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Effect of Distraction on Exercise Steady State

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EFFECT OF DISTRACTION ON EXERCISE STEADY STATE

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CERTIFICATE OF APPROVAL

MASTER OF SCIENCE THESIS

This is to certify that the Master of Science Thesis of

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submitted in partial fulfillment of the requirements for the degree of Master of Science in the School of Health Sciences and Human Performance At Ithaca College has been approved.

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ABSTRACT

This study was conducted to determine if distraction during exercise affects the exercise steady state. If distraction affected the exercise steady state, then a secondary purpose was to determine if coping strategies (cognitive training) improve task focus thus maintaining steady state. Forty participants volunteered and a repeated measures design was employed. All participants exercised on an elliptical trainer (self-paced device) during Visit 1 and distractions were initiated while they were exercising. On the second day (Visit 2) participants were divided into a treatment and control group and followed the Visit 1 procedure exactly except that the treatment group received cognitive training prior to exercise. During both visits, measuring BP was used as a physical distraction and engaging in a conversation was used as a cognitive distraction. Elliptical trainer stride rate in revolutions per minute (RPM) and exercise heart rate (HR) were used as dependant measures of exercise intensity. The participants were asked to maintain a moderately hard exercise intensity (80% of the age predicted maximum HR) for 15 min. They were blinded to the true purpose of the study and were told "we are testing two different techniques for measuring BP". Deception was necessary so the participants perceived the exercise as a routine workout day, thereby minimizing any potential bias that might have affected their effort. A 2x2 RM ANOVA and dependent sample- t-tests were employed for data analyses. It was seen that measuring BP or engaging in a conversation, physical and cognitive distraction respectively, lowers the exercise intensity. Cognitive training in the form of instruction helps cope with distractions, resulting in maintenance of exercise steady state, leading to improved exercise performance. This information should be useful to exercise professionals who are interested in helping clients maintain exercise steady state and achieve optimal results.

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INTRODUCTION

Though cardiovascular diseases (CVD) are the number one cause of death in the United States, a steady decline of 24.7% in related death rates occurred from 1994 to 2004 (American Heart Association, 2004). It is hypothesized that this decline is in part due to increased awareness of regular physical exercise and its role in primary and secondary disease prevention. People are recognizing the numerous benefits achieved from undertaking physical activity on a regular basis (Keysor & Jette, 2001). To best achieve health benefits, it is recommended to exercise at a prescribed intensity. The Surgeon General's Report (1996) recognized the need to standardize the use of terms related to exercise intensity and thus provided a classification scheme which has been modified several times (Armstrong, 1998). Simply, exercise is broadly classified as very light, light, moderate, hard, very hard and maximal based on relative and absolute exercise intensity.

It is known that there is a linear increase in heart rate (HR) and blood pressure (BP) with increasing exercise intensity in response to the requirements of the muscles for oxygen rich blood. When doing cardiovascular exercise for health benefits, the intensity is usually held constant and exercise HR and BP achieve a steady state. Measuring these parameters helps to ensure that a physiological steady state is achieved and exercise intensity is optimized. Some otherwise healthy individuals may find their BP reaches excessively high levels during exercise and this may indicate early signs of artery disease. Griffin and colleagues (1997) concluded that, "careful attention should be paid to exercise BP as a part of medical evaluation, or during a workout at a gym, since it may be a warning that the resting BP may also increase". Therefore, accurate measurement of exercise BP and HR are useful for monitoring exercise intensity and also provide valuable clinical information. HR, BP and rating of perceived exertion (RPE) are the most basic parameters used to measure a "safe zone" of exercise intensity in almost every clinical as well as many non-clinical settings (Griffin, Robergs, & Heyward, 1997).

Measuring BP during exercise, however, may act as physical distracter that might affect maintenance of the exercise steady state. Anecdotal information and observations suggest that it is common to observe a drop in exercise intensity when distracted. If exercise intensity is attenuated with distraction then related BP or HR measurements might not reflect the true exercise intensity. It is important to quantify the effect of distraction on the exercise steady state. The effect of distraction on maintaining steady state exercise intensity during exercise is undocumented, however some have suggested that distraction can impair focus on a primary task.

Weerdesteyn and colleagues (2003) concluded that divided attention negatively affects obstacle avoidance performance during walking (Weedesteyn, Schillings, VanGalen, & Duysens, 2003) Moreover, Tanaka and colleagues (2001) demonstrated that distraction affected golf performance leading to a shorter back swing and biased ball locations to the left (Tanaka, Seikya, & Yoshifumi, 2001). Distractions may be internal/psychological or external/physical. Internal distractions (cognitive interference) are thoughts not related to execution of the task and these may be detrimental to the performance because performance and attention are closely related. Attention, described as the mental ability to focus only on one amongst the various possible objects or thoughts. Research within sport settings has shown that attention can take different forms during exercise and, in particular, that different individuals manifest different attentional styles while performing physical exercise (Nideffer, 1976). Such styles relate to the way individuals attend to internal and external distractions (Nideffer, 1976).

Cognitive strategies are learned and used to cope with distractions that affect performance (Morgan & Pollock, 1977; Nideffer, 1976). Such treatments have never been applied to the matter of maintaining steady state exercise intensity. Hence to maintain the prescribed exercise intensity, it may be feasible to teach strategies to cope with distractions and thereby achieve the desired performance outcome.

Statement of Purpose

The purposes of the present study were:

1) To determine if distraction during exercise affects the steady state exercise intensity.
2) If distraction affects exercise intensity, then to determine if coping strategies improve task focus and help maintain steady state exercise intensity.

Hypothesis

The null hypothesis:

1) Measuring BP (physical distraction) or having a conversation (cognitive distraction) during exercise on a self-paced device does not affect the steady state exercise intensity as measured by the HR or RPM.

The alternate hypotheses:

1) Distraction lowers exercise intensity on a self-paced device.
2) Coping strategies help to maintain steady state exercise intensity during a distraction.

Scope of the Problem

Practical experience suggests that any distraction may impair performance unless the performer is well-trained to focus on the primary task. The ability to attend to a specific task while resisting the interference of distracting information is extremely important in sports, where athletes have to devote maximum physical and mental resources to optimize performance. Similarly, it is important during exercise to remain undistracted so that a physiological steady state can be achieved and maintained. Checking BP during exercise is recommended and practiced in most clinical and many non-clinical settings. Measuring BP, or simply engaging in a conversation, may act as a distraction during exercise that could in turn affect the desired goal and outcome of the exercise. This interfering role of distraction on physiological measures during exercise has not been studied. It is important to examine this issue because measuring BP during exercise is often vital to patient safety and maintaining exercise intensity is important for effective exercise. This study would be of interest to all exercise professionals and more generally all those who exercise.

Assumptions of the Study

For the purpose of this study, the following assumptions were made at the start of the investigation:

1) The participants did not get fatigued or anxious during exercise and hence these factors did not impact performance.
2) Distractions were adequate to affect attention and task focus.
3) Exercise HR and RPM are sensitive to distraction and are acceptable measures of exercise intensity.
4) Deception was effective and participants were not aware that physical and cognitive distracters effects on steady state exercise intensity were the focus of the study.
5) The participants followed the instructions given to them honestly.

Definition of Terms

1) Performance or task: A set of actions that accomplish a job, a problem or an assignment.
2) Attention: A cognitive process of selectively concentrating on one task, while ignoring other less important information.
3) Distraction: Diversion of attention of an individual or a group from the chosen object of attention onto the source of distraction. May be internal (i.e., cognitive) or external (i.e., physical).

4) Exercise intensity: Level of effort exerted during an exercise, usually measured by the exercise HR.

5) Experienced exercise participant: A person who is well versed in the use of an elliptical trainer defined by having exercise on an elliptical trainer at least 10 times in past 6 months.

6) Self-paced exercise device: A non-motorized exercise device that is run and paced by the effort of the individual.

Delimitations

1) The participants were between the ages of 18 and 65 years.
2) The participants had at least ten previous exercise sessions on the elliptical trainer to ensure a learning curve did not affect results.
3) For each participant only two types of distraction (i.e., cognitive and physical) were performed.
4) An elliptical trainer was the mode of self-paced exercise used.
5) Target HR at 80% of age-predicted maximum HR was set as the exercise intensity and 15 min as the duration.
6) Only participants who did not have prior cognitive or focus training were involved.
7) The attention training used was in the form of verbal instruction.

Limitations

1) The results of the study may not apply to older or younger people who may have altered sensitivity to distraction.
2) The results may not apply to people without previous experience on the elliptical trainer, as someone who is using it for the first time may be anxious from the start that affecting the performance in a manner similar to distraction.
3) The results may not apply to exercise equipment other than the elliptical trainer.
4) The results may not apply to other exercise durations or intensities then presently used.

5) The results may apply only to the type of physical and cognitive distractions used herein.

Chapter 2

REVIEW OF LITERATURE

Before studying how distraction affects exercise and related physiological responses, it is important to examine previous research related to this topic. There is limited work done in this area but there are tangent matters of importance. Thus, this chapter will review: 1) Importance of exercise intensity for health benefits; 2) Importance of exercise HR and BP; 3) Effect of distraction on performance; and 4) Effect of cognitive training on performance.

Importance of Exercise Intensity for Health Benefits

A large number of laboratory and population based studies have documented the health and fitness benefits associated with exercise training, such as improved physiologic, psychologic, and metabolic parameters as well as decreased risk of many chronic diseases (Kesaniemi et al., 2001). Exercise training is proven anti-thrombotic, anti-arrhythmic, anti-ischemic, and anti-atherosclerotic while controlling premature mortality (Dunn et al., 1999; Hamer, 2006; Kraus et al., 2002; Linxue et al., 1999; Thompson et al., 2003; Wang, 2006; Wannamethee et al., 2002).

To best gain the aforementioned benefits of exercise it is recommended to exercise at a prescribed intensity. Thus, monitoring exercise intensity is considered vital to ensure the quality (i.e., effectiveness and safety) and quantity of the exercise session. The American College of Sports Medicine (ACSM) recommends performing exercise three to five times each week, for 20 to 60 minutes each session at specified intensity to improve cardiovascular fitness. Exercise should involve large muscle groups (e.g., walking, running, cycling, and swimming) and be done at an intensity of at least 55% to 65% of maximum HR (William et al., 2007).

Similarly, the Surgeon General's Report (1996) on physical activity and health, states that 1) significant health benefits can be obtained by performing moderate intensity exercise and 2) additional health benefits can be gained through moderate to vigorous exercise. In fact, recently updated guidelines by the ACSM, recommend moderate intensity cardio-vascular exercise for 30 min, five days a week, or vigorous intensity cardiovascular exercise for 20 min, three days a week for adults under 65 years of age (ACSM Position Stand1998). Specifically, prescribed and monitored exercise intensity is strongly recommended for the disease free population to gain the benefits of exercise and it may be more important for those with disease.

Taylor (2002), in a meta-analysis of six randomized controlled trials with 8940 patients, assessed the effects of exercise training alone or in combination with psychological or educational intervention. Exercise training at a moderate intensity, as part of a multi-disciplinary cardiac rehabilitation program, was shown to reduce cardiac mortality rate by 31% in patients suffering from coronary artery disease (Joliffe, Rees, & Taylor, 2002). Thus, exercising at specific prescribed exercise intensity has proven to be cardio-protective.

In contrast to standard recommendations, Wright and Swan (2001) suggested that the prescribed exercise intensity differs from disease to disease and person to person. According to them, the generalized exercise intensity guidelines are based predominantly on epidemiological data and not on clinical research. They concluded that more intense exercise prescriptions, then the standard recommendation were needed to improve glucose tolerance and insulin action. Although higher exercise intensity is a key determinant for improvements in glucose homeostasis, high intensity may also produce mechanical and oxidative damage that can result in transitory impairments in insulin action and glucose tolerance. Therefore, the optimal exercise intensity for an individual with impaired glucose tolerance (IGT) appears to lie between these two extremes (Wright, & Swan, 2001). Hence, to carefully maintain and monitor exercise intensity is critical in these patients.

Tanasescu and colleagues (2002) provided a major revelation when they studied exercise type and intensity in relation to coronary heart disease in men. According to these authors, several studies had shown an inverse relation between exercise and risk of coronary heart disease, but data on type and intensity of exercise were sparse. They did a follow up on 44,452 men, every two years, from 1986 to 1998, to assess potential risk factors, newly diagnosed cases of CHD and assess levels of physical activity. They concluded that total physical activity, running, weight training, and walking were independently associated with reduced CHD risk. Moderate to high intensity exercise was associated with reduced risk independent of the number of MET-hours spent in physical activity as compared to no to low or low to moderate intensity of exercise. This study verified the importance not only of exercise but also for considering the intensity of exercise (Tanasescu et al., 2002). In a similar study, Winett & Carpinelli (1999) compared different exercise intensities to the risk of chronic diseases. They compared low, moderate and high level of physical activity to all cause mortality and morbidity, over 12 years. They concluded that all cause mortality and morbidity levels were lowest in the moderate to high intensity group as compared to low and very high intensity groups (Winette & Carpinelli).

In contrast, Manson and colleagues (1999) prospectively examined the association between walking, vigorous exercise and the incidence of coronary event among 72,488 female nurses. Participants were free of diagnosed cardiovascular disease or cancer at the time of entry and completed serial detailed questionnaires about physical activity. During eight years of follow-up, they documented 645 coronary events (nonfatal myocardial infarction or death from coronary disease). They concluded that brisk walking and vigorous exercise are associated with substantial and similar reductions in the incidence of coronary events among women. Though this study mildly contradicts the importance of exercise intensity, it strongly supports the fact that exercise is critical to reduce the incidence of coronary events (Manson et al.)

Thus to achieve the optimal health benefits from exercise the research supports the notion that it is necessary to exercise at a prescribed exercise intensity for a prescribed duration. Disruption in maintaining the prescribed exercise intensity may not allow or may diminish the desired benefit from the exercise performed.

Although the risk of serious medical complications during exercise is low, it is still higher than sedentary activities. Hence is becomes important to gauge a safe exercise intensity. Exercise intensity is often expressed as a percentage of maximum HR. HR is an accurate reflector of exercise intensity because an increase in HR is directly proportional to increase in exercise intensity (Mejia, Ward, Lentine, & Mahler, 1999). Exercising at an appropriate target HR produces maximum cardiovascular benefits with minimum risk (Whaley, Otto, & Brubaker, 2006).

Importance of Exercise HR and BP

Moderate intensity exercise is generally safe and recommended for most individuals. Nevertheless, the ACSM often recommends a health appraisal before starting an exercise program, because each individual has different physiological and perceptual responses to exercise. All who exercise should know how other extraneous factors, like temperature and humidity, affects HR (Whaley et al., 2006). Unsupervised exercisers must select an appropriate type and intensity of exercise, to provide optimal conditioning while minimize injuries. For example, in sedentary individuals high intensities may result in overuse injuries. Exercise testing is often used to gauge physical capacity and is frequently recommended for prescribing a safe and efficacious exercise regime. After the appropriate exercise intensity is determined it is subsequently monitored using HR and BP responses.

It is recommended that an exercise prescription should ideally be preceded and based on the exercise testing because an unsafe intensity of exercise increases cardiac stress, which may lead to sudden cardiac arrest (Pina et al., 2003). The ACSM provides guidelines to prescribe an appropriate exercise regime based on various risk factors, which should be considered during exercise testing and prescription. Although many of the general principles of exercise prescription are the same for individuals of all ages, special care must be taken when prescribing exercise for older or diseased individuals (Lim, 1999).

Gilman (1996) documented several ways of measuring exercise intensity and found target HR as the best measure of exercise intensity. However, caution is urged in using HR to monitor exercise intensity because there are many intrinsic and extrinsic factors that affect HR response to exercise. Intrinsic factors include a day-to-day variation of 1 to 6 bpm and cardiac shift, a phenomenon where HR tends to increase gradually as exercise duration increases 20 min (Gilman, 1996; Lambert, Mbambo, & Gibson, 1998). Extrinsic factors include intensity, posture, time of day, type of exercise and environmental conditions like humidity, temperature, altitude (Creagh, & Reilly, 1997; Jeukendrup, & Van Diemen, 1998; Lambert et al., 1998; Sutherland, Wilson, Aitchison & Grant, 1999).

As with HR, exercise and BP are intricately related. Measuring BP during exercise has useful clinical implications, as described by Sadoul and colleagues (1997). Their study was performed prospectively to assess the prognostic significance of BP response during exercise in young patients with hypertrophic cardiomyopathy (HCM). (Sadoul, Prasad, Elliot, Bannerjee, & Frenneaux, 1997). They used a maximum symptom-limited treadmill testing with continuous BP monitoring on 161 patients 8 to 40 years old. Based on BP response, patients were divided into a normal BP response Group (an increase in the systolic pressure of at least 20 mm Hg from rest to peak exercise), which was seen in 101 (63%) patients and an abnormal BP response (ABPR) group which was seen in 60 (37%) patients. During the follow-up period (44±20 months), sudden cardiac death (SCD) occurred in 12 patients: 3 (3%) in the normal blood pressure response group versus 9 (15%) in the ABPR Group (p<.009). Abnormal BP response had a sensitivity of 75%, a specificity of 66%, a negative predictive value of 97%, and a positive predictive value of 15% for SCD. Hence, they concluded that a normal exercise BP response identifies low-risk young patients with HCM, while an ABPR identifies the high-risk cohort.

Sung et al. (2003) also studied the importance of BP during exercise and evaluated adults aged 55 to 75 years who had untreated mild hypertension but were otherwise healthy. Researchers measured resting BP during four or five visits at least one week apart, and then compared those measurements to BP during maximal effort treadmill tests. They also used ultrasound to measure how well vasculature reacted to stress. They concluded that most clinicians focus on BP at rest, but this study showed that exaggerated BP during exercise was a more sensitive marker for resistance to blood flow through the arteries, a possible sign of atherosclerosis. They also concluded that a higher pulse pressure response to exercise made it more likely to have blood vessels that did not dilate as expected (Sung et al.).

In summary, HR and BP are important parameters used diagnostically as well as prognostically. HR and BP measurement not only help to prescribe the exercise regime and gauge exercise intensity but also help maintain safe and efficacious exercise. On the other hand, measuring HR and/or BP during exercise might act as a distraction thereby disturbing the steady that is desired for optimal exercise-induced benefits.

Effect of Distraction on Performance

Performance or tasks, usually used synonymously, are defined as a set of actions to accomplish a job, problem or assignment. These terms may refer to a ritual in a religious setting, an experiment in science, or an assignment in sports. Multitasking is common in society today and refers to performing two or more tasks simultaneously. Multitasking makes most people less effective, as they cannot focus as well when contemplating the resources required to accomplish the various tasks set out before them. For example, talking on a cell phone or conversing with people, while performing another task such as driving a car. However, some people are adept multi-taskers and can accomplish multiple tasks at the same time effectively.

Any distraction may affect focus from the primary task. Cognitive interference refers to internal distractions or thoughts experienced while performing a task, but not related to the execution of the task. Three theories developed to explain the relationship between cognitive interference and performance are the cognitive interference theory (Sarason & Pierce, 1996); the processing efficiency theory (Eysenck & Calvo, 1992) and the control process theory (Carver & Scheier, 1988). Although considerable evidence has confirmed these theories predictions (Paulmen & Kenelly, 1984; Seibert & Ellis, 1991; Sarason, 1984, 1988), some cases research has not provided support (Blankstein, Toner, & Flett, 1989; Calvo & Ramos, 1989).

Interestingly, several researchers in the past showed that distraction did not affect the performance. Threntham (1975) used four key studies in a meta-analysis on the effect of distraction on students in a testing situation. The first, by Super, Braasch, and Shay (1947), had two different tests given to students who were divided into two Groups. One Group tested under "normal, quiet" conditions and the other Group was subjected to distractions (e.g., breaking pencils, argument in the hall and a poorly played trumpet). Analysis of the scores showed no significant differences in the performance of the two Groups. The second study by Hovey (1928) experimented with distraction in college level testing. Hovey found that with college sophomores, distractions such as noise, light, music, whistles and stunt man performance did not affect performance on the test. The third study by Standt (1948) tested college women experiencing distracters like analogies, cancellations, addition and multiplication and found no significant differences in the accuracy of the performance. In contrast to these studies, the fourth study by Hagen (1967) involved a learning situation rather than a test. Children in grades one, three, five and seven were given a memory task in their classroom setting. Hagen found that distractions such as calling the children's attention away from the task during learning had a significant effect on performance when the children were tested on the task. Hagen (1967) concluded that distractions detrimentally affected learning. However, Threntham (1975) summarized the meta-analysis and concluded distraction in test situations with high school and college students did not affect test performance.

Studies that are more recent show that distraction does affect performance, which is in support of the current concepts of educational psychology. For example, Williamson and Cochran (1985) proposed that performing a low-demand secondary task would improve control of attentional processes on a primary task of importance. They studied 60 public elementary school students 9, 10, or 11 years of age; with 30 identified as learning disabled and 30 identified as non-learning-disabled. The primary task (consonant shadowing) involved repeating aloud Groups of letters consisting of three consonants each. The secondary task (psychomotor) consisted of a simple video game intended to require little conscious attention while controlling attentional processes and minimizing potential distraction. The experiment included five separate tasks or performance periods of 5 minutes each. The first two tasks used were to establish performance baselines for primary and secondary tasks. The remaining three tasks involved the primary task with the addition of a distracting event, the combined performance of the primary and secondary tasks, and combined performance with distracting event. They concluded that introduction of a secondary task adversely affected the performance on the primary task (Williamson & Cochran, 1985).

An adverse effect of distraction on performance was supported by Weerdesteyn and colleagues (2003) who examined dual task interference in obstacle avoidance tasks during human walking. Ten healthy young adults, while walking on the treadmill, tried to avoid an obstacle that suddenly fell in front of their left leg during mid-swing, early stance, or late stance of the ipsilateral leg. Participants were instructed to avoid the obstacle, both as a single task and while they were performing a cognitive secondary task (dual task). They found that when a short response time was available, rates of failure on the avoidance task were larger during the dual task then during single task. Smaller cross swing velocities were found during dual task than during single task. They concluded that divided attention affects young and healthy individuals' obstacle avoidance performance during walking (Weerdesteyn et al., 2003). This showed that distraction does negatively affect task performance.

Tanaka and colleagues (2004) showed that a distraction may affect single task accomplishment as well. They investigated the relationship among attention, kinematics and golf putting task under pressure. They took sixteen right-handed male university students who had no golf experience and made them do 150 acquisition trials followed by 10 test trials under pressure, which was induced by informing participants that they would receive a cash reward or an electric stimulus contingent on performance. After the test, participants answered a questionnaire designed to measure shifts in attention from the last 10 acquisition trials to the test. A two dimensional analysis of movement kinematics was used to evaluate the golf putting movement. They concluded that conscious control led to inconsistent movements and resulted in inconsistent ball locations and distraction led to a shorter back swing and biased ball locations to the left. This showed that such cognitive distractions negatively affected golf performance (Tanaka et al., 2004).

Interestingly, Goodell and colleagues (2006) quantified the effects of cognitive distraction on surgical task performance in residents and medical students using a laparoscopic surgical simulator at. Thirteen surgical residents and medical students performed six tasks on the minimally invasive surgical trainer-virtual reality (MIST-VR) under two different conditions (distracted & undistracted). Task order remained the same for all subjects, but the order of distraction was counterbalanced. Distractions consisted of mental arithmetic problems posed sequentially so that subjects were continually distracted. They found that time to task completion was significantly greater when subjects were distracted for all six tasks performed. Thus, they concluded that cognitive distraction negatively influenced performance of laparoscopic surgical tasks by increasing task completion time. Further study is required to determine what the effects would be on experienced surgeons and actual surgical outcomes (Goodell, Caroline, & Schwaitzberg, 2006).

Effect of Cognitive Training on Performance

Performance, attention and concentration are closely related. The ability to attend a specific task while resisting the interference of distracting information is extremely important to complete the task successfully and is important in sports competitions where athletes have to devote maximum physical and mental resources for the best performance (Moran, 1996). As stated by Dr. Gregory Dale (Coach and Athletic Director), “Athletes of all ages and capabilities have to constantly cope with all kind of distractions. Unless they learn to deal with them, they are going to experience a drop in their performance”. Cognitive training, which is training to improve concentration, attention and focus, is widely used in the world of sports.

Rotella and Colleagues (1990) studied the effects of a cognitive-behavioral intervention on adherence to pre-shot routines of elite collegiate golfers. Three male golfers served as subjects for the assessment of mental and behavioral pre-shot routines completed for nine holes during baseline and treatment conditions. Players' shots and putts were videotaped and the tapes were scored to determine the percent of behavioral routines completed. Mental routines were assessed after each round via interview. In addition, the number of strokes, putts, fairways hit from tee, and greens hit in regulation play for nine holes were also counted. The intervention taught each golfer how to consistently align to the target, make a good decision on each shot, and be totally committed to each shot. It was effective in improving players' adherence to both mental and behavioral pre-shot routines. Post treatment interviews showed that the golfers felt that intervention had a positive effect upon performance (Rotella, Cohn, & Lloyd, 1990). These results revealed that cognitive intervention helped both mental and behavioral routines thus improving performance.

Similarly, Driskell and colleagues (1994) studied the effects of implementing a cognitive training strategy via imagery with a youth basketball team over six months. Psychological evaluation took place during the entire program to monitor the frequency and efficacy of the skill trained. Results suggested that over period of six months, an increase was seen on applying the techniques learned over the course. Results also indicated a particularly positive effect on athletes' ability to anticipate and prepare their actions and moves during competition (Driskell, Copper, & Moran, 1994). The authors concluded that cognitive training helped improve attention and concentration leading to better performance in sports.

Further, it is interesting to see if cognitive training improves performance in areas other than sports. Ball and colleagues (2002) demonstrated this by examining three different cognitive training interventions that improved mental abilities and daily functioning in older, independent-living adults. They randomly assigned 2382 participants to one of four intervention groups: 10-session group training for memory (verbal episodic memory; n = 711), reasoning (ability to solve problems that follow a serial pattern; n = 705), speed of processing (visual search and identification; n = 712); or a no-contact control group (n = 704). They looked at the effect of these three training strategies on cognitively demanding everyday functioning. Results showed that each intervention improved the targeted cognitive ability compared with baseline and 87% of speed of processing-trained, 74% of reasoning-trained, and 26% of memory-trained participants demonstrated reliable cognitive improvement immediately after the intervention period (Ball et al., 2002). These results support the effectiveness and durability of the cognitive training interventions in improving targeted cognitive abilities.

To address the question, does cognitive or mental training enhance performance, Driskell and colleagues (1994) conducted a meta-analysis and tried to identify conditions under which mental training is most effective. Results indicated that mental training had a positive and significant effect on performance, the type of task, the retention interval between practice and performance. Additionally, the length or duration of the mental practice intervention moderated the effectiveness of the mental training (Driskell et al.).

All the above studies demonstrated that cognitive training helps improve performance. It is also speculated that the strategy used, post-cognitive training, to cope with distractions was closely related to the attentional style. Timothy and colleagues (2001), proposed a relationship between attentional styles and effective cognitive strategies and performance. They examined 60 novice rowers classified into a group of internalisers ($N = 30$) and externalisers ($N = 30$) through the Test of Attentional and Interpersonal Style Attentional Subcomponents (Nideffer, 1976). Each group completed two 15 min maximal tests on a rowing ergometer: one in an associative condition and one in a dissociative condition. Immediately following both tests, the participants completed a questionnaire evaluating their performance. Results revealed that the internal group completed a significantly greater distance in the associative condition than in the dissociative condition and, conversely, the external group completed a significantly greater distance in the dissociative condition. Questionnaire responses indicated that participants clearly preferred the strategy most similar to their attentional style. This confirmed the speculation that cognitive training strategies used to enhance performance are closely related to the attentional styles. To conclude, there is evidence that cognitive training does help improve attention and concentration, leading to a better performance. In addition, cognitive training that is matched to attentional style may be most effective (Timothy, Thierry, & Tim, 2001).

Summary

Physical activity brings immense benefits to those who exercise regularly. Past research and reputed organizations like the ACSM, recommend moderate intensity exercise for all individuals at least 3 to 5 days a week. For the exercise to be safe and efficacious, it should be performed at the prescribed exercise intensity, frequency and duration. Moreover, special precautions should be taken in the case of diseased individuals especially for the intensity of exercise, as too great an intensity may prove dangerous. HR and BP are well used to gauge exercise intensity to derive the optimal and desired benefits of the exercise. Measuring BP during exercise, or simply engaging in a conversation, might act as a distraction. It is possible that distraction (physical or cognitive) may interrupt the exercise steady state and adversely affect performance. On the other hand, cognitive training has been shown to help cope with distraction resulting in a better performance.

Chapter 3

METHODS

The general purpose of this study was to find if distraction, such as BP measurement or engaging in a conversation, would disrupt the exercise steady state when using a self-paced device. Secondly, if distraction affects steady state exercise intensity then can cognitive training help to maintain the exercise steady state. This chapter describes the methods of this study, including: 1) Participants; 2) Experimental Design; 3) Procedure; and 4) Statistical Analyses.

Participants

Participants who volunteered for this study (20 males and 20 females) were between 18 and 65 years of age. All were well versed in the use of an elliptical trainer, defined by having exercised on an elliptical trainer at least 10 times in the six months prior to the study. The participants were regular clients of the Wellness Clinic at Ithaca College and were generally healthy individuals. That is, no participants had any overt cardiovascular or metabolic disorder as noted from medical history records.

Experimental Design

A repeated measures design was employed wherein all participants exercised on an elliptical trainer (self-paced device) during Visit 1 and distractions were initiated while they were exercising. The same participants on a second day (Visit 2), were divided randomly into a treatment or control group. They followed the Visit 1 procedure exactly except that the treatment group received cognitive training prior to the exercise session. During both visits, measuring BP was used as a physical distraction and engaging in a conversation was used as a cognitive distraction. Elliptical trainer stride rate in revolutions per minute (RPM) and exercise HR were used as dependant measures of exercise intensity. The participants were asked to maintain a moderately hard exercise intensity (80% of age-predicted maximum HR) for 15 min. They were blinded to the true purpose of the study and were told "we are testing two different techniques for measuring BP". Deception was necessary so the participants perceived the exercise as a routine workout day, thereby minimizing any potential bias that might have affected their effort.

Procedure

At the initial meeting, the researcher met with the participants to explain the testing procedure. At this time, all subjects completed a physical activity readiness questionnaire (PAR-Q: Appendix A) and signed the informed consent (Appendix B). Any questions from the participants were answered promptly, keeping in mind not to inform them of the real purpose of the study. The participants specifically were told that we were testing two different techniques for taking BP measurement. For the study, 80% of the age-predicted max HR was calculated and participants were instructed to exercise consistently at that intensity for 15 min. Visits were arranged on participants' normal days of exercise. Visits 1 and 2 had a minimum gap of 48 hours and were not more then seven days apart.

Visit 1: On the first visit, the participants came to the Wellness Clinic and warmed-up for 10 min. Warm- up exercises consisted of 5 min of light, directed calisthenics and 5 min on an elliptical trainer (EFX^{TM} 546, Precor, USA) at 60% of age-predicted max HR. Following warm- up, participants advanced to 80% of their age-predicted maximum HR and were instructed, "It is important for the study that you maintain a consistent pace throughout the whole 15 min exercise session". BP for each participant was checked manually (as a physical distraction) using a standing sphygmomanometer between the 7th and 8th minute of the exercise session. Participants were engaged in a conversation (as a cognitive distraction) between the 11th and 12th minute of the exercise session. The conversation was' "Let me ask you a few questions on how we took your BP". The resistance of the elliptical trainer was held constant throughout the 15 min exercise session with RPM and HR documented as measures of exercise intensity. HR and RPM were noted every 15 sec between the 6th and 7th min (as a baseline measurement for physical distraction) and between the 7th and 8th min (during the physical distraction). Similarly, the HR and RPM were noted every 15 sec between the 10th and 11th min; (as a baseline measurement for cognitive distraction) and between the 11th and 12th min (during the cognitive distraction). It was important to take baseline measurement for both forms of distractions just prior to the distraction being applied to minimize the effect of potentially rising body temperature during exercise on the HR values. All participants were given a verbal feedback to encourage maintenance of exercise intensity at the 3rd, 5th, 9th and 12th min marks of the exercise session.

Visit 2: The second visit scheduled was at least 48 hours but less then seven days after Visit 1. Visit 2 scheduled was at the same time of day as Visit 1. Upon arriving for Visit 2, participants were divided using partial random assignment into treatment and control groups.

The control group underwent the same procedure as on Visit 1 while believing a new BP technique was being applied. Participants in the treatment group were trained cognitively by informing them to "concentrate only on exercise and maintaining the required exercise intensity at all times. Be sure to maintain the RPM level even while someone measures your BP or when someone comes to chat with you. Always be sure to maintain your pace. Your goal should be to avoid those distractions and concentrate only on maintaining your exercise intensity throughout the exercise session". Other then these instructions, the participants from the treatment group followed the same procedure as on the first visit. Data for each participant on both visits were documented on a data collection sheet (Appendix C).

Statistical Analyses

Statistical analyses were completed using SPSS (SPSS Science, Chicago, IL) version 15.0 for Microsoft Windows. Measuring BP (physical distraction) during exercise and involving participants in conversation (cognitive distraction) were the independent variables while exercise HR and elliptical trainer RPM, were the dependent variables that reflected exercise intensity. Visit 1 data were analyzed using paired sample T-tests comparing the physical and cognitive distraction data to the respective baseline measures on the dependent variables. The Visit 2 (i.e. cognitive training trials) was conducted dependent on the result of Visit 1 analyses. Visit 2 data were analyzed using 2 x 2 RM ANOVA comparing the groups on the dependent variables after distraction with respective baselines (i.e., baseline-physical distraction and baseline-cognitive distraction). Significance was set at $p < .05$, and, for any significant interaction a paired sample t-test and an independent sample t-test was completed as needed.

Chapter 4

RESULTS

The primary purposes of this study were to determine if distraction during exercise affects the exercise steady state and if it does then to determine if coping strategies improve task focus and help maintain steady state exercise intensity. Thirty-six subjects (18 male and 18 females) between 20 and 65 years of age volunteered for the study. Analyses were done using only 34 subjects for the second part of the study. This resulted in 16 and 18 subjects in control and treatment groups, respectively, for analysis of the cognitive training part of the study (Raw data in Appendix F, G, and H). Following data collection the results were analyzed and are presented here in the following sections: 1) Distraction effects on exercise steady state; 2) Cognitive training to cope with distraction; and 3) Summary.

Distraction Effects on Exercise Steady State

To find if physical or cognitive distraction affects the exercise heart rate (HR) and/or exercise pace (RPM), a dependent sample t-test was run for baseline HR versus physical distraction HR, baseline RPM versus physical distraction RPM, baseline HR versus cognitive distraction HR and baseline HR versus cognitive distraction RPM. The paired sample statistics in Table 1 gives means and standard deviations (SD) for these variables. Note that mean HR and RPM were consistently lower in the distraction condition than at baseline. The t-tests indicated that, compared to respective baselines, the drop in HR and RPM with physical distraction were statistically significant ($p < 0.001$). Similarly, compared to respective baselines, the drop in HR and RPM with cognitive distraction was also statistically significant ($p <0 .001$). Thus, there is evidence to conclude that both physical and cognitive distractions affect exercise steady state by reducing both exercise HR and exercise pace (RPM).

Table 1

Effect of Distraction on Exercise HR and RPM: Paired Sample t-tests

	X	SD	T	DF	P
B1 HR	143.83	15.88			
			7.86	33	0.000*
PD HR	140.88	15.69			
B1 RPM	132.63	17.49			
			7.14	33	0.000*
PD RPM	127.16	17.18			
B2 HR	145.01	15.74			
			7.54	33	0.000*
CD HR	142.21	15.66			
B2 RPM	133.12	17.85			
			8.16	33	0.000*
CD RPM	127.478	18.3774			

Note: * $p < .05$
B1 HR = Baseline heart rate for physical distraction
PD HR = Physical distraction heart rate
B1 RPM = Baseline pace for physical distraction
PD RPM = Physical distraction pace
B2 HR = Baseline heart rate for cognitive distraction
CD HR = Cognitive distraction heart rate
B2 RPM = Baseline pace for cognitive distraction
CD RPM = Cognitive distraction pace

Cognitive Training to Cope with Distractions

This section presents each dependent variable in a distraction coping treatment versus control group analyses. The treatment group underwent cognitive training in the form of additional instruction to maintain exercise pace despite distractions. The variables were: 1) physical distraction HR (PD HR); 2) physical distraction pace (PD RPM); 3) cognitive distraction HR (CD HR); and 4) cognitive distraction pace (CD RPM).

1) Physical Distraction HR (PD HR) – A 2 x 2 (Group x Time) RM ANOVA with repeated measures on time, was employed to inspect differences in HR with physical distraction between treatment and control groups. PD HR statistics as illustrated in Figure-1 and ANOVA table (Table 2) shows a significant Group x Time interaction ($F(1,15) = 29.82$, $p < .001$). Post-hoc analyses for the interaction detected, comparing baseline HR values of treatment group with baseline HR values of control group did not reveal a significant difference between the groups ($p > 0.05$). Similarly, comparing physical distraction HR values of treatment group with physical distraction HR values of control group did not reveal significant difference between the groups ($p > 0.05$). In addition, a comparison of baseline HR values of treatment group with the physical distraction HR values of control group did not reveal significant time effect ($p > 0.05$). While, comparison of baseline HR values with physical distraction HR values of control group showed a significant time effect ($p < .05$). The mean reduction in HR because of physical distraction in control group was about 3.75 +/- 2.3 BPM higher then the drop in HR in the treatment group. There is evidence to conclude that treatment was effective because the groups were not different before distraction yet the control group experienced a significant decrease in HR with distraction while the treatment group did not. Therefore, cognitive training helped avoid the HR lowering effect of physical distraction.

2) Physical Distraction pace (PD RPM) - A 2 x 2 (Group x Time) RM ANOVA with repeated measures on time, was employed to inspect differences in RPM with physical

Table 2

Physical Distraction Heart Rate: ANOVA Summary Table

	SS	DF	MS	F	P
Group	1.41	1	1.41	0	0.962
Error (Group)	8910.12	15	594.01		
Time	36.75	1	36.75	27.35	0.000*
Error (Time)	20.15	15	1.34		
Group x Time	20.82	1	20.82	29.82	0.000*
Error (Group x Time)	10.47	15	0.69		

Note: * Significant Group x Time Interaction ($p < .05$)
Control (n = 16)
Treatment (n = 18)

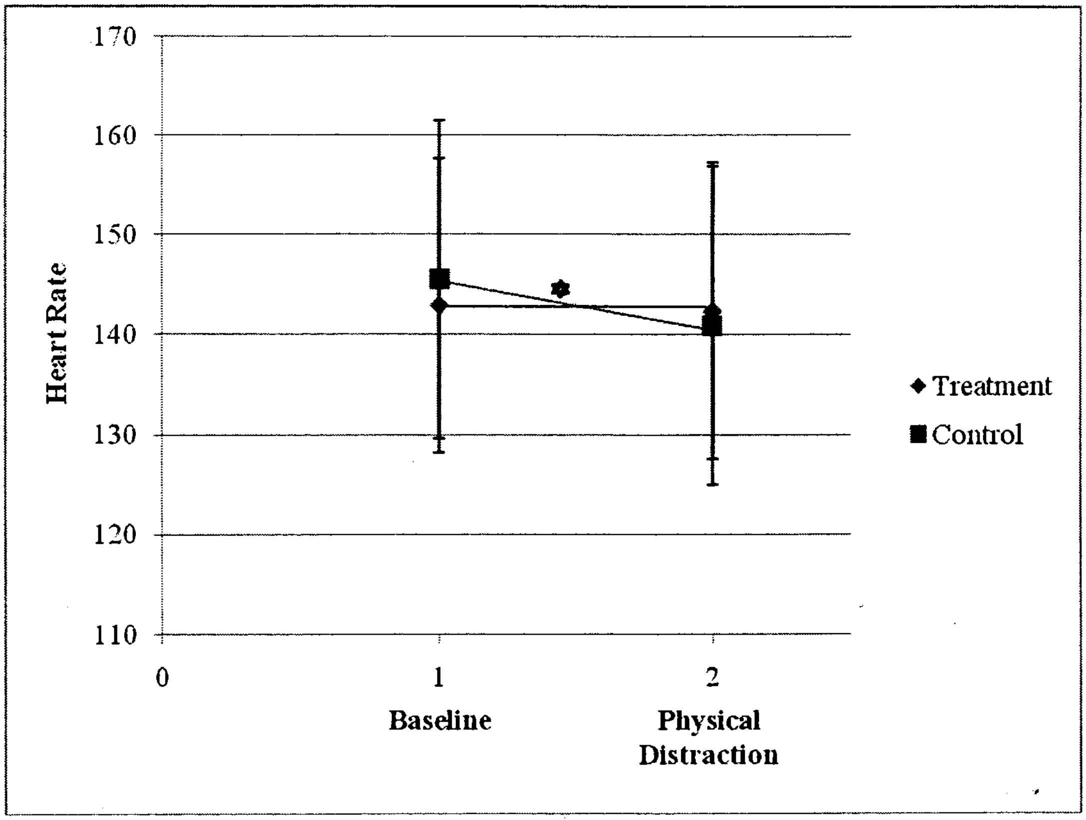


Figure 1.
Mean and standard deviation for baseline and physical distraction HR values for treatment and control groups. A significant Time x Group interaction was found. Post-hoc analysis showed a statistically significant (*$p < .05$) decrease in HR with physical distraction in the control group.

distraction between treatment and control groups. PD RPM statistics as illustrated in Figure-2 and ANOVA table (Table 3) shows a significant Group x Time interaction ($F(1,15) = 44.85$, $p < .001$). Post-hoc analyses for the interaction detected, comparing baseline RPM values of treatment group with baseline RPM values of control group did not reveal a significant difference between the groups ($p > 0.05$). Similarly, comparing physical distraction RPM values of treatment group with physical distraction RPM values of control group did not reveal significant difference between the groups ($p > 0.05$). In addition, a comparison of baseline RPM values of treatment group with the physical distraction RPM values of control group did not reveal significant time effect ($p > 0.05$). While, comparison of baseline RPM values with physical distraction RPM values of control group showed a significant time effect ($p < .05$). The mean reduction in RPM because of physical distraction in control group was about 5.6 +/- 3.2 RPM higher then the drop in RPM in the treatment group. There is evidence to conclude that treatment was effective because the groups were not different before distraction yet the control group experienced a significant decrease in RPM with distraction while the treatment group did not. Therefore, cognitive training helped avoid the RPM lowering effect of physical distraction.

3) Cognitive distraction HR (CD HR) - A 2 x 2 (Group x Time) RM ANOVA with repeated measures on time, was employed to inspect differences in HR with cognitive distraction between treatment and control groups. CD HR statistics as illustrated in Figure-3 and ANOVA table (Table 4) shows a significant Group x Time interaction ($F(1,15) = 44.85$, $p < .001$). Post-hoc analyses for the interaction detected, comparing baseline HR values of treatment group with baseline HR values of control group did not reveal a significant difference between the groups ($p > 0.05$). Similarly, comparing cognitive distraction HR values of treatment group with cognitive distraction HR values of control group did not reveal significant difference between the groups ($p > 0.05$). In addition, a comparison of baseline HR values of treatment group with the cognitive distraction HR values of control

Table 3

Physical Distraction Pace: ANOVA Summary Table

	SS	DF	MS	F	P
Group	500.64	1	500.64	0.53	0.475
Error (Group)	13989.64	15	932.64		
Time	58.14	1	58.14	39.95	0.000*
Error (Time)	21.82	15	1.45		
Group x Time	66.01	1	66.01	44.85	0.000*
Error (Group x Time)	22.07	15	1.47		

Note: * Significant Group x Time Interaction ($p < .05$)
Control (n = 16)
Treatment (n = 18)

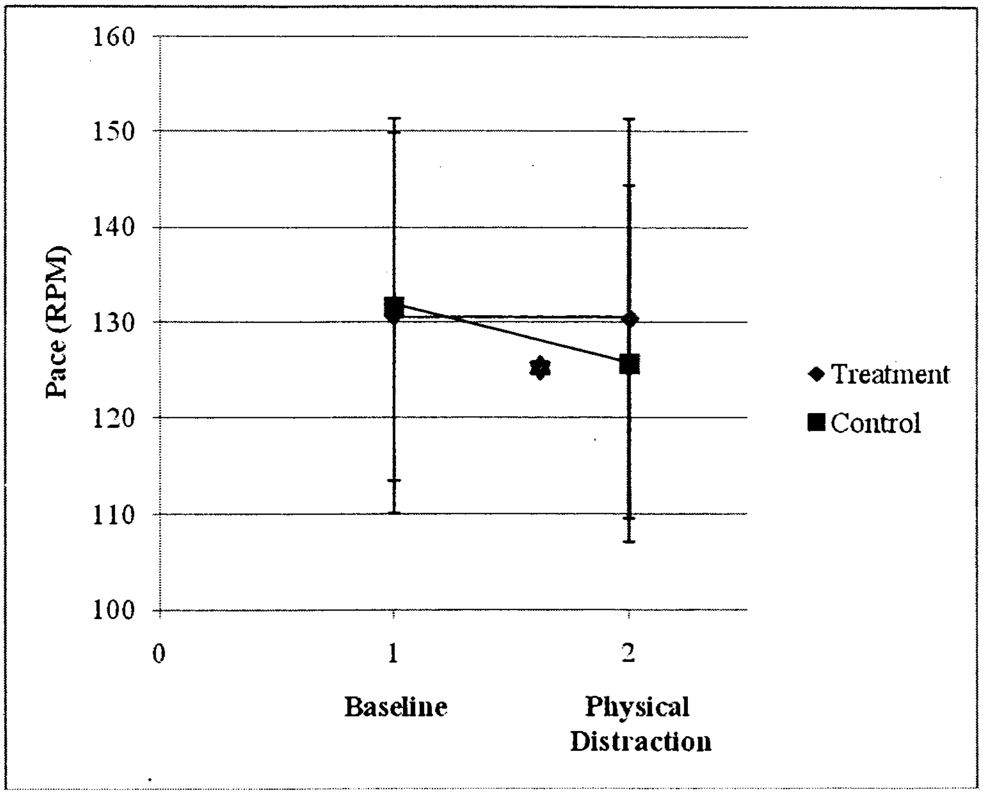


Figure 2.
Mean and standard deviation for baseline and physical distraction RPM values for treatment and control groups. A significant Time x Group interaction was found. Post-hoc analysis showed a statistically significant (*$p < .05$) decrease in RPM after physical distraction in the control group.

Table 4

Cognitive Distraction Heart Rate: ANOVA Summary Table

	SS	DF	MS	F	P
Group	0.71	1	0.71	0	0.972
Error (Group)	8211.27	15	547.41		
Time	27.89	1	27.89	18.67	0.001*
Error (Time)	22.4	15	1.49		
Group x Time	19.97	1	19.97	44.85	0.000*
Error (Group x Time)	16.82	15	1.12		

Note: * Significant Group x Time Interaction ($p < .05$)
Control (n = 16)
Treatment (n = 18)

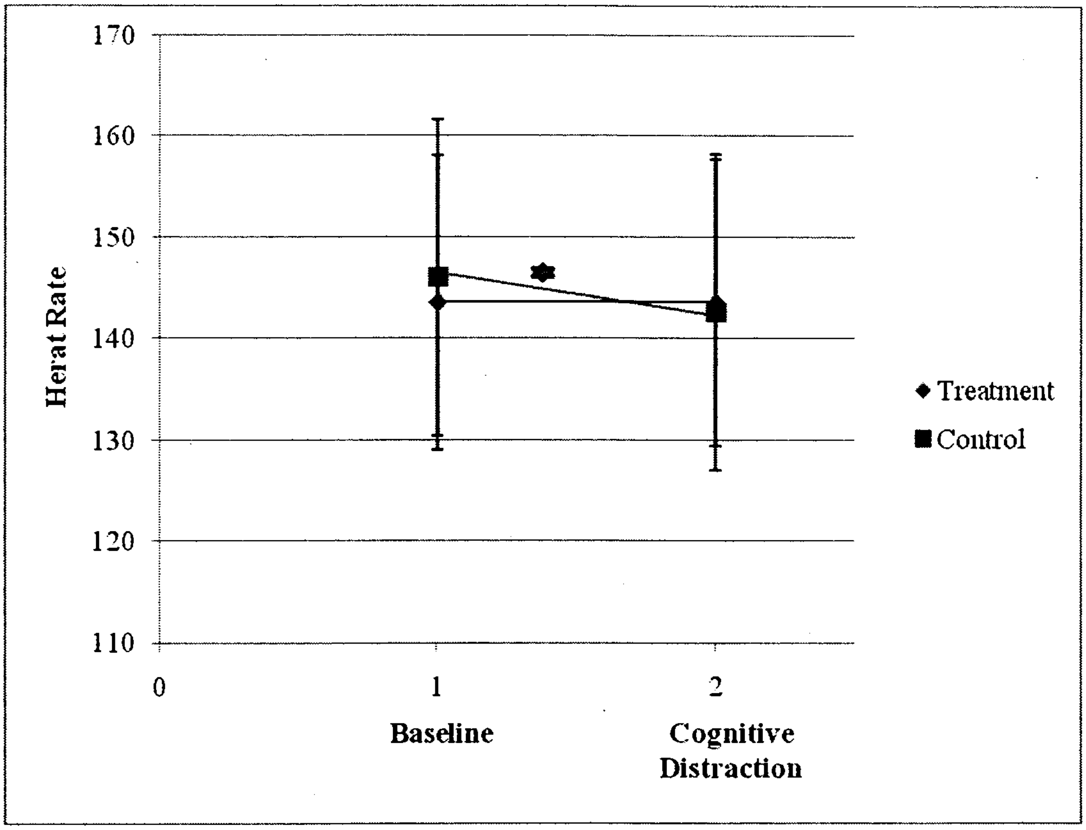


Figure-3·
Mean and standard deviation for baseline and cognitive distraction HR values for treatment and control groups. A significant Time x Group interaction was found. Post-hoc analysis showed a statistically significant (*$p < .05$) decrease in HR after cognitive distraction in the control group.

group did not reveal significant time effect ($p > 0.05$). While, comparison of baseline HR values with cognitive distraction HR values of control group showed a significant time effect ($p < .05$). The mean reduction in HR because of cognitive distraction in control group was about 4.2 +/- 2.1 BPM higher then the drop in HR in the treatment group. There is evidence to conclude that treatment was effective because the groups were not different before distraction yet the control group experienced a significant decrease in HR with distraction while the treatment group did not. Therefore, cognitive training helped avoid the HR lowering effect of cognitive distraction.

4) Cognitive distraction pace (CD RPM) - A 2 x 2 (Group x Time) RM ANOVA with repeated measures on time, was employed to inspect differences in RPM with cognitive distraction between treatment and control groups. PD RPM statistics as illustrated in Figure-4 and ANOVA table (Table 5) shows a significant Group x Time interaction ($F(1,15) = 28.38$, $p < .001$). Post-hoc analyses for the interaction detected, comparing baseline RPM values of treatment group with baseline RPM values of control group did not reveal a significant difference between the groups ($p > 0.05$). Similarly, comparing cognitive distraction RPM values of treatment group with cognitive distraction RPM values of control group did not reveal significant difference between the groups ($p > 0.05$). In addition, a comparison of baseline RPM values of treatment group with the cognitive distraction RPM values of control group did not reveal significant time effect ($p > 0.05$). While, comparison of baseline RPM values with cognitive distraction RPM values of control group showed a significant time effect ($p < .05$). The mean reduction in RPM because of cognitive distraction in control group was about 4.9 +/- 2.5 RPM higher then the drop in RPM in the treatment group. There is evidence to conclude that treatment was effective because the groups were not different before distraction yet the control group experienced a significant decrease in RPM with distraction while the treatment group did not. Therefore, cognitive training helped avoid the RPM lowering effect of cognitive distraction.

Table 5

Cognitive Distraction Pace: ANOVA Summary Table

	SS	DF	MS	F	P
Group	278.47	1	278.47	0.3	0.59
Error (Group)	13813.8	15	920.92		
Time	70.14	1	70.14	27.45	0.000*
Error (Time)	38.32	15	2.55		
Group x Time	39.84	1	39.84	28.38	0.000*
Error (Group x Time)	21.05	15	1.4		

Note: * Significant Group x Time Interaction ($p < .05$)
Control (n = 16)
Treatment (n = 18)

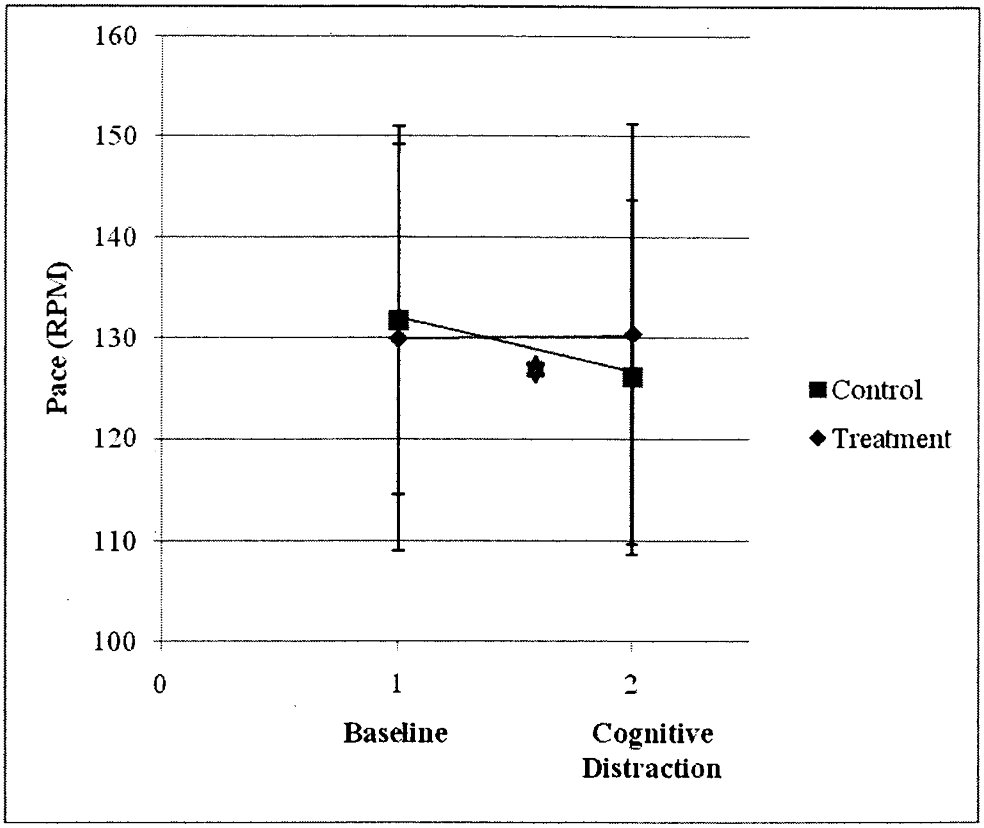


Figure 4.
Mean and standard deviation for baseline and cognitive distraction RPM values for treatment and control groups. A significant Time x Group interaction was found. Post-hoc analysis showed a statistically significant (*$p < .05$) decrease in RPM after cognitive distraction in the control group.

Summary

A comparison of HR and RPM before and after physical and cognitive distraction showed a statistically significant ($p < .001$) reduction in both after distraction. To inspect the effect of cognitive intervention on distraction, a 2 x 2 (Group x Time) RM ANOVA was performed on all the dependent variables for the treatment and control Groups. Analysis for each of these variables showed a significant interaction effect and post-hoc comparisons revealed that treatment prevented the distraction effect thereby allowing the exercise steady state to be maintained. The treatment group, who received cognitive training instruction, was able to maintain both the exercise HR and RPM even with distractions while a decrease in exercise HR and RPM occurred in the control group.

Chapter 5

DISCUSSION

Monitoring exercise intensity is considered vital to ensure the quality, safety, and intensity of an exercise session. A disruption in exercise intensity may reduce the desired benefits of exercise. HR and BP are used to monitor exercise intensity and they increase directly in proportion to an increase in exercise intensity (Mejia et al., 1999). The purpose of this study was to determine if distractions, such as measuring BP or engaging in conversation, affects the exercise steady state. Further, since distraction affected steady state we also studied the effect of cognitive training on coping with distraction to maintain steady state. Results showed that physical or cognitive distraction significantly decreased the exercise HR and intensity. After receiving cognitive training subjects were able to maintain exercise intensity despite distraction. This chapter discusses these results in the following sections: 1) Distraction effects on exercise intensity, 2) Cognitive training and performance, 3) Practical Applications, and 4) Summary.

Distraction Effects on Exercise Intensity

Measuring BP (i.e., a physical distraction) or engaging in a conversation (i.e., a cognitive distraction) affected exercise steady state by reducing HR an average of 3 BPM while exercise pace was reduced by an average of 5 RPM. Nearly 25 years ago, Williamson et al., (1985) reported that introduction of a low-grade secondary task affected performance of a primary task. In the present study, maintaining exercise steady state was the primary task, but introduction of a low-grade secondary task (i.e., measuring BP or engaging in a conversation) led to decreased exercise intensity. Measuring BP during exercise makes participant divert cognitively and physically to increase attention/focus and make physical adjustments to maintain balance respectively.

while engaging in conversation. Weerdestyn and colleagues (2003) found that dividing attention affected young and healthy subjects' ability to avoid obstacles during walking. They showed that when only a short response time was available, rates of failure on an avoidance task were larger during dual task than during single task situations. Tanaka and colleagues (2001) also investigated the relationship between distraction and task performance and quantified a decrement in task performance by percent change in kinematics. They found that cognitive distraction led to a shorter back swing with inconsistent and biased ball locations in golf. Though not considered, kinematics may have been useful in the present study. It was possible that participants had difficulty maintaining balance on the elliptical trainer during distraction, leading to slowing down. This may have been avoided if a stationary bicycle was used and balance was not an issue. The impact of distraction on balance should be considered in future studies.

Similarly, Goodell and colleagues (2006) quantified the effect of cognitive distraction on surgical task performance measured over time. They showed time to complete a surgical procedure was greater when participants were distracted during surgery. It is evident that during distraction even the most highly skilled performances are impacted and tend to slow down when challenged by two tasks. The conclusion by Goodell, that cognitive distraction affects task performance, supports the results of the present study.

In another recent example on the effects of divided attention, McCart and colleagues (2006) presented a review of driving tasks while engaging in phone use. Driving tasks are compromised by simulated phone conversations when using hands-free phones, and may be further compromised by the physical distraction of handling phones. They reported a fourfold increase in the risk of a crash-induced property-damage and crash-induced injury associated with phone use (McCartt, Hellings, & Bratiman, 2006).

In summary, it is evident that a primary task is negatively impacted by any kind of distraction. This applies when driving a car, performing surgery, or simply walking. The present study extends the finding of a distraction effect to exercise.

Cognitive Training and Performance

Performing while resisting the interference of distraction is important to task success. Cognitive strategies may be learned to help cope with distractions and maintain performance. Cognitive training may improve attention, concentration and focus, and is widely used in applying psychology to sports. Others have successfully demonstrated instruction as a successful means of cognitive training in the world of sports (Antonis, & Biddle, 2001; Driskell et al., 1994) and in clinical settings (Chandler & Sweller, 1991). The current study used cognitive training, in the form of instruction, with the intention of helping participants maintain exercise intensity during BP measurement or a conversation distractions.

In the present study, participants receiving cognitive training were able to maintain prescribed HR and pace. This finding is supported by that of Anger et al. (2008) who designed a cognitive training program for middle-aged employees. They found increased performance and efficiency at work in a treatment group receiving cognitive training. As in the present study, all participants receiving instructions demonstrated a positive impact on performance. These findings are also consistent with Gill and Strom (1985), who noted improved focus, attention, concentration and better efficacy of skill with cognitive training. They found improvements while studying the effect of cognitive training via imagery with a youth basketball team over six months. Participants in current study may have experienced improved focus and attention with cognitive training as seen by Hoffman (1993). The present study extends the benefits of cognitive training to the skill of maintaining exercise steady state in the face of distractions. Ball and colleagues (2002) also demonstrated reliable skill improvement immediately after a cognitive training strategy. They used three different training strategies and supported the effectiveness and durability of each type of cognitive training to improve targeted cognitive abilities. According to Driskell and colleagues (1994), the most effective cognitive training strategy is to intervene prior to the prescribed task. The present study made use of this tactic and found that cognitive training can be used to avoid distraction and maintain exercise intensity. In summary, cognitive training can help exercisers' avoid a distraction-induced drop in intensity.

Practical Applications

Griffin and colleagues (1997) found that manual and automatic sphygmomanometery are acceptable non-invasive methods to measure BP, however, both significantly underestimate diastolic pressure at rest and during exercise. Furthermore, the error in BP measurement increases with exercise intensity. Measuring BP during exercise is important for maintaining safe activity and to gauge and prescribe exercise intensity. It is ironic that the act of taking BP measurement during exercise might diminish the intensity and thereby the accuracy of the measure. An exercise study simultaneously measuring BP with an indwelling catheter and sphygmomanometer is needed to support the effect of physical distraction on BP readings. In practice, results of the present study provide incentive for a better theoretical and practical understanding of the link between cognitive training, distractions and exercise performance. Thus, a clear and intentional focus on maintaining exercise intensity seems to be required if a BP reading that accurately reflects the steady state is to be obtained.

Whaley and colleagues (2006) found that exercising at target HR produces maximum cardiovascular benefits with minimum risk, making it important to accurately measure exercise HR to have a safe measure of efficacious exercise. With respect to present study, distraction decreases the exercise HR by average of 3 BPM which is statistically significant but of undetermined clinical significance. It would be of interest to see if such disruptions in exercise steady state could affect the efficacy of exercise training. Physiological adaptations vary and may depend upon exercise intensity (i.e., greater adaptations with higher intensity). It may be important to cope with distractions during exercise so as not to potentially compromise desirable physiological adaptations. Thus, a change in HR during exercise because of distractions should be avoided and minimal cognitive intervention is all that is needed to improve distractibility. Administering such cognitive training is a skill that should be practiced by exercise professionals.

Yamashita and colleagues (2006) used music video (a physical distraction), finding that it decreases exercise HR and RPE. On the other hand, audio music (may act as a cognitive distraction) did not affect the HR but decreased the RPE at low intensities (Yamashita, Iwai, Akimoto, Sugawara, & Kono, 2006). Interestingly, the present study showed an equal drop in HR and RPM with both types of distractions (i.e., physical and cognitive distraction). Further studies should be used to determine if either physical or cognitive distraction is more detrimental to maintain the exercise steady state.

In addition, improvement in performance due to cognitive training is said to be related to the attentional styles of the individual, which was not looked upon in the present study. Timothy and colleagues (2001), and Nidefer (1976), found a relationship between attentional style and effective cognitive strategies during performance. Participants divided into group of internalisers and externalisers, based on Test of Attentional and Inerpersonal Style subcomponents (Nidefer, 1976), completed a maximal ergometer test in dissociative and associative condition. They revealed that internalisers in associative condition completed greater distance while externalizers completed greater distance in dissociative condition. These broader issues would require more work to resolve, but the basic findings of the present study are clear. Determining attentional style matched with the correct cognitive intervention might make cognitive training more effective at improving exercise performance but confirmation of this statement awaits further investigation.

Summary

Participants showed a similar and equal decrease in exercise HR and RPM with physical and cognitive distractions. This difference was statistically significant and potentially clinically relevant because a drop in exercise intensity could diminish long term benefits of exercise. Cognitive training in form of instructions allowed participants to maintain exercise intensity despite distractions while participants not receiving instructions did not. It is important for exercise professionals to understand the negative effect of distraction on exercise performance and the usefulness of cognitive training to help cope with them. Thus, exercise professional should try maintaining a distraction free environment in the exercise setting. This may not be possible in the real world, making cognitive training even more important to negate effect of distraction and thus gain maximum benefits of exercise performed.

Chapter 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purposes of this study were to determine if distraction affects exercise steady state and if it does, then to determine if coping strategies improve task focus to maintain steady state. HR and BP are used to prescribe and gauge intensity to provide a safe and efficacious exercise session and to derive optimal and desirable benefits. Measuring BP (i.e., physical distraction) or simply engaging in a conversation (i.e., cognitive distraction) are distractions that might affect the exercise steady state. Thirty-six healthy males (n=18) and females (n=18) volunteered for the study. Each participant exercised on an elliptical trainer for 15 min at 80% of age-predicted maximum heart rate preceded by a 10 min warm-up. On Visit1, exercise HR and pace (RPM) were noted while physical and cognitive distractions were induced between 7^{th}-8^{th} min and 11^{th}-12^{th} min respectively, and compared with baseline. On Visit 2, participants were randomly divided into treatment and control groups and repeated the same procedure as Visit 1 with the treatment group receiving cognitive training immediately prior to exercise.

A paired sample t-test for Visit 1 revealed that participants were not able to maintain exercise steady state during distraction and exercise HR and RPM were significantly ($p < 0.05$) reduced on average, by 3 BPM and 5 RPM respectively. For Visit 2, a 2 x 2 (Group x Time) RM ANOVA reinforced the findings of Visit 1 by showing a statistically significant ($p < 0.05$) reduction in exercise HR and RPM during distraction for the control group. However, the analysis did not show a statistically significant ($p > 0.05$) reduction in HR or RPM during distraction for treatment group. Thus the treatment group was able to maintain exercise steady state despite distractions after instruction to focus on maintaining exercise intensity (i.e., cognitive training).

Conclusions

The results of this study yield the following conclusions:

1. Measuring BP or engaging in a conversation, physical and cognitive distraction respectively, does affect exercise steady state and lowers exercise intensity.
2. Cognitive training, in the form of simple instruction, helps cope with distractions, resulting in maintenance of exercise steady state.
3. Exercise professionals should consider using a form of cognitive training to help participants overcome distractions that could impact the quality of exercise.

Recommendations

The following are recommendations for further study:

1. Examine the effect of distractions on other physiological measures (e.g., RPE, VO2 max) apart from HR and RPM.
2. Examine the effect of other forms of distractions (e.g., talking on the phone, watching television, listening to music) on exercise steady state.
3. Examine the effect of distraction during exercise on other self-paced devices (e.g., stationary bike, stepper, rowing ergo meter) that have various balance requirements.
4. Examine the effect of distraction when using intensities (e.g., low intensity, 40-50% of age predicted maximum HR or very high intensity, 90-95%) and durations (e.g., 30 min) other than in this study.
5. Examine the effectiveness of cognitive training for distraction coping when used on with individuals with different attentional styles.
6. Examine the effect of distraction and cognitive intervention with physically trained versus untrained individuals.

REFERENCES

American Heart Association's Heart Disease and Stroke Statistics (2004 update). Cardiovascular diseases death rate decline but risk factors still exact heavy toll.

Antonis, H., & Biddle, S. (2001). Athletes' perception of how cognitive interference during competition influences concentration and effort. *Anxiety, Stress, and Coping, 14,* 411-429.

Armstrong (1998). American College of Sports Medicine. Position Stand: The recommended quality and quantity of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine Science Sports Exercise, 33, 364-369.*

Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., Marsiske, M., Morris, J. N., Rebok, G. W., Smith, D. M., Tennstedt, S. L., & Unverzagt, F. W. (2002). Effects of cognitive training interventions with older adults. *Journal of American Medical Association, 288,* 2271-2281.

Blankstein, K. R., Toner, B. B., & Flett, G. L. (1989). Test anxiety and then contents of consciousness. *Journal of Research in Personality, 23,* 269-286.

Carver, C. S., & Scheier, M. F. (1988). A control process perspective of anxiety. *Anxiety Research, 1,* 17-22.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and format of instruction. *Cognition and Instruction, 8,* 293-332.

Creagh, U. & Reilly, T. (1997). Physiological and biomechanical aspects of orienteering. *Sports Medicine, 341,* 1351-1357.

Driskell, J. E., Copper, C., & Moran, A. P. (1994). Does mental practice enhance Performance? *Journaal of Applied Psychology, 79(4),* 481-492.

Dunn, A. L., Marcus, B. H., Kampert, J. B., Garcia, M. E., Kohl, H. W., & Blair, S. N. (1999). Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: A randomized trial. *Journal of American Medical Association, 281,* 327-334.

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition and Emotion, 6,* 409-434.

Gill, D.L., & Strom, T.E. (1985). The effect of attentional focus on performance of an endurance task. *International Journal of Sports Psychology, 16,* 217-223.

Gilman, M. B. (1996). The use of heart rate to monitor the intensity of exercise. *Sports Medicine, 21,* 73-79.

Goodell, K. H., Caroline, G. L., & Schwaitzberg, S. D. (2006). Effects of cognitive distraction on performance of laproscopic surgical tasks. *Journal of Laproedoscopic & Advanced Surgical Techniques, 16,* 94-98.

Griffin, S., Robergs, R., & Heyward, W. (1997). Blood pressure measurement during exercise. *Medicine and Science in Sports and Exercise, 29,* 149-159.

Hamer, M. (2006). The relative influences of fitness and fatness on inflammatory factors. *Preventive Medicine, 44,* 3-11.

Hoffman, D. A. (1993). The influence of goal orientation on task performance. *Journal of Applied Social Psychology, 23,* 1827-1846.

Jeukendrup, A. E., & VanDieman, A. (1998). Heart rate monitoring during training and Competition in cyclists. *Journal of Sports Sciences, 116,* S91-S99.

Jolliffe, J. A., Rees, K., & Taylor, R.S. (2004). Exercise-based rehabilitation with coronary heart disease. *The Americal Journal of Medicine, 116,* 682-692.

Kesaniemi, A. Y., Danforth, E. J., Jenson, M. D., Kopelman, P.G., Lefebvre, P., Reeder, B. A. (2001). Dose response issues concerning physical activity and health. *Medicine Science in Sports and Exercise, 22,* 351-358.

Keysor, J., & Jette, A. M. (2001). Health benefits of exercise. *Medicine and Science in Sports and Exercise, 33,* 351-358.

Kraus, W. E., Houmard, J. A., Duscha, B. D., Knetzger, K. J., Wharton, M. B., Cartney, J. S., Bales, C. W., Henes, S., Samsa, G. P., Otvos, J. D., Kulkarni, K. R., & Slentz, C. A. (2002). Effects of the amount and intensity of exercise on plasma lipoproteins. *New England Journal of Medicine, 347,* 1483-1492.

Lambert, M. I., Mbambo, Z. H., & Gibson, C. A. (1998). Heart rate during training and competitions for long distance running. *Journal of Sports Sciences, 16,* S85-S90.

Lim, Y. J. (1999). Exercise testing and prescription for the senior population. *The Sports Journal, 2, 48-54.*

Linuxe, L., Nohara, R., Makita, S., Hosokawa, R., Hata, T., Okuda, K., Hamazaki, H., Fujita, M., & Sasayama, S. (1999). Effect of long term exercise training in regional myocardial perfusion changes in patients with coronary artery disease. *Circulation, 63,* 73-82.

Manson, J. E., Hu, F. B., Rich-Edwards, J. W., Colditz, G. A., Stampher, M. J., Willett, W. C., Speizer, F. E., & Hennekens, C. H. (1999). A prospective study of walking as compared with vigorous exercise in the prevention of coronary heart disease in women. *The New England Journal of Medicine, 341,* 650-658.

McCart, T., Hellinga, A., & Bratiman, A. (2006). Cellphones and driving: Review of research. *Traffic Injury Prevention, 7,* 97-104.

Mejia, R., Ward, J., Lentine, T., & Mahler, D. A. (1999). Target dyspnea rating predict expected oxygen consumption as well as target heart rate values. *American Journal of Respiratory and Critical Care Medicine, 159,* 1485-1489.

Moran, A. P. (1996). The psychology of concentration in sports performance: A cognitive analysis. *Exeter, UK: The Psychology Press, 31,* 263-296.

Morgan, W.P., & Pollock, M.L. (1977). Psychologic characterisation of the elite distance runner. *Annals of the New York Academy of Science, 301,* 382-403.

Nideffer, R.M. (1976). Test of Attentional and Interpersonal Style. *Journal of Personality and Social Psychology, 34,* 394-404.

Paulmen, R. G., & Kennelly, K. J. (1984). Test anxiety and ineffective test taking: Different name, same construct. *Journal of Educational Psychology, 76,* 279-288.

Pina, I. J., Apstein, C. S, Balady, G. J., Belardinelli, R., Chaitman, B. R., Duscha, B. D., Fletcher, B. J., Fleg, J. L., Myers, J. N., & Sullivan, M. J. (2003). Exercise and heart failure: A statement from the American Heart Association Committee on exercise, rehabilitation, and prevention. *Circulation, 107,* 1210-1225.

Rotella, R. J., Cohn, P. J., & Lloyd, J. W. (1990). Effects of a cognitive-behavioral intervention on the preshot routine and performance in golf. *The Spots Psychologist, 4,* 33-47.

Sadoul, N., Prasad, K., Elliot, P. M., Bannerjee, S., & Frenneaux, M. P. (1997). Prospective prognostic assessment of blood pressure during exercise in patients with hypertrophic cardiomyopathy. *Circulation, 96,* 2987-2991.

Sarason, I. G. (1984). Stress, anxiety and cognitive interference: Reaction to tests. *Journal of Personility and Social Psychology, 46,* 929-938.

Sarason, I.G. (1988). Anxiety, self-preoccupation and attention. *Anxiety Research, 1,* 3-7.

Sarason, I. G., Pierce, G. R., & Sarason, B. R. (1996). Domains of cognitive interference. *Cognitive Interference: Theories, Methods, and Findings,* 139-152.

Seibert, P. S., & Ellis, H. C. (1991). Irrelevant thought, emotional mood states, and cognitive task performance. *Memory and Cognition, 19,* 507-513.

Sung, J., Oyuang, P., Silber, H., Bacher, A., Turner, K., Deregis, J., Hees, P., Shapiro, E., Stewart, K. (2003). Exercise blood pressure response is related to left ventricular mass. *Journal of Human Hypertension, 17,* 333-338.

Sutherland, R., Wilson, J., Aitchison, T., & Grant, S. (1999). Physiological responses and perceptions of exertion in a step aerobics session. *Journal of Sports Sciences, 17,* 495-503.

Tanaka, K., Sekiya, H., & Yoshifumi, J. (2001). Relationships among attention, kinemetics, and performance of a gold putting task under pressure. *Journal of Sports and Exercise Psychology, 35,* S30-S32.

Tanasescu, M., Leitzmann, M. F., Rimm, E. B., Wilette, W. C., Stampher, M. J., & Hu, F. B. (2002). Exercise type and intensity in relation to coronary heart disease in men. *Journal of American Medical Association, 288,* 1994-2000.

Taylor, R. (2002). Exercise based rehabilitation for patients with coronary heart disease: Systemic review and meta-analysis of randomized control trials. *The American Journal of Medicine, 116,* 682-692.

Thompson, P. D., Buchner, D., Pina, I. L., Balady, G. J., William, M. A., Marcus, B. H., Berra, K., Blair, S. N., Franklin, B., Gordon, N. F., Pate, R. R., Rodrigues, B. L., Yancy, A. K., & Wenger, N. K. (2003). Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease. *Circulation, 107,* 3109-3116.

Threntham, L. L. (1975). The effects of distractions on sixth grade students in a testing situation. *Journal of Educational Measurement, 12,* 13-17.

Timothy, B., Thierry, G., & Tim, H. (2001). Evidence for a relationship between attentional styles and effective cognitive strategies during performance. *Online Journal of Sports Psychology, 8,* 120-128.

Unites States Department of Health and Human Services. (1996). Physcial activity and health: A report of the Surgeon General.

Wang, J. S. (2006). Exercise prescription and thrombogenesis. *Journal of Biomedical Sciences, 13,* 753-761.

Wannamethee, S. G., Lowe, G. D., Whincup, P. H., Rumley, A., Walker, M., & Lennon,

L. (2002). Physical activity and hemostatic and inflammatory variables in elderly men. *Circulation, 105,* 1785-1790.

Weerdesteyn, V., Schillings, A., VanGalen, G., & Duysens, J. (2003). Distraction affects the performance of obstacle avoidance during walking. *Journal of Motor Behavior, 35,* 53-63.

Whaley, M. H., Brubaker, P. H., & Otto, R. M. (2006). *ACSM guidelines for exercise Testing and prescription, (7^{th} edition).* Philadelphia: Lippincott Williams and Wilkins.

William, H., Pate, R., Powell, K., Blair, S.N., Franklin, B. A., Macera, C., Heath, G., Thompson, P., & Bauman, A. (2007). Physical activity and public health: Update recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise, 41,* 348-352.

Williamson, T. W. & Cochran, S. (1985). Primary task performance as affected by secondary task involvement. *Journal of Experimental Psychology: Human Perception and Performance, 2,* 80-86.

Winett, R. A., & Carpinelli, R. N. (1999). The recommended quality and quantity of exercise for developing and maintaining cardiorespiratory and muscular fitness for healthy adults. *Medicine and Science in Sports and Exercise, 31,* 916-917.

Wright, D. C., & Swan, P. D. (2001). Optimal exercise intensity for individuals with impaired glucose tolerance. *Diabetes Care, 14,* 93-97.

Yamashita, S., Iwai, K., Akimoto, T., Sugawara, J., & Kono, I. (2006). Effects of music during exercise on RPE, heart rate and the autonomic nervous system. *Journal of Sports Medicine and Physical Fitness, 46,* 425-430.

APPENDIX A

PAR-Q FORM

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 ______________________________ WITNESS ______________________________
or GUARDIAN (for participants under the age of majority)

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.

Supported by: Health Canada Santé Canada

continued on other side...

APPENDIX B

INFORMED CONSENT FORM

Project Title: Effect of two different techniques of measuring blood pressure on blood Pressure readings.

Purpose of the Study
The purpose of this study is to examine if measuring blood pressure with two different techniques does actually affect the blood pressure readings.

Benefits of the Study
This study would be of benefit and interest to all exercise professionals and more generally all those who exercise. If two different techniques of measuring blood pressure gives two significantly different readings then the technique of measuring blood pressure would be of primary importance. If the readings differ then blood pressure measurements taken with wrong technique might not reflect the true exercise intensity. There are no specific benefits to you while participating in this study.

What You Will Be Asked To Do
You will be asked to fill out a physical activity questionnaire and the informed consent form. We will exclude you from the study or get your physician's approvals if you have medical issues that prevent you from engaging in the test that we will do. You will be tested on your scheduled visit at the Wellness Clinic, Ithaca College thus you will not have to give any time commitment other then that. Once you are at the Wellness Clinic, you will have to warm up for 10 min that is 5 min free calisthenics and 5 min on the elliptical trainer at 60% of age-predicted maximum heart rate that is at an intensity that we will tell you. Following the warm-ups you will have to exercise at the prescribed intensity (80% of age-predicted maximum heart rate) on the elliptical trainer for 15 min. You will have to repeat the same procedure on both the visits while we will check your blood pressure while you are exercise.

Risks
The physical risk for this study is quite less. Exercising on the elliptical trainer for 15 minutes continuously at a moderate intensity might be challenging, but the risk of hurting would be minimal. The risks include, but are not limited to musculoskeletal injury, fatigue or soreness. You might get tired during each visit and may experience muscle soreness for a day or two.

In the event of an injury, standard first aid will be administered and, if serious, emergency medical personnel will be called. If you suffer an injury that requires any treatment or hospitalization as a direct result of this study, the cost for such care will be charged to you. If you have insurance, you may bill your insurance company. You will be responsible to pay all costs not covered by your insurance. Ithaca College will not pay for any care, lost wages, or provide other financial compensation.

If you would like more information about the study
Please contact the principal investigator, Jigar Shah, to get more information or to obtain a copy of the results. He can be reached at (607) 423 5430 or at jshah1@ithaca.edu .

Initial: ________

APPENDIX B (continued)

Withdrawal from the study
You may stop participating or withdraw from this study at any point in time without any questions being asked or any penalty.

Confidentiality of the data
All data collected will be kept confidential. You will b assigned an alphanumeric id number by which you will be identified throughout the study. The key for this id number will be available only to the investigator and will be kept in a secure location. All data will be kept in a secure locker in the graduate office in the Center of Health Sciences building and the computer files will be protected by a password. Data may be used for educational or scholarly publications and presentations, but you will be not be identified by name or any other identifying comments. The testing sessions will not be video taped.

I have read the above and I understand its content. All my queries are well explained to me by the investigator. I agree to participate in this study. I acknowledge that I am 18 years of age or older.

Name (PRINT):________________________

Signature(SIGN):________________________

Date:______________

APPENDIX C

Data Collection Sheet

Name:________________________________
ID:____________________

Age/Sex:______________________________
Intensity:_________________

Visit 1 Date/Time:__________________________

Baseline	Physical Distraction (Measuring BP)	Baseline	Cognitive Distraction (Conversation)
HR-1__________ HR-2__________ HR-3__________ HR-4__________	HR-1__________ HR-2__________ HR-3__________ HR-4__________	HR-1__________ HR-2__________ HR-3__________ HR-4__________	HR-1__________ HR-2__________ HR-3__________ HR-4__________
RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________	RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________	RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________	RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________

BP-____________

Visit 2 Date/Time:________________________________ Group: Treatment/Control

Baseline	Physical Distraction (Measuring BP)	Baseline	Cognitive Distraction (Conversation)
HR-1__________ HR-2__________ HR-3__________ HR-4__________	HR-1__________ HR-2__________ HR-3__________ HR-4__________	HR-1__________ HR-2__________ HR-3__________ HR-4__________	HR-1__________ HR-2__________ HR-3__________ HR-4__________
RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________	RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________	RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________	RPM-1__________ RPM-2__________ RPM-3__________ RPM-4__________

BP-____________

APPENDIX D

FLYER

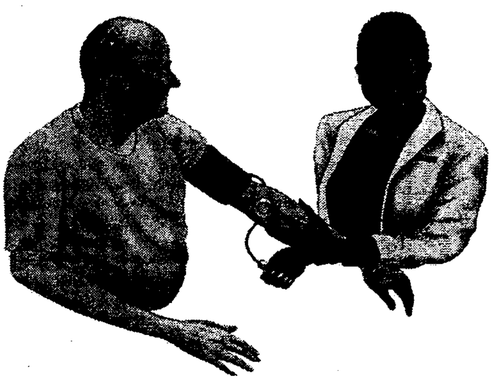
Effect of two different techniques of measuring blood pressure during exercise

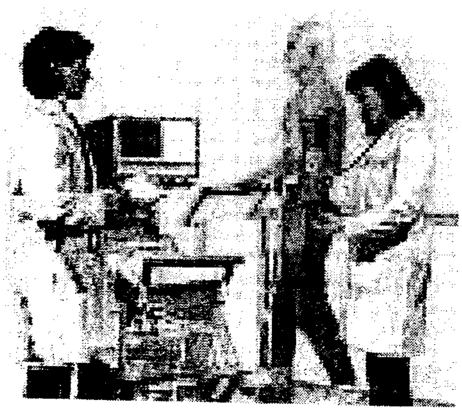
Researchers from the Department of Exercise and Sports Sciences at Ithaca College are seeking volunteers from the Ithaca College Wellness Clinic, ages between 18 and 60 years of age. We will ask you to exercise for 15 minutes on the elliptical trainer at the Wellness Clinic at a moderately difficult intensity on two occasions. Your blood pressure will be measured on both the visits by two different techniques and this testing will take approximately 30-40 min on each visit. Since, we can see you on your normal visit to the Wellness Clinic, you will not be asked to do anything very different from your regular exercise session. You should not experience any additional discomfort from participating in this study; however there is always a danger when exercising. All data acquired during the study will be kept confidential and you will not be identified in any reports that come from this study. Thank you for considering participation.

For more information, please contact:

Jigar Shah
Dept.of Exercise and Sports Sciences
Ithaca College

Phone: 607-423-5430
Email: jshah1@ithaca.edu





APPENDIX E
SUBJECT RECRUITMENT STATEMENT

Effect of two different techniques of measuring blood pressure on the blood pressure.

Hello, I am Jigar Shah, a researcher in the Department of Exercise and Sports Science at Ithaca College. We are seeking volunteers to participate in a study to find the effect of two different techniques of measuring blood pressure on the blood pressure. Participants must be between 18 and 60 years of age. We will ask you to exercise for 15 minutes in the elliptical trainer at the Wellness Clinic at the prescribed intensity that is at a speed that we tell you, preceded by 10 min warm-up. Your blood pressure shall be measured on the both the visits by two different techniques. Testing will take place on two separate visits with a minimum of gap of two days and less then 7 days between the two visits. You would spend approximately 30-40 min on each visit. Since, we will be testing you on the scheduled day of visit at the Wellness Clinic, you will not be asked to do anything different from your regular exercise session. You should not experience any additional discomfort, even with regards to time commitment, for participating in this study. All data acquired during the study will be kept confidential and kept locked up for 1-2 year time period. Participants will not be identified in any reports that come from this study. Do you have any questions? Would you like to read the informed consent, which describes the study in greater detail?

For more information contact:

Jigar Shah
Dept. Exercise & Sport Sciences
Ithaca College

Phone: (607) 423 5430
Email: jshah1@ithaca.edu

APPENDIX F

Visit-1 Mean HR and RPM

	B1. HR	PD. HR	B1. RPM	PD. RPM	B2. HR	CD. HR	B2. RPM	CD. RPM
1	167.2	164.5	170.0	160.0	166.7	162.2	170.5	159.5
2	130.0	129.5	149.5	146.0	134.0	134.7	150.0	150.5
3	131.7	128.0	143.5	141.0	131.7	131.5	143.5	138.5
4	151.7	147.5	144.0	139.7	151.0	149.0	146.0	140.0
5	155.0	153.7	163.0	153.0	156.0	155.5	159.0	155.5
6	154.0	149.5	118.5	114.0	153.7	150.2	113.5	110.0
7	127.7	125.5	142.5	138.5	129.0	126.0	143.0	138.0
8	168.2	160.5	129.0	107.5	170.5	168.5	129.5	126.5
9	136.5	135.0	120.5	116.5	138.0	133.5	120.0	114.5
10	127.0	127.0	122.0	118.0	126.0	122.7	121.5	120.0
11	112.7	108.5	143.5	138.5	114.2	113.2	148.5	144.0
12	155.0	150.2	112.5	108.5	165.2	160.2	119.5	116.0
13	151.0	150.5	119.5	113.0	156.0	153.0	115.5	109.5
14	136.5	133.0	150.0	149.0	139.7	134.5	150.0	144.5
15	107.5	107.7	113.0	104.5	114.7	112.0	117.2	112.5
16	143.5	134.5	140.0	126.0	140.5	134.5	128.5	122.0
17	145.5	141.5	146.7	139.2	143.5	142.0	151.5	142.5
18	130.5	127.5	108.5	103.0	138.0	135.2	108.5	100.5
19	164.5	165.2	121.5	124.5	165.2	161.7	121.5	118.5
20	161.0	158.7	147.0	144.2	160.5	157.5	147.5	145.7
21	133.2	130.5	83.0	81.0	135.7	132.5	85.0	71.5
22	138.7	133.7	127.5	122.0	136.5	128.0	129.0	127.0
23	139.5	137.7	127.5	125.5	140.5	136.2	126.7	120.5
24	170.2	168.5	113.0	108.5	171.2	170.7	117.0	113.0
25	148.0	147.0	134.5	133.0	149.5	147.0	140.0	129.0
26	159.7	158.5	133.5	129.0	159.5	158.5	133.0	131.5
27	155.2	149.0	117.5	112.0	155.7	148.0	117.0	99.0
28	154.2	150.2	143.5	138.0	156.2	152.7	145.2	141.0
29	164.5	161.0	125.0	118.0	167.5	167.0	125.5	123.0
30	124.2	120.2	141.0	139.5	126.5	127.5	144.5	140.5
31	135.0	131.0	130.0	127.0	137.2	134.2	130.2	126.5
32	127.7	126.2	149.0	146.5	127.7	126.2	154.5	142.0
33	144.2	143.5	126.5	119.5	134.5	134.0	117.5	116.0
34	138.5	134.5	153.2	139.2	137.2	134.5	156.0	145.0

APPENDIX F (cont.)

Note: B1 HR = Baseline heart rate for physical distraction
PD HR = Physical distraction heart rate
B1 RPM = Baseline pace for physical distraction
PD RPM = Physical distraction pace
B2 HR = Baseline heart rate for cognitive distraction
CD HR = Cognitive distraction heart rate
B2 RPM = Baseline pace for cognitive distraction
CD RPM = Cognitive distraction pace

APPENDIX G

Visit 2 HR and RPM (Treatment Group)

NO.	B1. HR	PD. HR	B1. RPM	PD. RPM	B2. HR	CD. HR	B2. RPM	CD. RPM
1	172.2	171.7	169.0	169.5	172.7	173.5	169.0	170.0
6	147.5	149.2	107.5	112.5	147.5	147.5	110.5	111.0
7	131.5	132.5	151.0	148.5	130.5	130.5	151.7	147.0
8	168.5	168.2	132.0	130.0	170.0	168.5	129.5	126.5
11	116.2	117.2	152.5	153.5	118.0	117.7	150.0	152.5
12	163.0	162.5	111.0	109.0	164.2	160.5	110.0	106.2
14	134.7	134.7	155.2	159.0	136.5	136.0	160.5	156.0
16	145.5	144.7	131.0	131.0	145.2	144.7	130.5	130.0
17	143.5	144.7	145.0	145.5	146.0	145.0	147.5	146.5
18	127.2	127.5	88.0	88.0	128.2	127.7	88.0	89.5
22	144.0	141.2	129.5	127.5	143.0	139.5	129.0	127.0
23	143.7	143.2	130.5	129.7	144.7	143.7	129.0	129.5
26	153.5	154.7	120.0	120.0	152.5	154.2	120.5	121.0
27	146.5	144.0	108.0	109.0	145.5	147.5	107.5	109.0
30	127.7	126.2	149.0	147.0	133.5	135.0	152.0	154.2
31	140.5	137.2	135.5	137.0	137.2	140.5	134.2	135.2
33	138.5	135.7	115.5	109.5	141.0	142.2	116.5	117.0
34	128.5	126.5	121.0	120.5	128.0	129.0	122.5	120.0

Note: B1 HR = Baseline heart rate for physical distraction
PD HR = Physical distraction heart rate
B1 RPM = Baseline pace for physical distraction
PD RPM = Physical distraction pace
B2 HR = Baseline heart rate for cognitive distraction
CD HR = Cognitive distraction heart rate
B2 RPM = Baseline pace for cognitive distraction
CD RPM = Cognitive distraction pace

APPENDIX H

Visit-2 Mean HR and RPM (control Group)

	SEX	B1. HR	PD. HR	B1. RPM	PD. RPM	B2. HR	CD. HR	B2. RPM	CD. RPM
2	M	136.7	136.2	139.5	139.0	138.7	136.0	141.0	138.5
3	M	133.7	131.2	145.0	140.5	136.0	132.2	147.5	145.2
4	M	143.2	139.0	144.5	141.0	143.5	141.0	149.5	143.2
5	M	152.2	151.2	163.0	158.5	150.2	148.2	160.5	157.0
9	M	142.2	141.2	127.0	124.5	142.2	140.2	126.5	122.0
10	M	127.5	123.5	125.5	120.5	127.5	123.2	127.5	122.0
13	M	156.5	153.0	110.5	105.5	155.5	151.5	115.0	110.5
15	M	111.7	109.0	107.0	103.0	113.7	111.0	109.0	106.0
19	F	160.2	158.5	123.5	119.0	159.7	159.0	123.5	121.0
20	F	157.7	154.2	143.5	140.0	160.2	157.0	145.7	143.0
21	F	136.5	132.2	93.5	89.0	136.2	134.2	97.0	94.2
24	F	162.0	159.0	104.5	99.0	161.0	161.2	106.5	101.5
25	F	154.0	152.5	141.5	138.5	152.7	151.0	139.5	136.5
28	F	160.2	155.2	137.7	133.75	162.7	159.5	136.2	134.0
29	F	168.5	166.7	124.5	120.5	169.7	165.7	126.5	120.0
32	F	125.7	123.5	127.0	122.5	126.7	126.5	126.5	124.5

Note: B1 HR = Baseline heart rate for physical distraction
PD HR = Physical distraction heart rate
B1 RPM = Baseline pace for physical distraction
PD RPM = Physical distraction pace
B2 HR = Baseline heart rate for cognitive distraction
CD HR = Cognitive distraction heart rate
B2 RPM = Baseline pace for cognitive distraction
CD RPM = Cognitive distraction pace