring

The subject scored each item with a corresponding number of one through six. For scoring purposes, scores given for items 1, 3, 4, 9, 11, 14, 17, 19, 20, 21, and 22 are reversed. The scores are then added for a total score on the scale, with possible scores ranging from 22 to 132. Higher scores represent a stronger sense of physical self-efficacy (Ryckman et. al., 1982). Normative data from two samples of caucasian undergraduate males and females showed a mean of 100.89 (SD=13.34) and 99.77 (SD=12.68) for males and a mean of 86.47 (SD=12.08) and 88.96 (SD=13.94) for females (Ryckman, Robbins, & Thornton, 1982). Test-retest reliability was established at .80 ($p<.001$) and validity of the scale in relation to the Tennessee Physical Self-Concept subscale was found to be .58 ($p<.001$) (Ryckman et al., 1982).

Appendix F

_____
Number

JENKINS ACTIVITY SURVEY

For each question, choose the answer that is true for you, and fill in the space in front of that answer.

1. Do you ever have trouble finding time to get your hair cut or styled?
   - □ Never
   - □ Occasionally
   - □ Almost always
2. Is your everyday life filled mostly by
   - □ Problems needing solution
   - □ Challenges needing to be met
   - □ A rather predictable routine of events
   - □ Not enough things to keep me interested or busy
3. When you are under stress or in a tense situation, do you
   - □ Lose your appetite and eat less
   - □ Eat more often or larger amounts to relieve the tension
   - □ Notice no change in eating patterns
4. When you are under stress or in a tense situation, does your heart beat
   - □ Go faster, harder, or both
   - □ Go slower or with an irregular "jumping" rhythm
   - □ Remain the same
   - □ Don't know. I have never noticed
5. When you are under pressure or stress, what do you usually do
   - □ Do something about it immediately
   - □ Plan carefully before taking any action
6. Ordinarily, how rapidly do you eat?
   - □ I'm usually the first one finished
   - □ I eat a little faster than average
   - □ I eat at about the same speed as most people
   - □ I eat more slowly than most people
7. Has your spouse or some friend ever told you that you eat too fast?
   - □ Yes, often
   - □ Yes, once or twice
   - □ No, never
8. When you listen to someone talking, and this person takes too long to come to the point, how often do you feel like hurrying the person along?
   - □ Frequently
   - □ Occasionally
   - □ Almost never

9. How often do you actually "put words in the person's mouth" in order to speed things up?
   - ☐ Frequently
   - ☐ Occasionally
   - ☐ Almost never
10. How often do you find yourself doing more than one thing at a time, such as working while eating, reading while dressing, or figuring out problems while driving?
   - ☐ I do two things at once whenever practical
   - ☐ I do this only when I'm short of time
   - ☐ I rarely or never do more than one things at a time
11. When you can do a job very easily and you see someone (not a beginner) doing it more slowly than you could do it, do you
   - ☐ Let him continue at his own pace
   - ☐ Offer help if he wants it
   - ☐ Suggest how he might do it more quickly
   - ☐ Actually step in an hurry things along
   - ☐ Take over the job yourself
12. When you are in the middle of doing something important and someone interrupts you, how do you usually feel inside
   - ☐ I feel O.K. because I work better after an occasional break
   - ☐ I feel only mildly annoyed
   - ☐ I really feel irritated because most such interruptions are unnecessary
13. If repeated interruptions have made you really angry, do you
   - ☐ Tell the next interrupter in a firm way
   - ☐ Tell the next interrupter in a quiet way
   - ☐ Close your door
   - ☐ Move to a quiet place
14. If you tell your spouse or a friend that you will meet somewhere at a definite time, how often do you arrive late?
   - ☐ Once in a while
   - ☐ Rarely
   - ☐ I am never late
15. Considering the last ten or so times you went to scheduled events such as group meetings, church services, concerts, sporting events, etc., how many times do you arrive late?
   - ☐ Not late for any
   - ☐ Late once
   - ☐ More than once, but not often
   - ☐ Fairly often
   - ☐ Not applicable, I haven't gone to such events recently
16. Suppose you are to meet someone at a public place (street corner, building lobby, restaurant) and the other person in already 10 minutes late. What will you do?
   - ☐ Sit and wait
   - ☐ Walk about while waiting
   - ☐ Usually carry some reading matter or writing paper so I can get something done while waiting

17. When you have to "wait in line" at a restaurant, a store, or the post office, what do you do?
    - □ Accept it calmly
    - □ Feel impatient but not show it
    - □ Feel so impatient that someone watching can tell I am restless
    - □ Refuse to wait in line, and find ways to avoid such delays
18. When you have to "wait in line, " such as for a cashier in a store, and the person ahead of you is being unnecessarily slow, does it
    - □ Make you feel angry and you show it
    - □ Make you feel angry but you hide it
    - □ Make you feel a little restless but not angry
    - □ I just relax during this time
19. When you play games with young children about 10 years old (or when you did so in the past years), how often do you purposely let them win
    - □ Most of the time
    - □ Half of the time
    - □ Only occasionally
    - □ Never
20. When you play on a team or take part in some group activity, are you satisfied with yourself
    - □ Only if your skill is clearly better than most others
    - □ As long as your skill is about average for the group
    - □ No matter how well you do, since you take part only for enjoyment
21. When you team loses, how do you usually feel?
    - □ It doesn't bother me at all
    - □ It bothers me a little
    - □ It really stirs me up
22. How do you feel about competition on the job or in outside activities?
    - □ Prefer to avoid it
    - □ Accept it because it's a necessary evil
    - □ Enjoy it because it's stimulating
23. When you were younger did most people consider you to be?
    - □ Definitely hard-driving and competitive
    - □ Probably hard-driving and competitive
    - □ Probably more relaxed and easygoing
    - □ Definitely more relaxed an easygoing
24. Nowadays do you consider yourself to be
    - □ Definitely hard-driving and competitive
    - □ Probably hard-driving and competitive
    - □ Probably more relaxed and easygoing
    - □ Definitely more relaxed an easygoing
25. Would your spouse (or closest friend) rate you as
    - □ Definitely hard-driving and competitive
    - □ Probably hard-driving and competitive
    - □ Probably more relaxed and easygoing
    - □ Definitely more relaxed an easygoing

26. Would your spouse (or closest friend) rate your general level of activity as
    - ☐ Too slow – should be more active
    - ☐ About average – busy much of the time
    - ☐ Too active – should slow down
27. How was your temper when you were younger?
    - ☐ Fiery and hard to control
    - ☐ Strong but controllable
    - ☐ No problem
    - ☐ I almost never got angry
28. How is your temper nowadays?
    - ☐ Fiery and hard to control
    - ☐ Strong but controllable
    - ☐ No problem
    - ☐ I almost never got angry
29. Would people who know you well agree that you tend to get irritated easily?
    - ☐ Definitely yes
    - ☐ Probably yes
    - ☐ Probably no
    - ☐ Definitely no
30. Would people who know you well agree that you tend do most things in a hurry?
    - ☐ Definitely yes
    - ☐ Probably yes
    - ☐ Probably no
    - ☐ Definitely no
31. Would people who know you well agree that you have less energy than most people?
    - ☐ Definitely yes
    - ☐ Probably yes
    - ☐ Probably no
    - ☐ Definitely no
32. Would people who know you well agree that you enjoy a "contest" (competition) and try hard to win?
    - ☐ Definitely yes
    - ☐ Probably yes
    - ☐ Probably no
    - ☐ Definitely no
33. How often do you do something mildly risky just for the excitement of it?
    - ☐ Never
    - ☐ Once in a while
    - ☐ Regularly
34. How often do you experience strong feelings that you feel you cannot (or should not) express?
    - ☐ Once a day or more often
    - ☐ A few times a week
    - ☐ About once a week
    - ☐ Once a month or less

35. Do you ever laugh at a "dirty joke"?
    - ☐ Often
    - ☐ Sometimes
    - ☐ Only rarely
    - ☐ Never
36. How easy is it for you to relax after a hard day?
    - ☐ No problem, I relax completely
    - ☐ Some trouble, but I get relaxed after a while
    - ☐ Very difficult, I stay somewhat tense for at least several hours
37. How often do you keep so busy all day that you find yourself completely "worn out" by evening?
    - ☐ About once or twice a month
    - ☐ About once a week
    - ☐ Two or three days a week
    - ☐ Four or more days a week
38. "Top executives" usually reach their high positions primarily because
    - ☐ They display a favorable social image, or they are fortunate enough to be in the right place when a chance for advancement opens up.
    - ☐ They consistently work harder, or they administer better than other workers at their earlier level
39. When you are in a group, how often do the other people look to you for leadership
    - ☐ Rarely
    - ☐ About as often as they look to others
    - ☐ More often than they look to others
40. In the past year, how often did you attend religious services?
    - ☐ Never
    - ☐ About once or twice a year
    - ☐ Several times a year
    - ☐ About once or twice a month
    - ☐ About once a week
    - ☐ More than once a week
41. In the last three years how has your personal yearly income changed?
    - ☐ It has remained the same or gone down.
    - ☐ It has gone up slightly (as the result of cost-of-living increases or automatic raises base on years of service)
    - ☐ It has gone up considerably
    - ☐ I had no personal income in this period

For questions 42-45 compare yourself with the average person having the same kind of daily activities and life situation as you (e.g. similar occupation, family responsibilities, outside interests) and mark the most accurate description

42. In the amount of effort put forth, I give
    - ☐ Much more effort
    - ☐ A little more effort
    - ☐ A little less effort
    - ☐ Much less effort
43. In being precise (careful about detail), I am
    - ☐ Much more precise
    - ☐ A little more precise
    - ☐ A little less precise
    - ☐ Much less precise
44. In sense of responsibility, I am
    - ☐ Much more responsible
    - ☐ A little more responsible
    - ☐ A little less responsible
    - ☐ Much less responsible
45. I approach life in general
    - ☐ Much more seriously
    - ☐ A little more seriously
    - ☐ A little less seriously
    - ☐ Much less seriously
46. How much schooling did you receive?
    - ☐ 0-4 years (skip to item 50)
    - ☐ 5-8 years (skip to item 50)
    - ☐ Some high school
    - ☐ Graduated from high school
    - ☐ Trade school or business college
    - ☐ Some college (including junior college)
    - ☐ Graduated from four-year college
    - ☐ Post-graduate work at a college or university
47. When you were in high school, what kind of grades or marks did you try to get in your courses?
    - ☐ Tried to get average grades ("C" in most school systems)
    - ☐ Tried to get grades which were the same as (or only slightly better than) those my friends were getting
    - ☐ Tried to get top grades ("A" in most school systems) even though this might have made the other students feel I was "different" if they had know about it
    - ☐ Didn't worry much about grades. I just took things as they came
48. When you were in high school or college, did you play on any athletic teams?
    - ☐ No
    - ☐ Yes, one team
    - ☐ Yes, two or more teams

49. When you were in school, were you an officer of any group, such as student council, glee club, 4-H club, sorority or fraternity, or captain of an athletic team?
    - ☐ No
    - ☐ Yes, I held one such position
    - ☐ Yes, I held two or more such positions

The next questions deal with your current life situation and activities.

50. Thinking now of your immediate family (including spouse, children, or others living with you), how would you compare the total amount of problems and disappointments they cause you with the total amount of help and encouragement they give you?
    - ☐ Far more help and encouragement than troubles
    - ☐ A little more help and encouragement than troubles
    - ☐ About an even balance
    - ☐ A little more problems and disappointments than help
    - ☐ Far more problems and disappointments than help
51. Do the people with whom you live give you as much affection as you would like?
    - ☐ Yes, almost all of the time
    - ☐ Only part of the time
    - ☐ Only rarely or never
52. In the past year during the average busy week, how many hours did you spend doing work at home or in other places, including volunteer activities?
    - ☐ Less than 20 hours
    - ☐ 20 to 34 hours
    - ☐ 35 to 40 hours
    - ☐ 41 to 45 hours
    - ☐ 46 to 55 hours
    - ☐ More than 55 hours
53. How often do your daily activities "stir you into the action"?
    - ☐ Less often than most people's activities
    - ☐ About average
    - ☐ More often than most people's activities
54. Do you ever keep two jobs moving forward at the same time by shifting back and forth so rapidly from one to the other?
    - ☐ No, never
    - ☐ Yes, but only in emergencies
    - ☐ Yes, regularly
55. How often do you make yourself written lists to help you remember what needs to be done?
    - ☐ Never
    - ☐ Occasionally
    - ☐ Frequently

56. How often do you stay up later than you prefer, or get up especially early, in order to get more work done?
    - ☐ Less than once a week
    - ☐ Once or twice a week
    - ☐ Three or more times a week
57. How often are you faced with deadlines for completing things? (If deadlines do not occur regularly, please mark the closes answer below.)
    - ☐ Daily or more often
    - ☐ Weekly
    - ☐ Monthly
    - ☐ Rarely or never
58. These deadlines usually carry
    - ☐ Minor pressures because of their routine nature
    - ☐ Considerable pressure, since delay would upset other people who are involved
    - ☐ I never encounter deadlines
59. Do you ever set deadlines or quotas for yourself at work or at home?
    - ☐ No
    - ☐ Yes, but only occasionally
    - ☐ Yes, once a week or more
60. When you have to work against a deadline, what is the quality of your work?
    - ☐ Better
    - ☐ Worse
    - ☐ The same (pressure makes no difference)
61. If you were looking for a job, which would you rather take?
    - ☐ A job with somewhat higher pay, but less prestige and challenge
    - ☐ A job with more prestige and challenge, but somewhat less pay
62. To what extent do you like to plan in advance for a holiday or vacation?
    - ☐ I like to plan it hour by hour
    - ☐ I like only a general plan for each day
    - ☐ I don't like to make a plan, but prefer to take it as it comes
63. After you have been away from your normal daily schedule for a week or more (such as vacation), do you
    - ☐ Want to stay away longer if possible?
    - ☐ Feel about ready to return to your normal daily activities
    - ☐ Feel impatient for the vacation to end so you can get back to your regular schedule

Jenkins Activity Scale Scoring

Items 3, 5, 6, 8, 9, 14, 23, 25, 26, 27, 31, 39, 43, 45, 48, 55, 60, 61, and 63 comprise the Type A subscale. Items 1, 6, 7, 8, 9, 10, 16, 17, 25, 27, 28, 29, 30, 54, and 59 comprise the Speed and Impatience subscale. Items 1, 2, 9, 14, 17, 22, 27, 29, 31, 32, 39, 46, 49, 53, 54, 55, 59, 60, 61, and 63 comprise the Involvement subscale. Items 2, 12, 23, 24, 28, 32, 39, 42, 43, 44, 45, 48, 59, 60, and 63 comprise the Competitive subscale. The raw scores for each subscale is determined by referring to point recode chart, which assigns a weight depending on the subjects answer. On items where no response is given a "blank" score is available, and if 6 or more items are given a "blank" score, no score is calculated for that scale. The raw score is then calculated and converted to a standard score by a conversion table for that scale. This is a linear transformation of raw scores, with a mean of 0.0 and a standard deviation of 10.0 in the normative population (Jenkins, Zyzanski, & Rosenman, 1979).

The Type A scale uses 19 items to establish a Type A versus a Type B personality, with possible scores ranging from –25.4-26.8, with higher scores representing more of a Type A personality. The Speed and Impatience scale uses 15 items to measure the degree to which the subject is impatient with possible scores ranging from –23.0-33.2, with higher scores representing more of an impatient personality. The Involvement scale uses 20 items to determine the extent of involvement in extracurricular activities with possible scores ranging from –41.0-25.0, with higher scores representing more involvement in extracurricular activities. The Hard-Driving and Competitive scales uses 16 items to determine the degree to which the subject has a competitive personality, with possible scores ranging from –24.2-34.2, with higher scores representing a more competitive personality (Jenkins, Zyzanski, & Rosenman, 1979). The JAS was designed as measure of Type A behavior and coronary prone behavior. Reliability for

the JAS Type A subscale is between 0.83 – 0.85, and ranges between 0.73 – 0.83 for the remaining three subscales. The statistically significant association between the JAS and the Type A ratings based upon the structured interview establishes concurrent validity. Predictive validity is established through the findings of the Western Collaborative Group study, with analysis of JAS type A scores of 2750 healthy men distinguishing the future clinical cases of coronary heart disease (Jenkins, Zyzanski, & Rosenman, 1979).

Appendix G

ENCOURAGEMENT PHRASES

Non-competitive

Let's go (name) you are doing great!

Come on (name) you can do it!

Nice job (name) keep it up!

All right (name) you look strong!

Good job (name) you're doing awesome!

Use those arms!

Drive those knees!

Push up that hill!

Competitive

Same as above, and also:

Don't let them beat you!

You don't want to quit first!

Don't give up!

Come on push each other!

Appendix H

RAW DATA

Subject	Gender	Group	Speed	VO2_1	RER_1	Time_1	VO2_2	RER_2	Time_2	VO2_3	RER_3	Time_3	Power
1	1	2	7.5	55.59	1.07	12.00	52.54	1.07	10.00	51.75	1.19	12.37	51
2	1	2	8.5	66.69	1.13	14.65	63.15	1.11	15.00	61.94	1.09	13.50	52
3	2	1	5	36.14	1.10	13.75	35.56	1.08	13.47	37.18	1.10	14.82	46
4	2	1	5	44.74	1.00	17.58	42.78	1.07	16.68	43.41	1.06	15.58	46
5	1	2	7.5	51.31	1.05	10.37	46.85	1.16	10.60	49.87	1.12	11.23	40
7	2	2	7	45.72	1.08	12.90	45.69	1.18	11.88	44.60	1.22	12.72	55
8	2	2	7	50.14	1.07	12.95	47.40	1.13	12.42	51.02	1.13	13.57	43
9	1	1	8.5	62.63	1.08	13.58	57.80	1.12	13.72	56.57	1.10	12.62	45
10	2	2	6.7	46.79	1.04	15.00	55.25	1.05	16.65	52.16	1.06	15.90	46
11	1	2	7.5	56.02	1.08	13.80	55.11	1.09	12.42	51.03	1.07	10.27	46
12	2	1	6.7	48.46	1.03	11.07	44.57	1.01	10.25	44.22	0.96	8.50	45
15	2	2	7.3	47.36	1.14	10.75	49.62	1.13	10.88	44.77	1.19	9.13	48
16	2	1	7	45.76	1.06	9.57	46.18	1.14	10.93	44.49	1.08	9.75	47
17	1	1	8.8	72.38	1.09	15.58	67.89	1.11	15.02	71.35	1.09	15.72	44
18	1	1	9.3	69.82	1.03	12.57	65.29	1.07	12.77	68.99	1.09	13.90	53
19	2	2	6.3	47.41	1.06	13.13	49.05	1.02	13.50	48.92	1.09	13.87	37
20	2	1	5.7	34.34	1.17	8.07	35.35	1.18	8.82	34.74	1.18	8.92	46
21	1	2	8	57.31	1.10	13.50	51.09	1.11	13.78	55.55	1.04	13.02	48
22	2	2	6.7	45.53	1.06	10.92	45.34	1.07	12.38	45.61	1.12	11.97	53
23	2	1	5.5	37.65	1.08	12.02	36.17	1.11	11.37	36.95	1.09	11.92	41
25	1	1	9	73.12	1.13	16.67	70.95	1.09	18.20	74.53	1.12	19.25	52
26	1	2	7.5	42.57	1.15	8.83	45.37	1.18	9.73	47.65	1.21	9.78	41
27	2	2	7.5	49.97	1.13	11.08	47.60	1.10	10.37	47.64	1.10	9.68	43
28	1	2	7.5	51.09	1.17	10.07	52.04	1.15	10.28	52.24	1.22	10.25	49
29	1	1	8.7	61.85	1.08	12.82	63.11	1.13	13.25	62.33	1.13	13.21	46
30	1	1	8	53.57	1.12	11.72	50.74	1.19	12.17	53.22	1.19	12.03	42
31	2	1	6	37.35	1.08	9.42	36.07	1.11	9.67	36.32	1.11	10.38	52
32	1	1	8.7	68.13	1.10	13.70	67.74	1.14	14.85	67.41	1.14	15.25	51

Subject	Success	Failure	PSE	TypeA	Impatnce	Involve	Comp	Age	Weight	Height	Yrs in Cmp
1	61	38	122	-11.3	4.4	11.8	1.2	24	75.9	172.7	6
2	75	30	86	3.4	-2.9	-12.2	-7.2	20	71.8	182.9	8
3	62	26	102	9.2	2.9	13.7	6.6	40	60.5	162.6	10
4	64	26	79	1.5	-1.4	3.2	-10.2	21	70.9	172.7	8
5	53	30	89	-13.4	-5.5	-2.8	-9.8	42	85.0	175.3	20
7	69	35	76	10.2	-5.8	14.2	21.4	22	75.0	177.8	10
8	69	39	81	1.6	4.9	13.4	1.6	23	59.1	167.6	3
9	64	34	101	-16.3	-12.0	17.6	-7.2	43	75.0	182.9	25
10	73	37	109	5.3	-11.8	-3.6	13.8	28	46.4	162.6	3
11	61	32	101	-14.2	-16.0	-3.6	-9.8	23	87.3	188.0	13
12	71	32	110	1.7	-3.5	-1.6	6.8	28	45.2	160.0	3
15	69	34	97	6.4	1.7	5.4	5.9	20	63.6	177.8	6
16	62	35	100	6.6	-4.1	9.4	5.0	21	64.1	165.1	10
17	74	32	93	-14.5	-4.0	-2.4	-7.8	20	75.0	177.8	10
18	78	34	105	-3.2	-1.9	7.0	13	23	69.1	174.0	12
19	67	36	97	5.4	-0.6	2.8	8.8	23	70.5	170.2	4
20	68	38	91	3.7	5.9	7.0	3.0	43	61.4	160.0	20
21	70	41	111	16.4	-4.7	18.2	8.4	38	73.6	168.9	25
22	79	31	105	6.0	1.9	4.4	10.8	20	69.5	167.6	9
23	55	31	88	-17.4	-1.8	11.8	-6.2	44	64.1	160.0	3
25	68	35	75	10.1	0.0	7.4	16.9	25	63.6	180.3	12
26	69	28	96	-10.3	-0.6	7.0	-7.6	22	75.0	177.8	6
27	69	32	86	8.4	-1.8	3.8	15.6	20	60.5	162.6	7
28	68	30	102	2.4	-10.5	13.2	5.6	25	61.8	172.7	20
29	67	34	95	3.2	-1.1	5.4	3.9	43	66.8	172.7	6
30	54	34	80	2.8	7.8	13.2	-10.8	27	92.7	188.0	10
31	73	42	90	10.7	18.8	5.4	19.8	38	88.6	172.7	10
32	79	40	86	10.7	3.6	-1.2	4.6	38	72.7	180.3	24

Subject	Previous Competition	T2 Competitor	T3 Competitor
1	weight lifting	5	8
2	swim, crew, lacrosse, X-country	6	10
3	track		
4	volleyball, track/field		
5	lacrosse, running	1	27
7	volleyball, soccer, softball	11	19
8	X-country skiing, soccer	1	10
9	running		
10	triathlons, running	2	8
11	swimming	21	7
12	triathlons		
15	X-country, tennis, swim, water polo, rock climb	26	22
16	swimming, track		
17	football, baseball, track		
18	field hockey, cycling		
19	tennis, cycling	21	7
20	softball, soccer		
21	running, X-country skiing, soccer	11	19
22	X-country	28	15
23	swimming, gymnastics		
25	running, track, X-country		
26	baseball, soccer	28	15
27	running, crew, X-country, track	5	14
28	baseball, basketball, football, golf	26	22
29	running, boxing		
30	running		
31	soccer, lacrosse, basketball softball, track		
32	running		

Appendix I

CODEBOOK

Subject – Number randomly assigned to subject to keep confidentiality.
Gender – Gender of subject: 1=Male 2=Female
Group – Group of subject: 1=Control Group 2=Experimental Group
Speed – Speed of treadmill in all trials measured in miles per hour
VO2_1 – Maximal oxygen consumption of subject during trial 1 (T1) measured in ml/kg/min.
RER_1 – RER of subject during T1 measured by CO_2/O_2
TIME_1 – Time until exhaustion during T1, determined from the time the subject reached their testing speed until they signaled to end the test, measured in minutes.
VO2_2 – Maximal oxygen consumption of subject during trial 2 (T2) for the control group, or versus a male competitor for the experimental group, measured in ml/kg/min.
RER_2 – RER of subject during T2 for the control group, or versus a male competitor for the experimental group, measured by CO_2/O_2.
TIME_2 – Time until exhaustion during T2 for the control group, or versus a male competitor for the experimental group, measured in minutes.
VO2_3 – Maximal oxygen consumption of subject during trial 3 (T3) for the control group, or versus a female competitor for the experimental group, measured in ml/kg/min.
RER_3 – RER of subject during T3 for the control group, or versus a female competitor for the experimental group, measured by CO_2/O_2.
TIME_3 – Time until exhaustion during T3 for the control group, or versus a female competitor for the experimental group.
Power – Measurement of power using the Sports Attitude Inventory (SAI). Scores can range from 12 (less power) to 60 (most power)
Success – Measurement of motive to achieve success using the SAI. Scores can range from 17 (low motive to achieve success) to 85 (high motive to achieve success).
Failure – Measurement of motive to avoid failure using the SAI. Scores can range from 11 (low motive to avoid failure) to 55 (high motive to avoid failure).
PSE – Measurement of self-efficacy using the Physical Self Efficacy Scale. Scores can range from 22 (low self-efficacy) to 132 (high self-efficacy).
TypeA – Measure of personality type using the Jenkins Activity Survey (JAS). Scores determined using linear transformation and can range from –25.4 (Type B personality) to 26.8 (Type A personality).
Impatnce – Measure of impatience using the JAS. Scores determined using linear transformation and can range from –23.0 (low impatience) to 33.2 (high impatience).
Involve – Measure of involvement using the JAS. Scores determined using linear transformation and can range from –41.0 (little involvement) to 25.0 (high involvement).
Comp – Measure of competitiveness using the JAS. Scores determined using linear transformation and can range from –24.2 (low competitiveness) to 34.2 (high competitiveness).
Age – Subject's age at time of study, measured in years.
Weight – Subject's average weight of the three trials, measured in kilograms.
Height – Subject's height at time of study, measured in centimeters.
Yrs in Cmp – Number of years the subject participated in competitive athletics as indicated by the subject on the health history form.

Previous Competition – Activities the subject participated competitively in, as indicated by the subject on the health history form.
T2 Competitor – Number of the subject competed against during trial 2.
T3 Competitor – Number of the subject competed against during trial 3.