EFFECT OF COMPETITION ON PERFORMANCE AND PHYSIOLOGICAL RESPONSES

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ABSTRACT

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Purpose: The purpose of the study was to determine if a competitive environment, without prior knowledge of competing, would increase an athlete's performance. **Methods:** Eighteen female athletes were analyzed. Each participant performed a VO_{2max} test and 3 trials (familiarization, control, competition). The competition consisted of 2 matched participants running at the same time; matched within a VO_{2max} of 5 ml/kg/min. Participants were blinded to the purpose, until the study was completed. **Results:** A significant difference was found in overall distance (CT: 3.063 ± 0.445 vs. COMP: 3.274 ± 0.437 km p=.017). There were no significant differences in HR (CT: 178.3 ± 19.6 vs. 183.9 ± 14.3, p=.134) or RPE (CT: 14.4 ± 2.7 vs. COMP: 14.4 ± 1.5, p=.999). **Discussion:** The COMP didn't affect RPE or HR; however, distance was significantly increased. This indicates that if female athletes are presented with a competitive environment, the athletes will compete without instruction.

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CHAPTER I

INTRODUCTION

Every person at some point in life will face a competitive environment; whether it is in school, sports, career, or simply with family members. Some people thrive in competitive situations, and some run from it. These different types of individuals are referred to as high in achievement motivation (HAMs) or low in achievement motivation (LAMs; Tauer & Harackiewicz, 1999). Individuals that not only thrive in competitive situations, but also find them enjoyable, and more challenging than the same activity without competition are categorized as HAMs. Individuals that have a decrease in performance with competition, find the activity less enjoyable, and do not like to participate if the activity has become, or is, a competition, are categorized as LAMs (Tauer & Harackiewicz, 1999). Participants in sports score higher on competitiveness scales when compared to participants not in sports (Gill & Deeter, 1988), indicating that athletes are more competitive than individuals who have not participated in athletics.

Athletes are surrounded by competitive situations. In many ways competition can have a toll on individuals and athletes; it can be stressful, cause anxiety, and nervousness. Competition has little, if any, effect on individuals

physiologically, whereas it has a much bigger effect on individuals psychologically (Cooke, Kavussanu, McIntyre, & Ring, 2011; Oudejans & Pijpers, 2010; Taylor, Gould, & Rolo, 2008; Viru et al., 2010; Wadey & Hanton, 2008). Competition can be mentally challenging; competition is not purely about ability or strength, but also how athletes handle the mental strains of competition (Cooke et al., 2011; Oudejans & Pijpers, 2010; Taylor et al., 2008; Viru et al., 2010; Wadey & Hanton, 2008). Athletes may handle these mental strains with many different tactics such as self-talk, imagery, task-oriented thoughts, emotional control, self-confidence, or goal setting (Cooke et al., 2011; Manderlink & Harackiewicz, 1984; Oudejans & Pijpers, 2010; Taylor et al., 2008; Wadey & Hanton, 2008).

Individuals may partake in competition in many different environments and for many different reasons. Athletes may be internally or externally motivated. Internal motivation is an individual's desire to compete for the pure joy of competing, and external motivation is caused by an external source; i.e. money, trophies, fame, and bragging rights (Robinson & Carron, 1982).

Receiving money can always be a huge motivator in any setting. It is used quite often in business as well as athletics. Often times a boss will give a monetary prize for the employee who finishes a project or for the most devoted employee to increase production in that company. Professional athletes that play

tennis, golf, or track get paid by the rank the athletes achieve at the end of competition. First and second place tend to receive more money than fourth or fifth. With a monetary gain involved, competition is soon to follow. Typically the competitions seen on television are stemmed by external motivation. Professional athletes are getting paid to play or win more money the higher they place. Collegiate athletes are striving to win their conference or the national title. High school athletes are striving to win district or go to state. Stereotypically, most of these athletes enjoy the sport and enjoy competing; however, athletes also have an external prize to work towards or to push them to reach a certain level. To create a competitive environment, researchers will use monetary gain (Cooke et al., 2011; Deci, 1971; Harackiewicz, 1979; Oudejans & Pijpers, 2010; Viru et al., 2010). Involving money in a research study has been utilized to "simulate" competition (Cooke et al., 2011; Deci, 1971; Oudejans & Pijpers, 2010; Viru et al., 2010). Several studies using this form of external motivation have been successful; individuals report competing to win and having a higher motivation to win (Cooke et al., 2011; Deci, 1971; Harackiewicz, 1979; Oudejans & Pijpers, 2010; Viru et al., 2010). Studies have determined increases in time to fatigue, faster running times, power output, heart rate, and VO_{2peak} during competitive activities compared to noncompetitive activities performed in a lab setting (Cooke et al., 2011; Viru et al., 2010; Wilmore, 1968).

During a competition many factors play a role in how competition is handled. Underlying mechanisms that interfere with performance during competition can be detrimental to performance if not properly controlled (Cooke et al., 2011; Kim, Chung, & Shin, 2009; Manderlink & Harackiewicz, 1984; Oudejans & Pijpers, 2010; Taylor et al. , 2008; Wadey & Hanton, 2008). If an individual has problems with anxiety, which is typically heightened during competitions, the anxiety may have a negative effect on competition performance (Oudejans & Pijpers, 2010; Taylor et al., 2008; Wadey & Hanton, 2008). Many different strategies have been implemented to help athletes counteract these problems (ex: self-talk, imagery, task-oriented thoughts, coping with adversity, emotional control, self-confidence, and goal setting; Oudejans & Pijpers, 2010; Taylor et al., 2008; Wadey & Hanton, 2008). These different strategies have been studied in several different ways to understand how they can affect athletes and if they can be enhanced. The studies that will be mentioned have shown that just as athletes train to increase athletic ability, they can train to increase mental abilities to deter adverse effects (Cooke et al., 2011; Kim et al., 2009; Manderlink & Harackiewicz, 1984; Oudejans & Pijpers, 2010; Taylor et al., 2008; Wadey & Hanton, 2008). Oudejans and Pijpers (2009) demonstrated that mild anxiety training will decrease anxiety levels during high anxiety performance.

These adaptations will help athletes when high pressure moments are experienced.

Competition can be stimulated with monetary gain or by telling the participants to compete against each other (Cooke et al., 2011; Deci, 1971; Harackiewicz, 1979; Moffatt, Chitwood, & Biggerstaff, 1994; Oudejans & Pijpers, 2010; Viru et al., 2010.; Wilmore, 1968) Stimulating competition by the aforementioned means has demonstrated changes in performance, physiological responses and psychological responses (Cooke et al., 2011; Deci, 1971; Harackiewicz, 1979; Moffatt et al., 1994; Oudejans & Pijpers, 2010; Viru et al., 2010; Wilmore, 1968). If participants have not been told the activity is a competition and have not been given a monetary gain for better performance, will they still compete against the other participants in the study? Can the pressure of competition push the athlete to perform better than if there were no competition? The purpose of this study is to determine if a competitive environment without prior knowledge of competing will increase an athlete's performance.

Statement of the Problem

Does competition increase task performance or physiological responses? Incentives such as money along with encouragement from the investigators, can improve performance, some physiological responses and psychological

responses (Cooke et al., 2011; Deci, 1971; Harackiewicz, 1979; Moffatt et al., 1994;Oudejans & Pijpers, 2010; Viru et al., 2010). Several different questions arise from these findings. Could the reason for the improvements only be because of the financial incentive, or is it from the feeling of competition? Would different incentives or just the satisfaction of winning be enough to improve performance? Are athletes competitive enough against each other to try and out-perform one another? In order to improve performance, do incentives need to be given? Does the participant need to be told it is a competition, or would running side by side with another participant be enough competition to improve performance?

For this present study the goal is to determine if a competitive environment, without prior knowledge of this competition, will drive athletes to increase their performance so they may perform better than another athlete performing near them.

Hypotheses

The hypothesis for this investigation is that the athletes will be categorized as having a high degree of competitiveness. The following null hypotheses will be tested by this investigation.

1. There will be no difference between the distance run on the competition and control trials.
2. There will be no difference between the participants' HR on the competition and control trials.

3. There will be no difference between the participants' RPE on the competition and control trials.

Definition of Terms

1. Competition – the act or process of competing; a contest between rivals (merriam-webster.com)
2. Athlete – An individual who has competed at a varsity level (college or high school), currently or formerly.
3. Internal (intrinsic) motivation – The internal drive of individuals to actively engage at a task for no apparent external reward (Robinson & Carron, 1982).
4. External (extrinsic) motivation – motivation that comes from outside an individual (About.com).
5. High in achievement motivation (HAMs) – those who seek challenge, desire to attain competence, and strive to outdo others (Tauer & Harackiewicz, 1999).
6. Low in achievement motivation (LAMs) – individuals that dislike evaluation and avoid achievement situations (Tauer & Harackiewicz, 1999).
7. Objective outcomes – the literal success of a competitive event (i.e. winning and losing; McAuley & Tammen, 1989).
8. Subjective outcomes – the perceived success of a competitive event (McAuley & Tammen, 1989).

9. Social comparison – thinking about the self in relation to other people (Blackwell Encyclopedia of Sociology, 2007)
10. Perceptions of fatigue – the thought of feeling or not feeling fatigued regardless of actual physiological symptoms of fatigue (Pennebaker & Lightner, 1980).
11. External sources – stimulus in the form of sights, sounds, or environments outside of the body (Pennebaker & Lightner, 1980).
12. Direct competition – the presence of an opponent (thefreedictionary.com).
13. Indirect competition – no presence of an opponent, i.e. competing against self, previous competitors, a set goal, etc. (thefreedictionary.com).
14. Confederate – A person who is perceived to be a participant but instead is working with the researchers to compete against true participants (Tauer & Harackiewicz, 1999).
15. Exhaustive test – performing an exercise test until the participant can no longer physically keep up with the pace of the test.
16. VO_2 Plateau – An increase or decrease of VO_2 less than or equal to 150 ml/min with an increase in workload (American College of Sports Medicine, 2009).
17. Competence – Being well qualified or having adequate ability to perform the task (Tauer & Harackiewicz, 1999).

Assumptions

This study was conducted based on the following assumptions:

1. Two athletes running on a treadmill at the same time would elicit competition among the participants.
2. The participants did not compete with previous trials (self) or other participants during the control trial.
3. Participants had a similar routine (exercise, diet, hydration status, etc.) before each trial.

Limitations

This study was conducted with the following limitations:

1. Participants will include both current and former athletes. The athletes will not be separated by athletic status.
2. Participants are able to control treadmill speed.
3. Participants will have the option of pointing to or verbally stating RPE.

Significance of the Study

The information found in this study will provide the opportunity of coaches, administrators, and the general public to recognize how subliminally competitive athletes can be. Coaches, administrators, and the general public may have a better understanding of athletes, through this study.

CHAPTER II

REVIEW OF LITERATURE

Competition cannot only be seen in several different environments but may also be elicited by many different means of motivation. Internal motivation derives from within the individual, and no external force has influenced the decision to be competitive (Robinson & Carron, 1982). External motivation, caused by external sources, can influence individuals to be competitive by using material gain, verbal feedback, outcome feedback, environment, etc. (Cooke et al., 2011; Deci, 1971; Oudejans & Pijpers, 2010; Pennebaker & Lightner, 1980; Viru et al., 2010). Both internal and external motivation occurs during every sporting event and even while exercising at the gym. Individuals will rely on either internal motivation to increase performance or external motivation by watching another individual perform better.

Competition can be very stressful on individuals, especially athletes, and different underlying mechanisms can become mentally strenuous. There are several strategies that have the capability to divert the problems that can arise with mental stress. Individuals can train using these strategies to lower mental stress (Taylor et al., 2008).

Internal Motivation

Internal motivation (or intrinsic motivation) is defined as being motivated without any reward except for the accomplishment of the activity or event itself (Robinson & Carron, 1982). Several different factors have been shown to influence internal motivation either positively or negatively. When competition is involved with no external rewards (trophies, money, fame, etc.), individuals may be internally motivated to win for the pure satisfaction of winning or competing. How an individual is internally motivated by competition depends on how the individual interprets this situation. When individuals see the competitive situation as a means of competence, internal motivation may be increased and the individual becomes more determined to "win" during the competition (Deci & Ryan,1980, 1985; McAuley & Tammen, 1989). The winners of competitive situations have an increase in internal motivation compared to the losers of competitive situations (McAuley & Tammen, 1989). Also, individuals who felt that the performance was successful had an increase in internal motivation compared to the individuals who felt the performance was not successful (McAuley & Tammen, 1989). If individuals perceive that they performed well in an activity, they will have increased internal motivation for that particular activity (Manderlink & Harackiewicz, 1984; McAuley & Tammen, 1989). This subjective interpretation

can increase internal motivation more so than objective outcomes (Manderlink & Harackiewicz, 1984; McAuley & Tammen, 1989).

With respect to competitiveness, there are two different types of people: people who enjoy competition and people who dislike or shy away from competition (Harackiewicz & Sansone, 1991; Tauer & Harackiewicz, 1999). These types of people have been referred to as high in achievement motivation (HAMs) or low in achievement motivation (LAMs). High in achievement motivation individuals respond positively to competition, crave receiving competence, seek challenges, and enjoy or strive to outperform other individuals. Low in achievement motivation individuals respond negatively, do not like evaluations, and evade achievement situations (Harackiewicz & Sansone, 1991; Tauer & Harackiewicz, 1999). In competitive situations internal motivation may actually decrease, regardless of how competition is incorporated (i.e. monetary gain, outperforming other individuals, etc.), due to the personality of the individual being closer to LAM (Tauer & Harackiewicz, 1999). Knowing this information about participants could be crucial to a study involving a competitive situation. Although this statement is not evidence based, it is believed athletes would be in the HAM category. Athletes deal with and seek competitive situations in almost every aspect; even the less competitive athletes at least enjoy being in a competitive situation regardless of how competitive they, in actuality, are. These

actions can be seen in college athletes especially. Although some athletes may decrease performance under tremendous amounts of pressure, that action is linked to anxiety and underlying mechanisms rather than being categorized as a HAM or LAM individual (Tauer & Harackiewicz, 1999; Wadey & Hanton, 2008).

Another factor that has influence on competitive situations is goal setting. Goal setting has been found to increase internal motivation compared to no goal setting and it can positively affect internal motivation through informational processes (Weinberg, Bruya, & Jackson, 1990). There are two different types of goal setting, distal and proximal. Distal goal setting was found to increase internal motivation while proximal goal setting was seen as external pressure and decreased internal motivation (Manderlink & Harackiewicz, 1984). Some studies have tested goal setting by giving the individuals either a goal to reach or no goals. The studies were looking to see if performance would increase if the goal was set at a higher level. The problem with most of these studies is that the individuals in the "no goal setting" group still formed their own goals. This threw the data off and compromised the findings (Weinberg et al., 1990). Although this was a negative aspect of the study, it showed that individuals, regardless of the competitiveness of the situation, will have an increased internal motivation, set personal goals, and compete (Weinberg et al., 1990).

When individuals are in a competitive situation it can bring about an ego-involved motivation, which has the individual motivated to compete to maintain self-worth and to show superior abilities (Ames, 1986; Butler, 1989; Deci & Ryan, 1985; Nicholls, 1984). When trying to maintain this attribute in school work, some students may stoop low enough to look at a peer's work. If it is a competitive situation, it can become very common, especially among younger students, to look at peer's work; although for some ages, looking at a peer's work may be used as a social comparison (Butler, 1989). Butler's (1989) study found a significant difference in looking at a peer's work in the competitive situation compared to the noncompetitive situation. The competition undermined internal motivation and the student's interest in another student's paper increased. This action seemed to increase with age to a certain point and the task oriented activity became more ego-involved, or about pride; which shows that internal motivation is undermined and taken over by ego-involved motivation (Butler, 1989).

Internal motivation can be affected by personality of the individual, and type of competition.

External Motivation/Sources

External motivation may be involved with competitive situations, and thereby impact internal motivation. The different types of external motivation

may both increase and decrease internal motivation. External sources, although not always motivating, may as well affect internal motivation and/or process of internal information.

One type of external motivation that has been found to increase is feedback from objective outcomes. There are two types of feedback from an objective outcome; positive and negative. Only positive outcome feedback (i.e. winning in a competitive situation) has an increasing effect on internal motivation. When individuals win a competition, the individuals are receiving positive feedback and this will increase internal motivation by increasing the chances the individuals will play or compete again in this particular activity (Deci & Ryan, 1985; McAuley & Tammen, 1989). A different type of feedback is verbal feedback. Some studies have tested whether positive verbal feedback will increase performance or not. Although in untrained personnel it can have an effect and significantly improve performance (Karaba-Jakovljevic, Popadic-Gacesa, Grujic, Barak, & Drapsin, 2007; Moffatt et al., 1994), it does not affect athletes (Bullinger, Hearon, Gaines, & Daniel, 2012; Moffatt et al., 1994).

Another form of external motivation that shows evidence to affecting internal motivation is monetary gain. As discussed earlier it is very effective in causing competition. Monetary gain can decrease internal motivation. Although monetary gain can increase or enhance interest, it tends to decrease internal

motivation more than other forms of external motivation (Deci, 1971; Harackiewicz, 1979; Harackiewicz, Abrahams, & Wagerman, 1987). The individuals are no longer completely competing for the pure joy of competing. They are now competing to win or obtain money. For some participants the increase in performance may be linked to the external pressure monetary gain has on performance instead of the act of competing (Cooke et al., 2011). The competition is still seen as enjoyable to participants (Cooke et al., 2011; Harackiewicz et al., 1987). This interaction between internal and external motivation has shown to be the reason internal motivation decreases. The informational processes have moved to concentrate more on the external motivation, money gain, than the internal motivation (Cooke et al., 2011; Pennebaker & Lightner, 1980).

Monetary gain may have negative effects on internal motivation, but it has demonstrated in several different studies that individuals will try harder and push themselves further to win both the money and the competition it invokes. When participants are given the situation of monetary gain for either beating their own score/performance and/or the other participants, the participant's performance significantly increases (Cooke et al., 2011; Viru et al., 2010).

External sources are seen more as a distraction than a motivator in exercise situations and can be both positive and negative. External sources may

be negative if a situation, for example, involved heights. If a novice is performing an activity that is modified and performed 20 feet in the air instead of on the ground this “distraction” or external source will affect performance negatively instead of positively. Individuals will be more focused on the possible injury or, in their mind, life-threatening situation instead of on performing the activity well. Oudejans and Pijpers (2010) took novices at dart throwing and put the participants in competitive, as well as, anxiety filled situations. The purpose was to determine if mild anxiety during training would it help attenuate the decrement in performance when put in a high anxiety situation. Participants took a pretest, while situated with a climbing harness 0.14 m above ground. After the pretest the participants were split into two groups (control and treatment) and performed two training sessions. Training Session 1 was performed 10 min after the pretest and 40 sets of 6 darts were thrown. After each set the scores were recorded and the darts were returned to the participant for the next set. Training Session 2 was performed 2-4 days after the pretest and 32 sets of 6 darts were thrown. The same procedure was used for both training sessions. The control group threw darts with no stipulations or added anxiety and the treatment group threw darts while multiple stipulations were made to increase anxiety. The amount of darts thrown was the same for each group. The treatment participants were videotaped and told the tape would be used in a popular scientific program to

analyze the learning process. The combined scores of both training programs of a grouped couple (already paired) were be added and the highest scoring couple received money. Other stipulations for the treatment group were that each 6th dart thrown was double points, and the list of participants and their scores would be circulated for all participants to see. All of those stipulations were meant to cause anxiety and competition. After the training programs were completed the posttest was conducted. Each participant was harnessed and situated on footholds either 0.14 m high or 3.96 m high. There were three posttests. The low anxiety (LA) posttest was performed just like the pretest on the 0.14 m high footholds. The mild anxiety (MA) posttest was at the same height as the LA test, but with all the stipulations that were incorporated in the treatment training sessions. The high anxiety (HA) posttest was performed without stipulations, but it was 3.96 m above the ground. The order of the posttests was in random order for each participant. Immediately after each test was completed the participants were brought down and completed a visual-analogue anxiety scale, known as an anxiety thermometer.

The treatment group had significantly higher anxiety levels during Training Session 1 compared to the pretest (2.6 ± 2.20 vs. 1.3 ± 1.45 $p < .05$) and Training Session 2 (2.6 ± 2.20 vs.1.4 ± 1.22 $p < .05$). The treatment group's MA and HA tests were not significantly different compared to LA. The control group's

scores under MA compared to LA were not significantly different; although they significantly deteriorated under HA compared to MA (177±14.4 vs. 187±7.9 $p < .05$) and LA (177 ± 14.4 vs. 185 ± 14.3 $p < .05$). These results demonstrate that external sources may negatively impact performance depending on the amount of anxiety, and demonstrate that mild anxiety training can have beneficial effects for maintaining performance under high anxiety situations (Oudejans & Pijpers, 2010).

Pennebacker and Lightner (1980) conducted a study to see how external sources may affect performance. Participants performed two treadmill trials; a control and a treatment. The participants started walking at 2 mph with a 12% grade for 1 min. After the first minute the speed was increased to 3.4 mph for 10 min. During the test participants wore headphones, were asked to breathe out of their mouth, and their breathing was recorded. After 10 min the test was completed and the participants were seated and post exercise measures were taken (blood pressure and pulse). Then the participants were taken to an adjacent room and asked to fill out a quick questionnaire about feelings of fatigue, symptoms, and mood (both trials). In the control trial the participants heard no noise from the headphones. In the treatment trial the participant heard 1 of 3 things: background or ambient noises with each segment lasting 20 s (cars driving by, people talking, radio talk shows, parts of movies or music), previously

recorded breathing amplified (from control trial), or nothing at all. The same procedures were used after completion of the treatment trials and questionnaires were filled out. When comparing the two trials the noise group had a significant decrease in amount of fatigue felt and the breathing group had a significant increase in amount of fatigue felt compared to the noise group. This shows that external sources can have both positive and negative influences on performance dependent on what the external sources are. When hearing different noises it helped distract participants from their internal notions of fatigue while the breathing noises amplified the notions of fatigue (Pennebaker & Lightner, 1980).

The second part of the study by Pennebaker and Lightner (1980) focused more on environmental external sources. In this part of the study the participants over the course of 4 weeks ran through two running courses. Each participant would run on both a circular track and a cross country course. The distance was measured and the same distance was allotted for both courses, the courses were both dirt surfaces, and the turns in both courses were the same amount. Participants would run every other day for 10 days on one course and then switch to the opposite course; this was to have an average for times on both courses since participants will start to improve as more running is acquired. Participants were split into two groups; one half performed the track course first and the other half performed the cross country course first. Participants were

timed and physiological measurements were taken (blood pressure and pulse); participants were not notified of these times or findings until after the completion of the study. The researchers found that the cross country course had significantly lower running times compared to the track course (9.17 min vs. 10.08 min $p < .01$). Participants reported feeling bored, frustrated, and less satisfied on the circular track compared to the cross country course run. There was no significant difference between perceptions of fatigue (track vs. course) in the environmental part of the study; however this pattern suggests that the participant, during the cross country course, had a lower perception of fatigue which allowed them to push themselves harder and achieve a better running time.

Although this overall study did not state an influence on internal motivation it showed decreased running times and perceptions of fatigue (processing of internal information). It is thought the reasoning for this occurrence is the combination of internal and external information being available. If both are available one can restrict the other. If enough external sources and/or distractions are available, feelings of fatigue may decrease. Another external source can be competition. The act of competing has been viewed as a "distraction" from internal information. The study mentioned has shown that

environmental distractions decrease internal attention which can promote both physical and psychological well-being (Pennebaker & Lightner, 1980).

Underlying Mechanisms

As much as sports are physically strenuous, they are also mentally strenuous. There is a theory called the “iceberg profile”. A successful athlete reflects positive mental health. Vigor is well above average in successful athletes, but more importantly tension, depression, fatigue, anger, and confusion are lower than the average in the population (Taylor et al., 2008). Having this solid base of mental health is what allows an athlete to be more successful in high pressure, and high anxiety situations. In order to cope with the mental aspect of the sport many athletes (if not all) use special techniques to help them before, during, and after a game or match. There is a tendency for the athletes that make it to the elite status to have the best use of these special mental techniques (Weinberg & Gould, 2003). There are several types of techniques that athletes or competitive individuals use; self-talk, imagery, task-oriented thoughts, coping with adversity, emotional control, self-confidence, anxiety, and goal setting. If these mechanisms are either used or controlled, it can be beneficial for athletes (Cooke et al., 2011; Kim et al., 2009; Manderlink & Harackiewicz, 1984; Oudejans & Pijpers, 2010; Taylor et al., 2008; Wadey & Hanton, 2008).

Studies have tested both elite and nonelite athletes side by side to compare these underlying mechanisms and how much they set the elite athletes a part from the nonelite. Elite athletes had a superior ability to cope with adversity, are better at mentally preparing themselves, as well as better at goal setting (Kioumourtzoglou, Tzetzis, Derri, & Mihalopoulou, 1997). In a study testing between medalists and nonmedalists the medalists had more use of these mechanisms than nonmedalists. The more successful athletes know these mental techniques and use them to their advantage. Elite athletes also have better concentration, higher self-confidence, more task-oriented thoughts, higher use of positive imagery, and lower levels of anxiety (Taylor et al., 2008). When comparing Korean junior golfers, the researchers found that the elite junior golfers had lower anxiety and emotional stress. Controlling these two mental aspects may be an important reason the elite golfers are “elite” and the nonelite are not (Kim et al., 2009). It is theorized that with all the pressures, distractions, and anxieties that are prevalent in the Olympics these mental capabilities are necessary to be successful (Gould, 2001). By using each of these skills the athletes have a heightened level of self-confidence and it helps the athletes before and during the competition (Wadey & Hanton, 2008). Even among competitive individuals, studies have shown that decreased anxiety and abilities to cope with the anxiety of competition have an inverse relationship with

performance in that performance increases when there is a lower amount of anxiety. This relationship may be caused by the lower amount of anxiety present, which helps increase process responses to other important things, like task performance (Cooke et al., 2011). Successful athletes have a better understanding of mental capability suggesting that it can come with training; although understanding these mental capabilities is not possible for everyone. The same studies that tested differences between the different types of athletes, show that these mental capabilities can be learned through training and experience, but the right knowledge of how to train these mechanisms is necessary (Kim et al., 2009; Oudejans & Pijpers, 2010). Introducing all of these psychological practices to athletes and educating them on how to use them in stressful situations can help protect against debilitative symptom interpretation (Wadey & Hanton, 2008). Oudejans and Pijpers (2010) found that even training with mild anxiety will help maintain performance in high anxiety situations. The control group with no anxiety training had significantly higher anxiety levels compared to the treatment group with mild anxiety training.

The biggest and most prominent mental practice that helps not only elite athletes, but also competitive individuals, is goal setting. Goal setting has shown to increase internal motivation and helps with anxiety (Manderlink &

Harackiewicz, 1984; Wadey & Hanton, 2008). Several studies have implemented goal setting to see its effects on participants.

Weinberg, Bruya, and Jackson (1990) conducted a study that was a moderated version of other studies conducted in the past (Hall & Byrne, 1988; Weinberg, Bruya, & Jackson, 1985). All three of these studies showed just how influential goal setting can be (Hall & Byrne, 1988; Weinberg, Bruya, and Jackson, 1985; Weinberg et al., 1990). Individuals were placed into 1 of 3 groups; hard, moderately hard, and do your best goal groups. Each group performed a 3-min sit-up test. A baseline test was taken to have an understanding of the differences between groups, and to have a number for the participants to improve on. The hard group was given a goal to improve by 45 sit-ups from baseline. The moderately hard group was given a goal to improve by 30 sit-ups from baseline. The do your best group was not given a goal to improve from baseline but rather told to do their best each session. No significant differences were found except that the hard goal group performed more sit-ups than the do your best goal group. The do your best group had no instruction to set goals; however, it was established through the questionnaire that 32% of the do your best group was mentally setting their own goals and 38% of that group reported being engaged in competition at some point during the task. Although this contradicts the study and undermines the purpose, the

results found by Weinberg et al. (1990) were an improvement to Hall and Byrne (1988). Both studies helped shed light on how individuals even when never told to compete will go beyond what is asked of them and set their own goals by either with competing with themselves or with others around them.

Locke and Latham (1985) stated that competition is a form of goal setting with the idea that participants will set goals depending on the competition between other participants or their previous performance; which also explains the problem in Weinberg et al. (1990)'s study. A competitive situation may stimulate participants to set higher goals than they would on their own, to become more committed to the performance, and/or help participants to focus on the task at hand (Locke & Latham 1985). Lerner and Locke (1995) found in their study that when participants were given specific goals (either hard or medium) their personal goals were influenced. The participants in the hard goal group set significantly higher personal goals than those in the medium goal group (Lerner & Locke, 1995). This finding could be interpreted by coaches to give athletes difficult, but attainable, goals during practice. Training in this manner may help or increase performance in practice and ultimately in the game. Training and increasing an athlete's ability to adequately set difficult, but reasonable goals, could make a difference in performance.

Mental health in athletes is becoming more and more known around the athletic community, and many researchers have shown many different ways that mental health is important in an athlete, especially in an athlete trying to become "elite" (Kim et al., 2009; Taylor et al., 2008; Wadey & Hanton, 2008). All of these mechanisms are important in an athlete's fight to improve and should never be overlooked by talent or skill.

Competition

There are several different types of competition, and different environments for competition. Different environments for competition may be competition in school (playground, classroom, friends, etc.), in the office (clients, projects, bonuses, etc.), and athletics. The different types of competition would be direct or indirect. Direct competition is face to face with another competitor or a confederate and indirect competition is no presence of an opponent. Examples of indirect competition could be that the participant is competing against a personal performance they had before, competing against an earlier participant's performance, or a goal the researcher has given them (Tauer & Harackiewicz, 1999). Most, if not all, of the aforementioned studies were dealing with competition in one or more of these forms trying to understand what happens mentally and physically when individuals are faced with competition, what

individuals can do to increase performance during competition, and if individuals can adapt to competition and increase performance.

Studies have been conducted to understand how competition would affect school aged children. Researchers split the children into two different groups; competition and no competition. In third grade children competition did have an effect on improving reading and math test scores; but greater competition actually decreased retention for children in both public and private school (Henry & Gordon, 2006). A second study done on school aged children wanted to see if competition would influence the children to look at their peer's work. With the application of competition student's interest in other student's work increased significantly (Butler, 1989). As it has been shown even at a young age competition can affect not only how athletic events are played out but also how school work can be improved (in relation to Henry & Gordon, 2006). This knowledge may be useful in schools to help enhance learning; although caution must be in place to not have too much competition and decrease retention in students (Henry & Gordon, 2006).

Other studies have focused on determining how competition affects athletic events (Cooke et al., 2011; Locke & Latham, 1985; Pennebaker & Lightner, 1980; Viru et al., 2010; Wilmore, 1968). A majority of the studies resulted in increases to performance but no physiological changes; although

there were a few with changes in heart rate. The result of performance changes but small if any physiological changes hints towards a psychological shift and the reason why a lot of these studies were testing psychological reactions to competition. Several studies used word games or puzzles as an event to invoke competition and to see how individuals would react to an opponent (both real and fake-confederate) or goals set by the researchers (Deci, 1971; Harackiewicz, 1979; Harackiewicz et al., 1987; Lerner & Locke, 1995; Taylor et al., 2008). Several studies, some depended on personality of the individual, resulted in increases in performance with competition (Deci, 1971; Harackiewicz, 1979; Harackiewicz et al., 1987; Lerner & Locke, 1995; Taylor et al., 2008). Individuals often saw the competitive situation much more enjoyable than the non competitive situation; they felt it was more challenging (Lerner & Locke, 1995). These increases in performance show that competition can be a great motivator in performance of a lot of different activities and the activities do not always have to be athletic.

A couple of studies did use athletic events or performances to determine how competition would affect individuals; some have already been mentioned, Oudejans and Pijpers (2010) and Pennebaker and Lightner (1980). Pennebaker and Lightner (1980) demonstrated how external distractions, can help increase an individual's performance and/or decrease perceptions of fatigue. Oudejans

and Pijpers (2010) showed how even mild anxiety training can help maintain performance in high anxiety situations (or competitions). Both of these studies showed different ways to deal with competition stress and how they may train to counteract on the anxiety or fatigue that comes with competitive sports. These next couple studies compared individuals with and without competition in a physical event.

Viru et al. (2010) wanted to see what kind of physiological changes may occur during competition and if endurance running time would change. The researchers compared endurance athletes with two exhaustive trials (treatment and control). Psychological measurements were not taken. Trials were randomized and athletes were unaware of conditions of testing until they walked into the lab for that test day. Each test was an exhaustive treadmill test. The running speed started at 8 $km*hr^{-1}$ and was increased by 0.5 $km*hr^{-1}$ after every 200 m of running. During the treatment trial the researchers strongly encouraged the athletes and monetary rewards were given for the best performance time; both between subjects and if the subject performed better than their previous trial. During the control trial the subjects ran on the treadmill until exhaustion with no encouragements or incentives. Results of the tests show that during the competitive trial athletes had a significantly longer running time compared to the control trial (1222 ± 100 s vs. 1173 ± 121 s $p < .05$). The only physiological

difference was VO_{2peak} was greater in the competitive trial (59.0 ± 4.2 ml/kg/min vs. 56.5 ± 6.2 ml/kg/min $p < .05$); no other physiological differences were seen among trials (Viru et al., 2010).

Cooke et. al. (2011), conducted a study measureing how competition has an effect on muscular endurance performance in individuals. Psychological measurements, to determine personality of the individual, were not measured. Participants were divided randomly into groups (same sex) of six, and each performance was conducted in the same room with all six participants. The six participants were seated in six partitioned stations in an oval shape. Handgrip dynamometers were used to test endurance performance. Participants were tested first for a baseline of maximal voluntary contraction (MVC). During each trial (control and treatment) participants had to maintain 40% of their MVC for as long as possible. The competition trial was completed without the partitioned stations, therefore all participants could see each other. During the competition trial the participants were told they were competing against each other, and they were competing as a team against the other groups of six. The prize for having either the longest individual endurance time or the longest team endurance time was either 15 euros or 30 euros. The control trial was described as a “do your best” trial within the partitioned stations. When performances were compared participants maintained MVC longer in the competitive trial than in the control trial

(119.14 ± 39.84 s vs. 98.01 ± 29.62 s $p < .05$). Physiological differences did not change among trials except heart rate increased when comparing the control and competitive (99.00 ± 15.23 bpm vs. 115.50 ± 17.63 bpm $p < .001$) trials (Cooke et al., 2011).

Wilmore (1968), conducted a study to directly test whether face to face competition would cause any physiological differences among individuals. Psychological measurements were not assessed. College aged men were asked to participate. Each participant performed three loaded bike tests on a cycle ergometer; two trials were control and one was treatment. The first test was just a familiarization trial for the participant as well as the test to pair the participants together. The second two trials were randomized among participants as to counter the learning effect. Participants were to maintain 60 rpm for the entire test except the last few minutes. The load on the bike was set at 12 kp·m for the first 5 min of the exercise and then increased immediately to 27 kp·m for the rest of the test. Each trial was an exhaustive trial. Participants were matched with other participants that had the same amount of work in the first control trial (familiarization). During the competition trial, the cycle ergometers of each participant were set up right next to each other and exercise started simultaneously. The participants were told that they were competing against not only each other but also their previous trial(s); this was meant to invoke

competition in both situations as to have desired results. The second control trial was conducted the same as the familiarzation trial. The compared trials resulted in a significant difference between the control and competitive trials in that riding time (379 ± 180 s vs. 457 ± 233 s $p < .05$) and work output (9,798 ± 3,484 kp·m vs. 11,136 ± 4,199 kp·m $p < .05$) were significantly higher in the competition trial (Wilmore, 1968).

These changes in performance times without differences in physiological data demonstrates that physiological maximums can be overcome mentally. If these mental blocks are lifted, individuals can push themselves to work past maximum levels for longer periods of time.

CHAPTER III

METHODS

Participants

To avoid differences that may occur between responses of males and females to competition, one gender was recruited. Females that were a part of an athletic program, and participating in a team sport at a local college, were recruited. Texas Woman's University is a local college in Denton, TX; therefore, female collegiate athletes were recruited from this college. Former athletes will also be recruited. The former athletes competed at a varsity level (high school or college) for 2 or more years within the last 4 years. Participants were physically active (works out 3 to 5 days a week) and between the ages of 18 and 26 years old.

Power analysis was calculated to know how many participants were necessary to have a power of 0.8. To result in a power of 0.8, 18 participants were tested (Barker Bausell & Yu-Fang Li, 2002). Therefore, 20 females aged 18 to 26 years that were current collegiate athletes or former athletes were recruited to participate in the study.

Procedures

Preliminary Protocol

The participants were asked to fill out a fitness survey (Appendix E), so the investigators may understand the type of activity each individual was accustomed to. The participants were also asked to keep a food log for 24 hr. before performing the familiarization trial (Appendix F). After completing the familiarization trial, copies were made of the food log and given back to the participant. The participant was asked to follow the food log, as close as possible, 24 hr before each remaining trial. The food log was used to diminish any differences in performance due to dietary reasons. The participants were also asked to maintain normal hydration throughout the day of or the day before testing, and in at least a 4 hr fasting state before testing. Water was provided before and after testing to ensure hydration.

Protocol

Each participant performed a maximal test to determine a baseline VO_{2max}. The Bruce protocol was used for each participant. The maximal test stopped, and recovery began, when the participant terminated the test. The criteria determining if VO_{2max} had been reached was attainment of age predicted heart rate (HR) max ± 10 bpm, respiratory exchange ratio (RER) >1.1, or a VO_2 plateau with an increase in workload (American College of Sports Medicine,

2009); one of the three criteria must be present to determine VO_{2max}. If none of the 3 (HR, RER, or VO_2) aforementioned criteria were met to determine VO_{2max}, the values were recorded as VO_{2peak}. Volume of oxygen consumed (VO_2), volume of carbon dioxide produced (VCO_2), ventilation (V_E), and RER was measured utilizing a Parvo Medics metabolic cart (TrueOne 2400 Metabolic Measurement System, Salt Lake City, UT). Resting heart rate (HR), resting blood pressure (BP), height (HT), and weight (WT) were measured prior to the maximal test. Heart rate was measured utilizing 12 lead electrocardiogram for the maximal test (Cardiac Science, Parkway Bothell, WA) and a Polar Heart Rate monitor for the trials (Polar Electro Oy, Kempele, Finland) and BP utilizing an aneroid sphygmomanometer (Aneroid Sphygmomanometer model 108M, Omron Healthcare, Inc.). When measuring WT, participants were requested to wear light clothes and no shoes and WT was recorded to the nearest 0.1 kg. Weight was measured utilizing a Tanita BWB-800 Digital Scale (Tanita Corporation of America, Inc., Arlington Heights, IL). When measuring HT, participants were asked to look straight forward without wearing shoes and HT was recorded to the nearest 0.1 cm. Height was measured utilizing a portable stadiometer. Heart rate, BP, and rating of perceived exertion (RPE) were measured throughout the maximal test during each stage (Appendix M). Rating of perceived exertion was recorded to assess the effort of the individual utilizing Borg's scale of Perceived

Exertion from 6 to 20 (Borg, 1982). Heart rate was measured every minute of every stage; BP and RPE were measured every 3rd min of every stage. After completion of the test each subject walked at 2.5 mph on the treadmill until HR reached ≤130 bpm. After HR reached ≤130 bpm, participants were seated to allow passive recovery; HR and BP were measured every 2 min, until 6 min after, to ensure values were continually decreasing.

Each participant was matched with another participant that had a VO_{2max} within 5 ml/kg/min; but participants were blinded to the purpose of the study (competition), until after trials were completed. The participants were told that the study was measuring performance based on participants' control of the treadmill speed, and when participants were being tested at the same time, it was because of time constraints. If participants knew the study was about competition, it was possible that participants might have pushed harder without structured competition, as to compete with self and other participants. Participants were also not given any data allowing knowledge of performance until after the completion of the study.

After performing a VO_{2max} test, participants completed a familiarization trial (FAM), control trial (CT), and a treatment (COMP) trial. The treatment trial was known as the competition trial. The familiarization trial was to acquaint the participants with the type of test that was to be performed. The control and

competition trials were a part of a cross-over balance design to try and decrease the effects of a learning curve. For example one participant's order of trials was VO_{2max}-Familiarization-Control Trial-Competition Trial. Another participant's order of trials was VO_{2max}-Familiarization- Competition Trial-Control Trial. The order of trials were randomized among participants. At least 5 days were given to each participant after each test to allow adequate recovery. Control and competition trials for each participant were held at the same time of day.

The familiarization, control, and competition trials consisted of a 20 min treadmill test with a 5 min warm up. The investigator explained the running protocol and answered any questions before the warm up. The investigator told each participant to run at her own pace and cover as much distance as possible in 20 min. The treadmill speed started at 5 mph and remained on 0% grade throughout the trial. Participants were allowed to control the treadmill speed. The participants were not able to manually control the speed due to lab treadmills not having the ability to change speed on the face of the treadmill; therefore, the participants told the investigator how much to increase or decrease speed by simply stating what speed was wanted or how much to increase or decrease (i.e. increase by 0.2). The warm up consisted of a light walk at 3 mph with 0% grade on the treadmill. The trial began after the warm up was finished. The investigator increased the speed to 5 mph. After the speed was increased to 5

mph the investigator reset the treadmill counter, started the timer, and told the participant the control of the treadmill speed was the runner's choice.

In the competition trials paired subjects tested in the same room at the same time. During control and competition trials, investigators did not encourage participants to ensure similar testing environments. Each participant had WT, HR, and BP measured before each performance test. During each test HR and RPE were measured. Each treadmill test was performed on a Quinton TM 65 Q Stress treadmill (Cardiac Science, Parkway Bothell, WA). To measure distance run, a device was made to count revolutions of the treadmill belt by means of a magnetic strip placed on the belt of the treadmill and a counter placed behind the treadmill. The number of revolutions and the length of the belt (12 ft.) factored into an equation (see below paragraph) to calculate how much distance was covered during the 20 min trial.

Total ft. covered = (# of revs) * (12 ft.)

Total miles = Total ft. covered / 5,280ft

Total kilometers = (ft. covered*12in*2.54cm)/100,000cm

During each performance test, physiological responses were measured. Heart rate was measured every 2 min, RPE was measured and recorded every 5 min, and distance traveled (number of revolutions) was recorded every 5 min. After each test was completed each participant stayed on the treadmill walking at

2.5 mph. After HR reached ≤130 bpm, participants were seated to allow passive recovery; HR and BP were measured every 2 min, until 6 min after, to ensure values are continually decreasing.

Questionnaire

The participants were asked to fill out a questionnaire to determine type of competitive personality, Work & Family Orientation – Mastery & Competitiveness Questionnaire (Appendix C). Participants were also asked to fill out another questionnaire to understand whether the treatment trial was competitive or not, Competitive Questionnaire (Appendix D). Each participant was asked to fill out both questionnaires following their last testing session before leaving the lab. After completing the questionnaires, the participant was debriefed and notified of the full intent of the study. The participant was also asked to keep the full intent of the study to themselves as to not compromise the remaining participants and their results.

Statistical Analysis

Descriptive statistics was used to analyze the mean and standard deviation for HT, WT, age, and relative VO_{2max}. A bivariate Pearson correlation was conducted between HR and distance, RPE and distance, as well as, HR and RPE in both CT and COMP. A paired t-test was used to determine if there was a significant difference in total distance covered (km), peak HR (bpm), and peak

RPE between treatments (competition-COMP vs. control-CT). A repeated measures ANOVA was used to determine if there was a significant difference in distance in 5 minute time points, HR at 2 minute time points, and RPE at 5 minute time points between treatments (competition-COMP vs. control-CT). Bonferroni was used for the post hoc. The significance level will be set at .05 and SPSS (19th ed.) will be the program used to determine statistical significance.

CHAPTER IV

RESULTS

The goal was to determine if a competitive environment, without prior knowledge of competition, would increase an athlete's performance.

Participant Description

Twenty healthy females, current and former athletes, were recruited to participate in this study. Two participants dropped out due to injury and time constraints; therefore, only 18 participants were included in the data analysis. During one CT and one COMP, two different participants had HR malfunctions. Statistics could not be run for those two participants' HR data due to the lack of data to compare. Therefore, only 16 participants' data could be analyzed for HR. Participants' demographics are presented in Table 1, and cardiorespiratory data for the VO_{2max} test can be found in Appendix N.

Table 1
Participant Baseline Demographics

Height (cm)	172.0 ± 6.7
Weight (kg)	68.1 ± 9.9
Age (years)	20.9 ± 1.8
Relative VO2max (ml/kg/min)	41.0 ± 5.4

Note. N = 18 All values expressed as mean ± standard deviation; VO_{2max} = maximal oxygen consumption.

Competition and Performance

Significant differences were not found between control and competition trials in the paired samples t-test for peak HR ($p = .134$), shown in Table 4, or peak RPE ($p = .999$), shown in Table 3; however, there was a significant difference found for total distance covered ($p = .017$), shown in Figure 2 and Table 3.

A repeated measures ANOVA was used to demonstrate differences between variables taken at different time points during the trials; distance covered in 5-min time intervals, HR taken every 2-min, and RPE taken every 5-min. Pairwise comparisons were used to interpret the results for each variable.

In the control trials, distance covered in the first time interval (0-5 min; 0.721 ± 0.097 km) was significantly different from distance covered in the last time interval (16-20 min; 0.823 ± 0.154 km) indicating that the participant covered more distance during minutes 16-20 than in minutes 0-5. In the competition trials, there were significant differences seen between the first time interval (0-5 min; 0.773 ± 0.102 km) and the third time interval (11-15; 0.827 ± 0.116 km), as well as, the fourth time interval (16-20 min; 0.876 ± 0.141 km); between the second interval (6-10 min; 0.799 ± 0.101 km) and the fourth interval (16-20 min; 0.876 ± 0.141 km), and lastly the third interval (11-15 min; 0.827 ± 0.116 km) and the

fourth interval (16-20 min; 0.876 ± 0.141 km). Distance covered in each time interval is shown in Figure 1.

The control trial compared to the competition trial for distance covered in each time interval is demonstrated in Figure 1 and Table 3. There were significant differences, for total distance covered, seen in both the first time interval (CT: 0.721 ± .097 km vs. COMP: 0.773 ± 0.102 km, p = .018) and the third time interval (CT: 0.763 ± 0.107 km vs. COMP: 0.827 ± 0.116 km, p = .018) between control and competitive trials.

The HRs for the control trial compared to the competition trial in each time period, shown in Table 4, and RPE shown in Table 3. No significant differences were found between control and competition trials for HR, except in the 11-12 min time interval (CT: 165 ± 19.7 vs. COMP: 173 ± 15.1 bpm; p = .037). There were no significant differences found between the control trials and competition trials for RPE.

There were significant correlations between HR and distance (r = 0.656, p = .004), RPE and distance (r = .497, p = .036), as well as, HR and RPE (r = 0.795, p = .001) within the CT. There was no significant difference between HR and distance (r = -0.028, p = .916), or RPE and distance (r = -0.220, p = .380) within the COMP. However, there was a significant difference between HR and RPE (r = 0.533, p = .028) within the COMP, shown in Table 2.

Table 2
Bivariate Pearson Correlations between Variables

Variables	Control	Competition
HR * Distance	0.656†	-0.028
RPE * Distance	0.497‡	-0.220
HR * RPE	0.795α	0.533β

Note. r values; N = 18 for Distance and RPE, n = 16 for HR; HR = Heart Rate, RPE = Rating of Perceived Exertion; † indicates significant difference between HR & distance in CT, p = .004; ‡ indicates significant difference between RPE and distance in CT, p = .036; α indicates significant difference between HR and RPE in CT, p = .001; β indicates significant difference between HR and RPE in COMP, p = .028

Questionnaires

For the Work and Family Orientation – Mastery and Competitiveness Questionnaire, 94% of the participants were considered masterful individuals (17/18), and 100% were considered competitive individuals (18/18). For the questionnaire that was used to determine if the external stimulus (running against another participant) was competitive, 83% of the participants felt the environment during the treatment trial (COMP) was competitive (15/18).

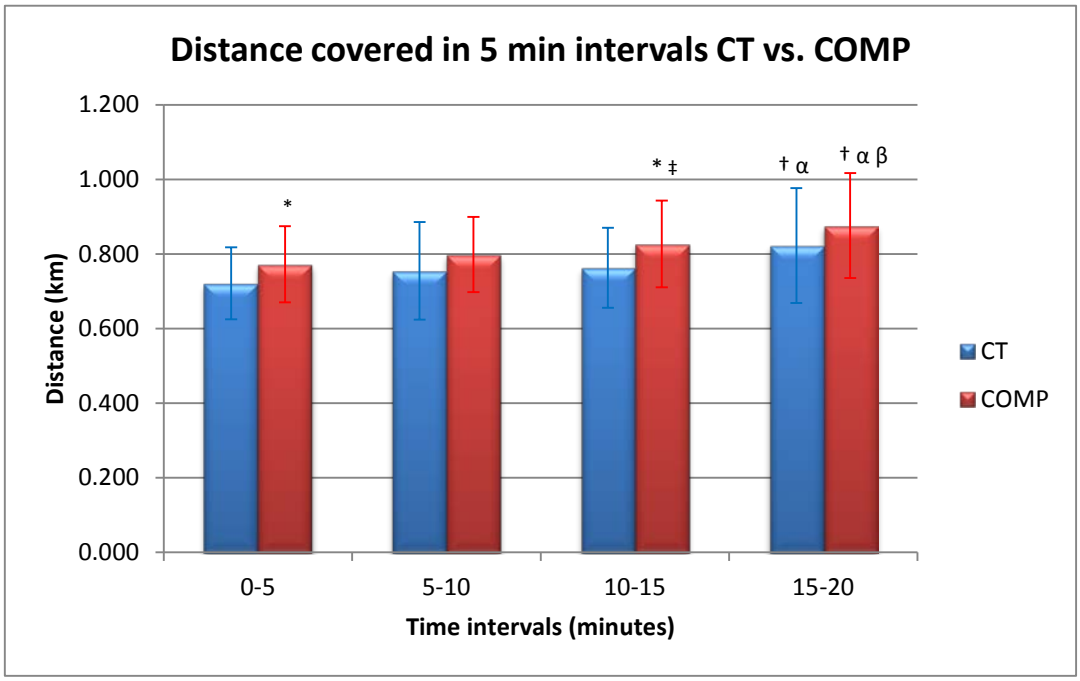

Figure 1: Distance covered in 5 min intervals CT vs. COMP. Mean values for distance covered (km) every 5 minute interval. N = 18; CT: 0.721 ± 0.097, COMP: 0.773 ± 0.102 km @ 5 min; CT: 0.755 ± 0.131, COMP: 0.799 ± 0.101 km @ 10 min; CT: 0.763 ± 0.107, COMP: 0.827 ± 0.116 km @ 15 min; CT: 0.823 ± 0.154, COMP: 0.876 ± 0.141 km @ 20 min; * indicates significant difference between CT and COMP, $p < .05$; † indicates significant difference between time interval 0-5 and 16-20, $p < .05$; ‡ indicates significant difference between time interval 0-5 and 11-15, $p = .004$; α indicates significant difference between time interval 6-10 and 16-20, $p < .05$; β indicates significant difference between time interval 11-15 and 16-20, $p = .021$; CT = Control Trial; COMP = Competitive Trial.

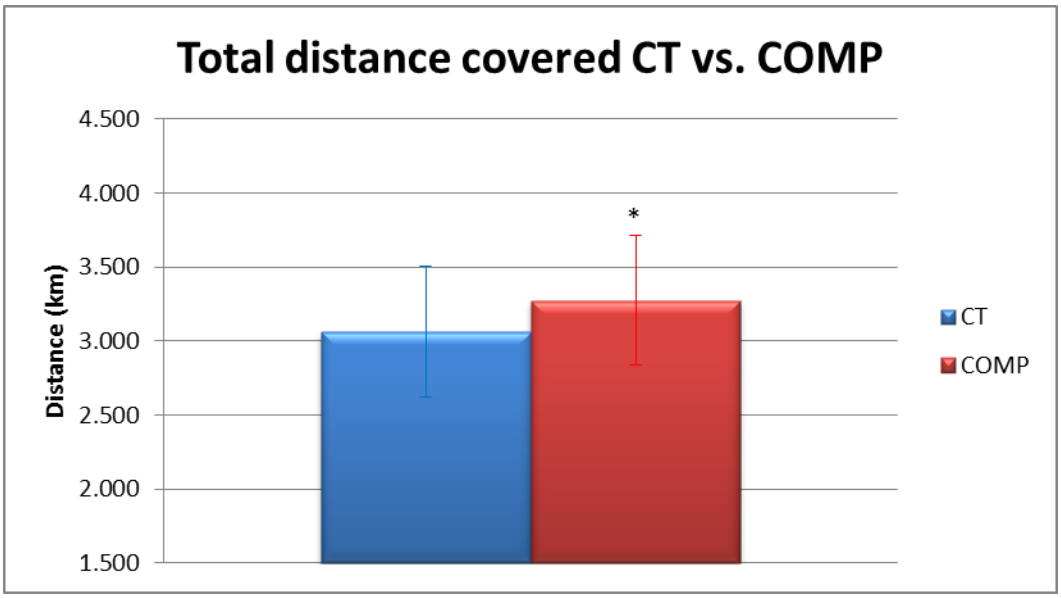

Figure 2: Total distance covered CT vs. COMP. Mean ± standard deviation values for total distance covered for CT and COMP trials. N = 18; CT: 3.063 ± 0.445, COMP: 3.274 ± 0.437 km; * indicates significantly different between CT and COMP p = .017; CT = Control Trial; COMP = Competitive Trial.

Table 3
Distance and RPE Differences between CT and COMP during Time Trials

Time Interval (min)	Distance (km)			RPE	
	CT	COMP		CT	COMP
0-5	0.722 ± 0.097	0.773 ± 0.102*		10 ± 2	10 ± 2
6-10	0.755 ± 0.131	0.799 ± 0.101		12 ± 2	12 ± 1
11-15	0.763 ± 0.107	0.823 ± 0.116*‡		13 ± 2	13 ± 1
16-20	0.823 ± 0.154†α	0.876 ± 0.141†αβ		14 ± 3	14 ± 2
Total	3.063 ± 0.445	3.274 ± 0.437*	**Peak**	14 ± 3	14 ± 2

Note. Mean ± standard deviation; N = 18; RPE = Rating of Perceived Exertion, CT = Control Trial, COMP = Competition Trial; * indicates significant difference between CT and COMP, $p < .05$; † indicates significant difference between time interval 0-5 and 16-20, $p < .05$; ‡ indicates significant difference between time interval 0-5 and 11-15, $p = .004$; α indicates significant difference between time interval 6-10 and 16-20, $p < .05$; β indicates significant difference between time interval 11-15 and 16-20, $p = .021$.

Table 4
HR Differences between CT and COMP during Time Trials

Time Interval (min)	**HR (bpm)**	
	CT	COMP
0-2	150 ± 19	154 ± 15
3-4	154 ± 20	160 ± 14
5-6	160 ± 20	166 ± 14
7-8	163 ± 19	168 ± 15
9-10	164 ± 20	170 ± 15
11-12	165 ± 20	173 ± 15*
13-14	169 ± 20	175 ± 16
15-16	172 ± 21	177 ± 16
17-18	174 ± 21	180 ± 16
19-20	177 ± 21	183 ± 14
Peak	178 ± 20	184 ± 14

Note. Mean ± standard deviation; n = 16; HR = Heart Rate, CT = Control Trial, COMP = Competition Trial; * indicates a significant difference between CT and COMP, p = 0.037.

CHAPTER V

DISCUSSION

The purpose of this study was to determine if a competitive environment, without prior knowledge of this competition, would drive athletes to increase their performance so they may perform better than another athlete performing near them. Presently, few studies have looked at direct competition involving athletic activities (Cooke et al., 2011; Locke and Latham 1985; Wilmore, 1968), with a majority of studies looking at indirect competition involving psychological activities (Deci, 1971; Harackiewicz, 1979; Harackiewicz et al., 1987; Lerner and Locke, 1995; Oudejans & Pijpers, 2010; Tauer & Harackiewicz, 1999; Taylor et al., 2008; Viru et al., 2010). The aforementioned studies do shed light on how individuals and athletes react to competition, but the participants were told to compete against either themselves or each other. Therefore, this present study was done to understand if athletes mentally compete without the instruction to do so.

Summary of Findings

The data analysis revealed that athletes did significantly cover more distance in the competitive trial than the control trial (t stat = -2.647, CT: 3.063 ± 0.445 vs. COMP: 3.27 ± 0.437 km; p = .017). In comparison, the distance covered in each time interval was also significantly different between control and

competition trials during the first 5-min interval (CT: 0.721 ± 0.097 km vs. COMP: 0.773 ± 0.102 km, p = .018) and third minute interval (CT: 0.763 ± 0.107 km vs. COMP: 0.827 ± 0.116 km, p = .018).

There were significant differences between time intervals in the corresponding conditions. Peak HR was not significantly different between the control and competitive trials (t stat = -1.585, p = .134). There were no significant differences for HR in the 2-min time intervals, except in the 11-12 min time interval (CT: 165 ± 19.7 vs. COMP: 173 ± 15.1 bpm; p = .037). The peak RPE's were not significantly different between the control and competitive trials (t stat = -.001, p = .999) and the RPE measurements taken every 5-min were also not significantly different.

There were significant correlations within the CT between HR and distance, RPE and distance, as well as, HR and RPE. However in the COMP the only significant correlation was between HR and RPE.

The following null hypotheses were accepted:

1. There will be no difference between the participants' HR on the competition and control trials.

2. There will be no difference between the participants' RPE on the competition and control trials.

The following null hypothesis was rejected:

1. There will be no difference between the distance run on the competition and control trials.

Psychological Responses to Competition

Questionnaires were used in this study to understand if the athletes were competitive psychologically and to understand if the athletes saw the treatment trial (COMP) as a competitive environment. By understanding if the athletes are naturally competitive, it can be assumed that the results from the questionnaire can support whether or not the athlete found the environment to be competitive. An uncompetitive person may not see the environment as a competition, regardless of any external stimulus. The individual may respond negatively to the external stimulus and shy away from the competitive situation (Tauer & Harackiewicz, 1999). A competitive person may take that same external stimulus and see the environment as a competitive situation. A competitive person may also find the activity to be enjoyable (Tauer & Harackiewicz, 1999).

In the present study, the Work and Family Orientation Questionnaire – Mastery and Competitiveness questionnaire was used to survey whether or not the athletes were masterful and competitive (Spence & Helmreich, 1983). There were 8 mastery questions and 5 competitiveness questions; each question was answered with a 5-point Likert scale ranging from “I strongly disagree” (1 point) to “I strongly agree” (5 points). By scoring higher than 24 on mastery (highest possible score being 40), athletes were considered masterful. By scoring higher than 15 on competitiveness (highest possible score being 25), athletes were

considered competitive. This questionnaire sheds light on how individuals react when presented with situations involving mastery or competition (Spence & Helmreich, 1983).

Out of 18 participants, 17 were considered masterful individuals (94%) and 18 were considered competitive individuals (100%). This finding supports the hypothesis that the participants have a high degree of competitiveness. Therefore, when presented with a competitive environment, the participants would significantly increase performance, according to Tauer and Harackiewicz, (1999). However, the survey was not given until after all trials were completed, so the questionnaire was merely used to help connect the competitive nature of the participant to the increase in performance.

The second questionnaire was used to understand whether or not the athletes felt that running next to another participant was competitive. This is important to understand whether or not the manipulated environment elicited a competitive situation. According to Weinberg et al. (1990), participants may interpret a situation into a performance or competitive situation and may compete against other participants even when not directed to compete. If the participants feel the situation involves evaluation or social comparison, this competitive nature may occur (Weinberg et al., 1990). Therefore, in the present study if participants had the perception of the environment being competitive,

performance may change due to this perception. Mueller (1983) found that a competitive environment could motivate individuals into setting higher goals than the individuals would otherwise (Lerner & Locke, 1995).

Out of 18 participants, 15 felt the environment during the treatment trial (COMP) was competitive (83%). This demonstrates that competition can be stimulated by having two athletes run side by side.

A measurement taken during the trials, rating of perceived exertion (RPE), is subjective and considered a psychological and physiological measurement (Yu, 1998). It is difficult to state if the number chosen is exactly how the participant was feeling or if the number chosen is deflated due to environmental influences. This measurement tool was used to understand how hard the athlete was working during the trials and whether or not the athletes' perception of exertion would significantly change when presented with a competitive environment. Pennebaker and Lightner (1980) found that individuals have felt less fatigued when presented with external sources, or distractions. Pennebaker and Lightner (1980) used running a cross country course as a distraction from the exercise. The present study looked at competition as being the external source or distraction. Although, Pennebaker and Lightner (1980) did not find significant differences in perception of fatigue, the running times were faster in the cross country trial. The increase in performance during the cross country run,

matched with similar perceptions of fatigue to running on the track, indicates that the participants overall felt less fatigued during the cross country run (Pennebaker & Lightner, 1980).

There was not a significant difference between the peak CT RPE and the peak COMP RPE. However, there was a significant difference in distance covered during the COMP. This increase in distance covered indicates that the participants were working harder; therefore, the RPEs should be higher in the COMP. The lack of change in RPE may be due to the participants being so focused on the competition aspect that amount of exertion was not noticed and performance could be increased (Pennebaker & Lightner, 1980). It could also be that the participants' perception of exertion was influenced by wanting to feel less exerted than the other participant. Rating of perceived exertion did not correlate to distance covered in the COMP indicating that the increase in distance covered did not increase RPE in the same manner, which supports that the participants' perception of exertion was influenced by competition.

Physiological Responses to Competition

Distance covered and HR were measured to demonstrate physiological differences due to the competitive environment. The distance covered by each participant was measured every 5-min during each trial. There were significant differences between time intervals when comparing CT to COMP. Significant

differences were also seen between time intervals within corresponding trials. This was to be expected since the participant would be running at a faster pace near the end of the trial. However, there were more significant differences during the competitive trials indicating that competition did affect the participants' performance which led to a significant difference in overall distance covered. The significant findings are supported by other studies that used competition as an external source to increase performance (Cooke et al., 2010; Viru et al. 2010; Wilmore, 1968).

Cooke et al. (2010) used a handgrip test to measure physiological differences between a control trial and a competitive trial. Cooke et al. (2010) told the participants about the competition and used monetary gain, as well as, a visual of the other participants' performance to elicit competition. Time to exhaustion was significantly increased during the competitive trial. Such results support those in the present study with the significant increase in performance during the competitive trial (Cooke, et al., 2010).

Viru et al. (2010) used a specified treadmill running test to measure if performance would increase when the participants were told to compete against their previous performance and other participant's performances. The participants were also given the incentive of money to increase competitive drive. Time to exhaustion was significantly increased during the competitive trial which

was similar to the present study with the significant increase in performance during the competitive trial (Viru et al., 2010).

Wilmore (1968) used an ergometer test to exhaustion to understand whether competition would increase performance. During the competitive trial, participants were set up side by side and told to compete and no monetary gain was offered to the victor. Wilmore (1968) found a significant difference in the competitive trials when compared to control trials, demonstrating that individuals will compete when presented with a competitive environment (Wilmore, 1968). This finding correlated with the present study in finding a significant increase in performance when participants were presented with a competitive situation.

All of the aforementioned studies elicited competition and saw performance increases during the competitive trials. However, the participants of those studies were well aware of competition and were told to compete (Cooke et al., 2010; Viru et al. 2010; Wilmore, 1968). The present study did not inform any of the participants about competing against one another. Although this may appear to be a subtle difference in protocol, it can make a difference in psychological interpretation of the trial. If the participant is not told to compete during a competitive environment, it then becomes solely the participant's decision whether or not there is a competition. With significant differences seen in overall distance found in this study, it can be concluded that female athletes,

who are characterized as competitive individuals, subliminally compete when presented with a competitive environment.

Heart rate was also measured to see if the participants worked harder during the COMP than the CT. The connection between VO_2 and HR is visible, as one increases the other increases indicating that the harder an individual works, the higher HR will be (McArdle, Katch, & Katch, 2009). Therefore, since more distance was covered in the COMP, the higher HRs should be. Heart rate was used in this study as another physiological indicator to determine whether or not the participant was working harder in one trial compared to the other.

In this study, there were no significant differences in peak HR and in HR measured every 2-min between the CT and COMP, except in the 11-12 min time interval. This finding does not coincide with the significant differences found in distance covered. Heart rate and distance did not correlate in the COMP showing that as one increased the other did not increase in the same fashion. This is perplexing since it is known that as work increases, so does HR. This could occur due to the possibility that the participants did increase pace in the COMP, but not enough to elicit the same increase in HR. Unfortunately, there were malfunctions during one CT and one COMP with the HR monitors. Therefore, two sets of data could not be recorded or used in the final analysis, where distance had 18 participants' data and HR had only 16. However, this occurred in both the

CT and COMP suggesting that it did not contribute to the lack of a significant correlation.

The lack of significant differences found in HR is not supported by a study done by Cooke et al. (2011). Cooke et al. (2011) found a significant difference in HR during the competitive trial compared to the control trial. However, the exercise tested (handgrip) was not very strenuous and elicited low HRs during the control trial (99 ± 15.23 bpm). This might account for the significant difference found during the competition trial.

Other studies (Viru et al., 2010; Wilmore, 1968) support the lack of significance finding in HR. Viru et al. (2010) found no significant differences between control and competition trials; however, this was accredited to the strenuous exercise. The trials were time to exhaustion, and therefore elicited an average HR of 200 bpm. Since HR was already so high, a significant difference might not be seen when working that hard (Viru et al. (2010). Wilmore (1968) also did not see a difference between the competitive trial and the second control trial. There was a significant difference between the first control trial and the competitive trial, but this was attributed to the learning curve. The first control trial was used to familiarize the participants to the protocol and reduce differences seen from the participants becoming more accustomed to the test (Wilmore, 1968). The lack of significance can also be directed to the fact that the

participants were exercising at a strenuous intensity (Viru et al., 2010; Wilmore, 1968). In this present study, participants had control over the treadmill speed. A majority of the participants started the trials at a lower speed and steadily increase throughout the trial. Even though the distance covered increased between control and competition trials, the effects on HR were similar.

Conclusion and Recommendations

This study showed an array of different exercise strategies; because the participants could decide on how fast the treadmill speed would be, some performed strenuous exercise and some performed moderate exercise. Control over the speed and the time limit contributed to some participants basing the speed of the treadmill off how much time was left in the trial. A couple of participants already had in mind their exercise strategy before coming in due to experience running on a treadmill By having control, the participants could run what they already planned instead of basing the running pace on their response to competition. Although, this is considered a weakness to the present study, there was an increase in distance covered in COMP; demonstrating that a portion of these participants may have used an exercise strategy but increased speed earlier, due to the competition, than what was planned and executed in the control trial. Other studies have used a predetermined increase in either speed or resistance and only stopped the exercise if the participant reached exhaustion

(Viru et al., 2010; Wilmore, 1968). This indicates that both methods can be effective and competition will increase performance in either manner. The results of this study showed that the athletes' performance did significantly improve when presented with a competitive environment. The presence of significant differences seen in distance demonstrated that the competitive environment did increase the push to work harder. Therefore, if female athletes are presented with a competitive environment it can be presumed that the athletes will compete without the instruction to compete.

Recommendations for future studies:

1. A competition study involving participants that play the same sport and completing an activity that is performed in that particular sport.
2. Using male participants instead of female to understand if there is a different response.
3. Using approved Questionnaires that have validity and reliability to completely understand what the athletes were thinking when presented with a competitive environment.

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Appendix A

Institutional Review Board Approval Letter

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378 FAX 940-898-4416
e-mail: IRB@twu.edu

February 1, 2013

Ms. Dyana Bullinger
P.O. Box 425647
Denton, TX 76204

Dear Ms. Bullinger:

Re: Effect of Competition on Performance and Physiological Responses (Protocol #: 17053)

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of the approved consent form with the IRB approval stamp is enclosed. Please use the consent form with the most recent approval date stamp when obtaining consent from your participants. A copy of the signed consent forms must be submitted with the request to close the study file at the completion of the study.

This approval is valid one year from January 18, 2013. Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

Sincerely,

Rhonda R Buckley

Dr. Rhonda Buckley, Chair
Institutional Review Board - Denton

cc. Dr. Charlotte Sanborn, Department of Kinesiology
Dr. Kyle Biggerstaff, Department of Kinesiology
Graduate School

Appendix B

Approved Informed Consent

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Title: Performance & Physiological Differences in Athletes with Control of Treadmill Speed
Investigator: Dyana Bullinger, B.S.....dbullinger3@twu.edu 832/492-2280
Advisor: Kyle Biggerstaff, PhD ..... KBiggerstaff@twu.edu 940/898-2596

Explanation and Purpose of the Research

You are being asked to participate in a research study for Ms. Bullinger's thesis at Texas Woman's University. The purpose of this research is to determine how being able to control the treadmill speed will affect participants' performance and physiological variables.

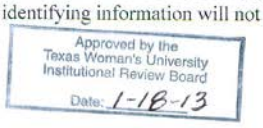
Description of Procedures

You will be asked to perform a maximal running trial, three 20 minute running trials, complete a fitness survey, 24 hr. food log, and two questionnaires. During the maximal trial, gas will be collected by you wearing a mouthpiece, nose clip, and headgear for the entirety of the trial. The maximal trial will require an electrocardiogram (ECG), and the remaining running trials will require a Polar Heart Rate monitor. The speed of the treadmill during all three running trials (excluding the maximal trial) will be determined by you. Based on the availability of the exercise physiology lab, you and the primary investigator will decide together on a testing dates and times. You will also be asked to fill out a food log, fitness survey and two questionnaires online. The 24 hr. food log will consist of what you have consumed 24 hrs. before fitness testing and used to diminish performance differences due to dietary reasons. The fitness survey and each questionnaire will be used to understand more about you in relation to the study and fitness. The food log will take less than 30 minutes to finish and the fitness survey and questionnaires will not take more than 10 minutes each to complete. Each trial will require, at most, 60 minutes, which will lead to a maximum total of 5 hours for the entire study. The researcher will give an I.D. number to you to increase confidentiality. Printouts of data collected can be requested but will not be given out until all participants have completed every trial. In order to be a participant in this study, you must be at least 18 years of age or older and be a current member of an athletic collegiate program.

Potential Risks

A maximal test and three running trials can present participants with an increased risk of light-headedness and possibly nausea; to reduce this risk, you should eat between 4 hours before maximal exercise. Additionally, as with all exercise, the exercise tests will present a small but increased risk of: (A) muscle cramping; (B) abnormal responses of the cardiovascular system; and (C) muscular and/or connective tissue injury with associated soreness. To reduce risk of muscle cramping (A), drink plenty of fluids throughout the day. In order to minimize risks abnormal cardiovascular responses (B) and muscular injury (C), you will be required to complete a health screening prior to participation and participate in pre- and post-testing warm-up/cool-down routines. Additionally, all testing will be conducted according to guidelines established by the American College of Sports Medicine. An irritation may occur from the electrodes. You will be asked if an allergic reaction may occur. Other brands of electrodes may be used to accommodate. If unknown and reaction does occur, the electrode will immediately be taken off and site will be cleaned with an alcohol swab. You will be told to consult a doctor.

Confidentiality will be protected to the extent that is allowed by law. Contact will be made through email. There is a potential risk of loss of confidentiality in all email, downloading, and internet transactions. The paper documents will be kept in a locked file cabinet, stored in a specified folder, only for the use of the primary investigator. The information collected will be shredded within 5 years after the study has finished. The electronic data will be stored on SkyDrive in the primary investigators possession. The SkyDrive account can only be accessed with the primary investigator's username and password, which will not be given to any other individuals. The results of the study will be reported in scientific journals but participants' names or any other identifying information will not be included.



Initials

You will be given an I.D. number so that your name will not be used. You will be referred to as the I.D. number to avoid loss of anonymity. Due to scheduling, some tests may be performed with more than one participant testing at one time; anonymity will be partially lost when performing side by side with another participant. You have the choice to withdraw from the study. You will not be coerced, participation is strictly voluntary. Each test will be done correctly and as efficiently as possible to minimize the amount of time lost.

To decrease embarrassment, no names will be used and no results will be told to any of the other participants regarding you. Testing will occur in the closed exercise physiology laboratory at Texas Woman's University. During testing only professors, investigators, and participants will be allowed in the enclosed laboratory. I or other female research assistants will apply all electrodes in preparation for testing.

The investigators will try to prevent any problem that could happen because of this research. You should let the investigators know at once if there is a problem and the investigators will help. However, TWU does not provide medical services or financial assistance for injuries that might happen because participants are taking part in this research.

Participation and Benefits

Involvement in this study is completely voluntary and you may withdraw from the study at any time. Following your completion of the study, you will receive a $25 check for participation. From participating in this you may also learn individual aerobic capacity, which may be of interest from a health or performance standpoint. If you would like to be informed of the results of this study, an email can be provided at the end of this consent form and the investigators will mail or email the results.**

Questions Regarding the Study

A copy of this signed and dated consent form will be given to you to keep. If there are any questions about the research study, the researchers will be able to answer; phone numbers are at the top of this form. If there are any questions about individual rights as a participant in this research or the way this study has been conducted, contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or via e-mail at IRB@twu.edu.

_____ _____

Signature of Participant Date

This study is being funded by Texas American College of Sports Medicine (TACSM).
**If you would like to know the results of this study tell us where you want them to be sent:

Email: _____
Or
Address:

_____

_____

_____

Contact Info: Dyana Bullinger dbullinger3@twu.edu 832-492-2280

Appendix C

Work & Family Orientation – Mastery &

Competitiveness Questionnaire

Work & Family Orientation – Mastery and Competitiveness Questionnaire

Mastery

1. I would rather do something at which I feel confident and relaxed than something which is challenging and difficult.
2. When a group I belong to plans an activity, I would rather direct it myself than just help out and have someone else organize it.
3. I would rather learn easy fun games than difficult thought games.
4. If I am not good at something, I would rather keep struggling to master it than move on to something I may be good at.
5. Once I undertake a task, I persist.
6. I prefer to work in situations that require a high level of skill.
7. I more often attempt tasks that I am not sure I can do than tasks that I believe I can do.
8. I like to be busy all the time.

Competitiveness

1. I enjoy working in situations involving competition with others.
2. It is important to me to perform better than others on a task.
3. I feel that winning is important in both work and games.
4. It annoys me when other people perform better than I do.
5. I try harder when I'm in competition with other people.

Note: Each item will be answered on a 5-point Likert scale ranging from "I strongly agree" to "I strongly disagree".

High scores reflect a high degree of mastery and competitiveness (Spence & Helmreich, 1983).

Appendix D

Competition Questionnaire

Competition Questionnaire

1. Did you compete against yourself during any of the trials?
    a. Yes
    b. No

2. Did you feel competitive against the other individual while running side by side?
    a. Yes
    b. No

3. Did you mentally compete against the other individual running next to you?
    a. Yes
    b. No

4. Did you push yourself more or less when running next to someone compared to when you were running by yourself?
    a. More
    b. Less
    c. The same

5. During which trial did you feel more competitive?
    a. By myself
    b. Running side by side with another participant
    c. The same for both trials

Note: This questionnaire is to determine whether or not competition was elicited and if the participants competed even when never told to compete.

Appendix E

Fitness Survey

Fitness Survey

1. How many hours do you work out a week?
    a. <20
    b. 20-30
    c. 30-40
    d. >40

2. Does your workout involve running?
    a. Yes
    b. No

3. When running do you use a treadmill?
    a. Yes
    b. No

4. If you answered yes to question 3, how many hours do you spend on a treadmill a week?
    a. <2
    b. 2-4
    c. 5-7
    d. 7-10
    e. >10

Note: This is to understand how accustomed to the treadmill the athletes are.

Appendix F

24 Hour Food Log

24 Hour Food Log
Time of Trial: _____

Breakfast:

Snack:

Lunch:

Snack:

Dinner:

Appendix G

Recruiting Email Script

Recruiting Email Script

Dear (*Coach's name)*,

I am conducting a study utilizing collegiate athletes and am emailing you to ask whether or not I may recruit your athletes. All participants' information will be kept in a locked file cabinet only available for my use, and identification numbers will be given to each of the athletes to provide confidentiality. Part of testing during the study may require more than one participant to test at the same time; therefore, anonymity would be lost among the individuals having to participate in the same room. Each athlete will be compensated ($25) if they complete the study. Participation is strictly voluntary and athletes may withdraw from the study at any point in time; but will only be compensated if the entire study is completed.

I am testing athletes to understand if control over treadmill speed will elicit better performance. The study will consist of a maximal test to measure oxygen consumption (to understand fitness level), and three 20 minute running trials. All three running trials will allow the athlete to decide how fast or slow they will be running on the treadmill. How much distance is covered in the 20 minute trial will be measured to determine whether performance, as well as other physiological variables, increased during each trial.

During each trial, I will be measuring heart rate and distance covered. Heart rate and blood pressure will also be measured before and after each trial. The total time spent in the lab for each trial will be, at max, 60 minutes.

If any athletes would be interesting in participating, please have them email me (dbullinger3@twu.edu).

Thank you for your time,

Dyana Bullinger, B.S.
Graduate Student
Teaching Assistant
Exercise Physiology
Texas Woman's University

*There is a potential risk of loss of confidentiality in all email, downloading, and internet transactions.

Appendix H

VO_{2max} Script

VO2max Script

Before Testing:

This will be told to the participant prior to testing:

Today you are being maximally tested to understand how physically fit you are and to know how hard you are working in the subsequent trials.

The test is performed on a treadmill and made up of several increasing stages, with increases in speed and grade. Throughout the treadmill test you will be wearing a mouthpiece, to collect gas, and an ECG to monitor heart rate. During the test the investigators will be measuring and recording blood pressure, rating of perceived exertion, and heart rate. Blood pressure will be taken during the last minute of each stage. For rating of perceived exertion, a scale will be placed in front of you and you will be asked how you feel, point to the number the most explains how you feel at that moment (show example of RPE scale).

Each stage is 3 minutes long (show them the stages on paper). Warning will be given at the end of every stage to alert you for the next stage. Warnings will be given with 15 seconds left and then a countdown from 5 until the next stage starts.

If you feel you have reached maximum and you cannot go any further, grab the front handrail and we will take you down in speed and grade. DO NOT try to straddle the belt or try to get off the treadmill. I repeat DO NOT try to straddle the belt or try to get off the treadmill. We will take you down as soon as you grab the front rail. After completion of the test you will walk at 2.5 mph and 0% grade until your HR falls below 130 bpm. You will then be seated and recovery measurements will be taken.

During Testing:

The following will be told to the participants during testing:

Fifteen more seconds until the next stage begins (at 2:45 each stage).

How do you feel on a scale from 6 to 20? (Show scale at 2:45 of each stage after the 15 second warning has been given).

The speed and grade will increase in five…four…three…two…one.

The next stage has begun (told at 2:55 of each stage).

After Testing:

The following will be told to the participants after testing:

All results from the study are not released to you until after all participants have finished. This is for testing and evaluating purposes of the study. If you indicated on your consent form that you wanted your information we will send it to that email or address. Thank you for your participation.

Appendix I

Trial Script

Trial Script

Before Trials:

This will be told to the participant prior to testing:

Today you are performing a 20 minute trial run on the treadmill. Heart rate and blood pressure measurements will be taken before the trial starts. You will start off with a 5 minute warm-up at 3 mph and 0% grade. After the 5 minute warm-up has finished, the speed will be increased to 5 mph and the timer will start.

Once the timer has started, you have complete control over the treadmill speed. The keyboard will be placed on a shelf in front of you and you can increase or decrease the speed of the treadmill. The objective is to cover as much distance as possible in the allotted 20 minutes.

Add this for competitive trial

You will have someone performing next to you during this trial. Scheduling constraints has caused us to have both of you run at the same time.

Throughout the treadmill test you will be wearing a Polar Heart Rate monitor to measure heart rate. During the test the investigators will be measuring and recording rating of perceived exertion and heart rate. For rating of perceived exertion, a scale will be placed in front of you and you will be asked “how you feel”, point to the number that most explains how you feel at that moment (show example of RPE scale).

After completion of the trial, you will walk at 2.5 mph and 0% grade until your heart rate falls below 130 bpm. You will then be seated and recovery measurements will be taken.

During Trials:

Participants are able to control speed of the treadmill and a timer is visible; therefore, the only talking during the trial is to ask “how do you feel?” for Rating of Perceived Exertion.

After Trials:

The following will be told to the participants after testing:

Thank you for your participation.

Appendix J

Debriefing Script

Debriefing Script

Thank you for your participation in the study. I would like to take a few minutes to tell you about the purpose of this study. The objective of this study is, to look at the performance enhancement when athletes are running side by side with another athlete compared to running alone while neither athlete was told it was a competition. In addition, we are also interested in heart rate responses and the effect on each individual while running. Several times during an athletic career an athletic is told they are to compete; however, how competitive are athletes subconsciously? This is the question we are trying to answer. We did not fully inform you on our true purpose to avoid conflict with the final outcome. Allowing you to not feel compelled in any way to compete or not. Furthermore, our purpose was not to "trick" you, but to allow you to respond naturally to the environment. So, as you may see there are some misleading aspects to this study, but we hope that you understand that they were included for an important reason. Are you all ok with this or have any further questions about these aspects of the study?

We believe this study is important because it allows us to better understand how athletes react psychologically and physically to competitive stimuli. All of the information that was collected today will be kept completely confidential and there will be no way of identifying your responses with your identity. We are not interested in any one participant's responses by themselves. Rather, we are interested in the general responses of all participants when they are combined together. If you are uncomfortable in any way as a result of answering any of the questionnaire items, then please speak with me before you leave. Your participation today was greatly appreciated and will help in furthering our understanding of athletes.

We ask that you do not discuss this research with anyone else, at least until the every participant has finished the study, because it could ruin the study for other participants. Would that be ok with you?

If you have any questions or concerns regarding your participation in this study please contact Dyana Bullinger. Her contact information is listed on your copy of the consent form. Thank you again for your participation.

Contact Info:
Dyana Bullinger
dbullinger3@twu.edu

Appendix K

TWU Athletic Approval Letter

PIONEERS TEXAS WOMAN'S UNIVERSITY

January 2013

To whom this may concern:

The bylaw, stated below, is the NCAA rule for current collegiate athletes participating in a research study that includes compensation. If Dyana Bullinger's research study falls under those rules, then compensation of Texas Woman's University current athletes is permitted.

16.11.1.7 Research Studies.

A student-athlete may receive compensation for participation in institutional and noninstitutional (e.g., NCAA) research studies. Such compensation shall be consistent with the going rate for compensation offered in studies involving nonathlete populations. The study may not be sponsored or conducted by an institution's athletics department, and compensation may not be provided or determined by the athletics department. There shall be no indication that the student-athlete expressly or implicitly endorses any commercial product or service. **[R]**

(Adopted: 1/10/00, Revised: 10/21/08, 6/22/11)

Sincerely,

Charolette L Hunt

Charolette Hunt
Coordinator of Athletics Compliance

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Appendix L

Physical Activity Readiness Questionnaire

(Par-Q)

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☐	1.	Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2.	Do you feel pain in your chest when you do physical activity?
☐	☐	3.	In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4.	Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5.	Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
☐	☐	6.	Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7.	Do you know of any other reason why you should not do physical activity?

If you answered ... YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) _____ WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

CSEP | SCPE

Appendix M

Rating of Perceived Exertion Scale

(RPE scale)

rating	description
6	NO EXERTION AT ALL
7	
8	EXTREMELY LIGHT
9	VERY LIGHT
10	
11	LIGHT
12	
13	SOMEWHAT HARD
14	
15	HARD (HEAVY)
16	
17	VERY HARD
18	
19	EXTREMELY HARD
20	MAXIMAL EXERTION

Appendix N

Individual Cardiorespiratory VO_{2max} Data

Individual Cardiorespiratory VO_{2max} Data

Participant	VO_{2max} (ml/kg/min)	VO_{2max} (L/min)	V_E (L/min)	VCO_2 (L/min)	RER	HR (bpm)	RPE
1	-	-	-	-	-	-	-
2	48.4	3.86	82.57	4.17	1.12	179	13
3	39.7	3.49	79.76	3.73	1.07	178	15
4	43.0	2.82	75.91	3.28	1.16	196	19
5	37.8	2.57	79.62	2.92	1.14	184	16
6	52.2	3.35	87.84	3.78	1.13	194	19
7	49.0	3.40	87.55	3.86	1.13	196	17
8	46.4	3.31	86.03	3.88	1.17	176	15
9	42.1	2.59	74.26	2.85	1.12	192	15
10	-	-	-	-	-	-	-
11	40.2	2.63	66.84	3.18	1.21	192	13
12	39.3	2.54	76.06	3.15	1.24	182	19
13	34.4	2.48	58.83	2.90	1.17	195	15
14	38.7	2.48	67.18	2.88	1.16	190	16
15	36.9	2.53	70.19	2.78	1.10	183	15
16	35.6	3.18	87.08	3.58	1.13	180	19
17	37.7	2.74	60.51	3.19	1.16	189	15
18	32.8	1.88	59.4	2.22	1.18	213	15
19	38.6	2.06	66.77	2.55	1.23	189	15
20	45.9	2.48	66.83	2.76	1.11	191	19
Total (μ±SD)	41.0 ± 5.4	2.80 ± 0.52	74.07 ± 9.94	3.20 ± 0.53	1.15 ± 0.04	189 ± 9	16 ± 2

Note. Participant 1 and 10 dropped out of the study, therefore, data was not included in the final total; N = 18; VO_2 = Volume of Oxygen consumed, V_E = Ventilation, VCO_2 = Volume of Carbon Dioxide produced, RER = rating of perceived exertion, HR = Heart Rate.

Appendix O

Individual Participant Baseline Demographics

Individual Participant Baseline Demographics

Participant	Height	Weight	Age
1	-	-	-
2	188	79.7	19
3	178	88	21
4	171.5	65.6	21
5	170	65.4	19
6	167	64.2	22
7	179	69.5	24
8	176.5	71.3	21
9	169.5	61.6	22
10	-	-	-
11	181	65.4	22
12	172	64.5	20
13	172	72.2	19
14	171	64.1	18
15	165	68.5	25
16	175.5	89.3	22
17	170	72.7	21
18	162.5	57.2	19
19	164	53.4	21
20	164	54	20
Total (μ±SD)	172 ± 6.7	68.1 ± 10	20.9 ± 1.8

Note. Participant 1 and 10 dropped out of the study, therefore, data was not included in the final total; N = 18.

Appendix P

Individual Distance Covered in CT (km)

Individual Distance Covered in CT (km)

Participant	0-5 min	6-10 min	11-15 min	16-20 min	Total
1	-	-	-	-	-
2	0.680	0.746	0.812	0.907	3.138
3	0.742	0.746	0.768	0.812	3.074
4	0.699	0.761	0.797	0.860	3.122
5	0.680	0.721	0.739	0.768	2.913
6	0.662	0.881	0.881	0.903	3.331
7	0.936	1.112	0.849	1.112	4.007
8	0.772	0.698	0.677	1.024	3.170
9	0.816	0.874	0.944	1.002	3.637
10	-	-	-	-	-
11	0.680	0.680	0.790	0.933	3.090
12	0.849	0.900	0.892	0.907	3.541
13	0.816	0.816	0.816	0.816	3.267
14	0.677	0.680	0.680	0.677	2.720
15	0.732	0.750	0.750	0.834	3.058
16	0.735	0.746	0.746	0.772	2.993
17	0.479	0.497	0.497	0.505	1.979
18	0.680	0.677	0.812	0.691	2.865
19	0.673	0.629	0.611	0.611	2.527
20	0.677	0.677	0.680	0.677	2.704
Total (μ±SD)	0.721 ± 0.097	0.755 ± 0.131	0.763 ± 0.107	0.823 ± 0.154	3.063 ± 0.445

Note. Participant 1 and 10 dropped out of the study, therefore, data was not included in the final total; N = 18; CT = control trial.

Appendix Q

Individual Distance Covered in COMP (km)

Individual Distance Covered in COMP (km)

Participant	0-5 min	6-10 min	11-15 min	16-20 min	Total
1	-	-	-	-	-
2	0.684	0.750	0.816	0.892	3.138
3	0.757	0.742	0.801	0.728	3.026
4	0.684	0.746	0.764	0.830	3.026
5	0.680	0.677	0.702	0.819	2.881
6	0.881	0.955	1.020	1.145	4.007
7	1.013	0.922	1.068	1.064	4.056
8	0.845	0.885	0.940	1.035	3.701
9	0.885	0.958	0.925	1.009	3.782
10	-	-	-	-	-
11	0.684	0.742	0.845	0.834	3.106
12	0.819	0.852	0.863	0.999	3.541
13	0.819	0.819	0.819	0.885	3.347
14	0.677	0.680	0.680	0.677	2.720
15	0.772	0.778	0.779	0.845	3.170
16	0.739	0.742	0.742	0.768	2.993
17	0.684	0.677	0.677	0.764	2.800
18	0.688	0.816	0.823	0.907	3.235
19	0.684	0.680	0.677	0.614	2.655
20	0.911	0.955	0.947	0.958	3.766
Total (μ±SD)	0.773 ± 0.102	0.799 ± 0.101	0.827 ± 0.141	0.876 ± 0.141	3.275 ± 0.436

Note. Participant 1 and 10 dropped out of the study, therefore, data was not included in the final total; N = 18; COMP = competition trial.

Appendix R

Individual HR (bpm) for CT

Individual HR (bpm) for CT

Participant	0-2 min	3-4 min	5-6 min	7-8 min	9-10 min	11-12 min	13-14 min	15-16 min	17-18 min	19-20 min	Peak
1	-	-	-	-	-	-	-	-	-	-	-
2	147	152	157	158	160	165	167	170	173	176	176
3	161	166	170	173	176	178	180	182	185	186	186
4	154	152	152	155	157	156	160	167	170	180	180
5	152	155	160	164	170	173	177	179	179	183	183
6	-	-	-	-	-	-	-	-	-	-	-
7	166	171	190	187	192	164	179	186	193	196	196
8	125	126	132	141	140	138	141	144	159	165	165
9	166	162	172	174	178	183	185	188	190	189	190
10	-	-	-	-	-	-	-	-	-	-	-
11	139	146	149	154	156	161	171	182	190	195	195
12	133	150	154	158	162	172	173	178	179	179	179
13	182	188	190	192	193	195	197	198	200	200	200
14	162	166	173	175	175	178	182	183	184	185	185
15	145	150	155	158	161	163	165	167	173	181	181
16	151	158	161	165	165	167	169	169	170	176	176
17	117	118	124	120	124	124	122	121	117	120	124
18	183	187	188	185	188	197	199	195	192	193	199
19	158	164	170	172	170	169	171	176	171	172	176
20	127	124	131	143	136	136	148	141	144	141	148
Total (μ±SD)	150 ± 19	154 ± 20	160 ± 20	163 ± 19	164 ± 19	165 ± 20	169 ± 20	172 ± 21	174 ± 21	177 ± 21	178 ± 20

Note. Participant 1 and 10 dropped out of the study, therefore, data was not included; Participant 6's HR monitor malfunctioned, therefore, data was not included; Participant 3's HR monitor malfunctioned in COMP, therefore, data was not included; n = 16; HR = heart rate; CT = control trial.

Appendix S

Individual HR (bpm) for COMP

Individual HR (bpm) for COMP

Participant	0-2 min	3-4 min	5-6 min	7-8 min	9-10 min	11-12 min	13-14 min	15-16 min	17-18 min	19-20 min	Peak
1	-	-	-	-	-	-	-	-	-	-	-
2	138	140	150	152	153	158	158	165	166	169	169
3	159	-	-	-	-	-	-	-	-	-	-
4	154	159	155	155	155	159	166	169	172	177	177
5	145	152	157	161	163	165	168	171	174	180	180
6	145	146	159	159	161	171	171	178	183	186	186
7	175	179	182	176	178	181	191	195	188	191	195
8	141	152	156	156	154	162	163	163	169	173	173
9	148	168	176	180	179	182	184	182	187	185	187
10	-	-	-	-	-	-	-	-	-	-	-
11	158	167	171	177	182	187	190	194	197	190	197
12	135	140	145	152	159	159	159	162	170	174	174
13	174	175	181	185	188	191	192	198	200	201	201
14	164	169	175	178	179	183	184	184	188	188	188
15	153	155	158	160	162	165	168	168	174	184	184
16	149	160	163	166	169	172	173	168	174	186	186
17	151	154	159	159	158	165	163	170	175	176	176
18	187	192	199	202	206	210	213	216	218	217	218
19	140	145	170	175	180	179	180	174	174	180	180
20	150	151	153	152	154	155	154	156	155	157	157
Total (μ±SD)	154 ± 14	160 ± 14	166 ± 14	168 ± 15	170 ± 15	173 ± 15	175 ± 16	177 ± 16	180 ± 15	183 ± 14	184 ± 14

Note. Participant 1 and 10 dropped out of the study, therefore, data was not included; Participant 3's HR monitor malfunctioned, therefore, data was not included; Participant 6's HR monitor malfunctioned in CT, therefore, data was not included; n =16; HR = heart rate; COMP = competition trial.

Appendix T

Individual RPE for CT & COMP

Individual RPE for CT & COMP

	CT					COMP				
Participant	**0-5 min**	**6-10 min**	**11-15 min**	**16-20 min**	**Peak**	**0-5 min**	**6-10 min**	**11-15 min**	**16-20 min**	**Peak**
1	-	-	-	-	-	-	-	-	-	-
2	9	10	12	13	13	10	11	12	13	13
3	9	12	13	15	15	9	10	13	9	13
4	11	13	14	15	15	10	13	14	16	16
5	9	11	15	16	16	9	11	12	15	15
6	10	12	13	14	14	7	9	12	15	15
7	9	15	12	16	16	13	11	13	14	14
8	12	12	13	16	16	12	12	13	15	15
9	11	12	13	13	13	11	12	13	15	15
10	-	-	-	-	-	-	-	-	-	-
11	11	12	14	16	16	11	12	15	15	15
12	11	13	14	15	15	8	11	12	13	13
13	8	13	16	18	18	8	12	13	15	15
14	13	15	15	15	15	11	13	13	15	15
15	13	15	16	17	17	13	15	14	17	17
16	12	13	14	15	15	11	12	13	15	15
17	7	9	9	9	9	11	11	12	13	13
18	13	14	16	14	16	11	12	14	15	15
19	9	12	13	13	13	10	13	15	15	15
20	7	7	7	7	7	10	10	10	10	10
Total (µ±SD)	10 ± 2	12 ± 2	13 ± 2	14 ± 3	14 ± 3	10 ± 2	12 ± 1	13 ± 1	14 ± 2	14 ± 2

Note. Participant 1 and 10 dropped out of the study, therefore, data was not included in the final total; N = 18; RPE = rating of perceived exertion, CT = control trial, COMP = competition trial.