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EFFECTS OF TYPES AND INTENSITIES OF BACKGROUND MUSIC ON TREADMILL ENDURANCE

A Thesis

Presented for the

Master of Science

Degree

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Brenda L. Copeland

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DEDICATION

To Margaret Hutson and Eleanor Hutton, who implanted the dream and encouraged me to pursue it.

To my parents, who have always believed in me.

To Dale, who was patient and loving enough to let me try.

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ABSTRACT

The effects of different types and intensities of music on heart rate (HR), rating of perceived exertion (RPE), and time to exhaustion during submaximal and maximal treadmill work were investigated. Twenty-four (13 female and 11 male) volunteers participated in two accommodation exercise sessions and three multi-staged progressive walk/run maximum tests. In the progressive maximum (max) tests, an equal number of subjects (in equal fours) was randomly assigned to different treatment orders: loud, fast, exciting, popular music (Type A); soft, slow, easy-listening, popular music (Type B); and no music (control). Treatments were administered with portable light-weight headphones. HR was recorded halfway through each minute and at max. Time to exhaustion was recorded in seconds. Subjective estimates of RPE were obtained after the test for five different points during the test. Differences ($p < .10$) between gender and experimental treatments were determined by a 2-way (2x3) ANOVA. HR was significantly higher with Type A and control treatments than with Type B treatment in minutes one and six. In the minute before max, HR was significantly higher with Type B treatment than with Type A and control treatments. A significant interaction of music and gender was found for max HR with males having significantly lower max HR in the control treatment than in the music treatments. Female HR was significantly higher than male HR at each minute of work (excluding the minute before max and at max). RPE was significantly lower with the two music treatments than with the control treatment for submaximal work. There was no significant gender difference for RPE. Time to exhaustion was significantly longer during the Type B music treatment than during the control treatment. Time to exhaustion was longer for male than for female subjects. It was concluded that (a) soft, slow, easy-listening, popular music reduces HR response in submaximal work and increases endurance time, and that (b) music reduces RPE response for submaximal work.

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CHAPTER I

INTRODUCTION

Music has long been considered a stimulus for emotional arousal. It produces a diversity of responses. Music has been utilized in industry to increase production and moral (Farnsworth, 1969). It is used for therapy, stress reduction, and sleep as well as for enjoyment and recreation.

Individuals have often felt more rested and full of energy after listening to music. Howes (1927) referred to music as good emotional tone and felt it was the best possible factor for releasing vast quantities of physical energy. Discerns (1952) stated that music arouses emotions which in return releases adrenalin. Many studies have shown that music affects bodily processes. Based on a series of experiments on the influence of music on behavior, Discerens and Fine (Farnsworth, 1969) concluded that music increases metabolism, muscular energy, and respiration as well as affecting blood pressure and volume. Also, it has been stated that music tends to delay or reduce fatigue and consequently increase muscular endurance. Music also acts as a distracting factor (Farnsworth, 1969).

One of the most important components in physical fitness is cardiorespiratory endurance, a persistence to continue in the activity and resist fatigue. Fatigue, a mental or muscular impairment, plays a role in endurance time. The agents which retard fatigue also increase endurance (Karpovich, 1965). DeVries (1974) states that the limits of human cardiorespiratory endurance are set by such psychological factors as motivation and willingness to take pain, as well as many physiological factors. Motivation, based on emotions, is an important factor in physical performance capacity and in determining endurance during heavy exercise (Astrand & Rodahl, 1977; DeVries, 1974).

Psychologically, the mechanisms of endurance include perception of the workload being performed. Similar to Nideffer's (1981) theory of attentional focus, Pennebaker and Lightner (1980) agree that the internal sensory stimulus and the external environmental stimulus are in opposition for the attentional focus. The athlete may perceive the difficulty of the task differently according to the amount of motivation or distraction received through external or internal stimuli. Nideffer (1979) refers to "associative" and "dissociative" strategies to cope with the pain of exercising, by either associating the pain in an internal fashion or dissociating from the pain through external distractions. These subjective feelings of work intensity (perceived exertion) can be quantified using a rating of perceived exertion (RPE) scale. This technique, revised by Borg (1982), requires the exercising subject to choose a number to represent the subjective feeling of the intensity of work being performed.

Physiologically, endurance components include the blood, heart, lungs and amount of oxygen utilized. Maximal oxygen uptake (max V02), the greatest amount of oxygen utilized in the body during physical work, is considered to be the single most accurate index of maximal cardiovascular function (Fox & Mathews, 1981) and a valid measure of endurance. However, some physiological variables, such as max V02 do not change due to an emotional stimulus. Max V02 can improve 5-20% following 8-12 weeks of training (Fox & Mathews, 1981). Time to exhaustion, or the decision to stop running, is related both to physiological responses to work as well as psychological factors such as motivation or pain tolerance.

Research has shown that music, as a psychological or emotional influence, sometimes results in a physiological response. Athletic and fitness performances depend on the interaction of physiological and psychological mechanisms. To understand one's performance level, both physiological and psychological responses must be measured with the combination being a more accurate estimate of exertion.

There are several implications for a study involving music. The athletes with the highest maximal aerobic power usually perform successfully in endurance events (Astrand & Rodahl, 1977). In sports in which cardio-respiratory endurance is involved, the treadmill endurance test can be utilized. However, the assessment is not a valid measurement unless the athlete can reach a true maximum. Often, lack of motivation is a factor in peak performance. Music, during the test, may interact with emotional factors, to enable the athlete to perform at a higher level.

All physical training and fitness programs involve overloading the utilized systems in order to increase performance/fitness levels. Overcoming physical and mental fatigue for increased improvement is a pertinent concern. However, it remains to be determined whether or not music reduces the effects of fatigue which in turn increase the performer's endurance and ability to tolerate overload.

The type and intensity of music are considerations in choosing a proper musical selection for motivational purposes. For example, a greater intensity of music produces more excitation (Stoudenmire, 1975) and may increase the fatigue blocking effect of music. Thus, it might be predicted that increased musical intensity should produce a higher level of cardiorespiratory endurance.

Farnsworth (1969) stated that tempo plays the largest role of the variables which a listener uses to give meaning to music. Fast, exciting music has been found to cause more anxiety, a psychological response of arousal (Fisher & Greenberg, 1972), while calm, relaxing music has been shown to decrease anxiety and stress (Kibler & Rider, 1983; Stoudenmire, 1975). If arousal is increased or decreased, the music type (including tempo) must be a consideration in motivation. Many studies dealing with subjective responses to music employed classical music. Thus, it remains to be determined whether popular music will have a similar or adverse effect on arousal/performance.

Music is popular in personal fitness programs. Is listening to the music through portable earphones advantageous to jogging endurance? Several studies (Anshel, 1976; Mikol & Denny, 1955; Pennebaker & Lightner, 1980) have investigated effects of synchronization of exercise to music. Synchronization is not always feasible in a real life setting since the rhythm of jogging, walking, or cycling may not necessarily be synchronous to the rhythm of the music. Physical activity is needed for the

Definition of Terms

Endurance--the ability to persist in physical activity by resisting fatigue (DeVries, 1974). In this study, endurance was measured as the time to voluntary exhaustion on the treadmill test.

Tempo--the rate of speed of music measured in beats per minute (b/min). In this study tempo was varied from 100 b/min. for slow music to 140 b/min. for fast music.

Background music--music played during performance which is not in rhythm with the work pace. In this study, background music was played through earphones.

Intensity of music--the amount of force of sound, i.e., high (loud) or low (soft).

Synchronization--rhythmical movement in pace with the music condition. In this study, movement on the treadmill was not synchronized with the music.

Type A music--selections of high intensity (loud, 75-85 db) upbeat popular music with a fast tempo of approximately 140 b/min.

Type B music--selections of low intensity (soft, 60-70 db) easy-listening popular music with a slow-moderate tempo of approximately 100 b/min.

Light work--light work is exercising in the 5 MET range. In this study, light work refers to walking in stage 1 (i.e., subjects' mean percent of max HR was 57-59%).

Moderate work--moderate work is exercising in the 8 to 13 MET range. In this study, moderate work refers to jogging in stages 2 to 3 (i.e., subjects' mean percent of max HR was 68-84%).

Heavy work--heavy work is exercising in the 15 to 19 MET range. In this study, heavy work refers to running in stages 4 to 7 and includes the minute before maximal exertion to maximal exertion (i.e., subjects' mean percent of max HR was 89-99%).

Hypotheses

The following hypotheses were tested in this study.

1. For light and moderate work, the HR response with Type B music will be lower than that with Type A music and with no music (control).

2. There will be a lower RPE response to light and moderate work with Type B music than with Type A music and with no music (control).

3. Time to exhaustion will be longer with Type A music than with Type B music and with no music (control).

4. Both HR and RPE responses for submaximal exercise will be lower for male than for female subjects.

5. Time to exhaustion will be longer for male than for female subjects.

CHAPTER II

REVIEW OF LITERATURE

This review of literature will deal with the effects of music on: (a) heart rate, psychological measures, and occupational work indices; (b) endurance and performance, both with rhythmical music and with background stimuli; (c) physical education activities and, (d) rating of perceived exertion (RPE) and attentional focus. The review will also summarize pertinent gender studies.

Effects of Music-Types on Heart Rate Psychological Measures and Occupational Work Indices

Coleman (1920) studied the correlation of heart rate (HR), breathing, bodily movement, and sensory stimuli. Subject's HR and observations of the bare abdominal wall were measured during the tests. The tests included self-pulse taking while (a) walking with attention on footsteps, (b) walking in different moods, (c) sitting erect with attention on a metronome, (d) singing, (e) being in the presence of a public speaker giving a speech, and (f) leg swinging. It was found that the external stimuli of the heart, footsteps, and breathing affected HR responses as the HR became more synchronous with the rhythm of each stimulus.

Based on Coleman's (1920) study, Johnson and Trawick (1938) conducted three experiments with nine subjects in each to test the possibility of achieving synchronous accord between HR and external stimuli. A metronome, earphones, and a visual light stimulus were used to obtain either eynchrony between HR and rate of stimulus or acceleration or deceleration of HR response to rhythm changes. No significant differences were found.

Ellis and Brighouse (1952) used thirty-six college students to study the effects of music on respiration and HR. A thirty minute test using jazz, classical, and dynamic classical music was given while HR and respiration were assessed before, during, and after the test. Subjects read two articles to camouflage the true nature of the test. Significant findings included an increase in respiration, especially with the dynamic classical music. However, none of the selections caused a significant change in HR.

Zimny and Weidenfeller (1963) used eighteen college students to investigate the effects of exciting and calming music upon galvanic skin response (GSR) and HR. The GSR measurement, using a psychogalvanometer, showed a decrease in skin resistance indicating emotional arousal. Six minute portions of exciting, neutral and calm music with pre-music, music, and post-music measurements were repeated three times. There were no significant differences in HR. The skin responses were highest in the exciting music condition. GSR remained unchanged throughout the neutral and calming music. The pronounced decrease in resistance on the GSR response indicated that exciting music may have caused an emotional arousal.

Coutts (1965) used fifteen physical education students to investigate the aftereffect that five weeks of fast music, slow music, or no music had on HR and work output of short duration. HR was taken before music, after music and after an all-out ride of 75 pedal revolutions on a bicycle ergometer. No significant alterations in either HR or work output were found, indicating the music had no significant arousal aftereffect.

Fisher and Greenberg (1972) investigated the psychological effects of exciting and calm music on women. Ninety subjects were assigned to one of three groups: exciting music, calm music, and no music. The subjects responded to psychological tests while listening to the music. Analyses of variance of scores on the Nowlis Mood Scales showed significant differences in the amount of anxiety produced with the varying conditions. Music had significant effects on mood and responses to psychological tests with exciting music producing more anxiety and aggression.

Stoudenmire (1975) investigated the effects of muscle relaxation training and relaxing music on reductions in anxiety. One Hundred and eight undergraduate females were pre- and post-tested. The measures of anxiety were the A-State and A-Trait scales of the State-Trait Anxiety Inventory (Spielberger, Gorsuch & Lushene, 1980). Significant results were found for relaxing music as a method of state-anxiety reduction.

In a similar study, Kibler and Rider (1983) used seventy-six non-music majors. The usefulness of music, progressive muscle relaxation and a combination of the two for tension reduction was investigated. Three groups were assigned to either sedative music, progressive muscle relaxation, or both. Finger temperature was used to measure the stress level before and after the music. Significant increases in temperature were found in all groups indicating that there was a relaxing effect of the music. No significant differences in the three groups were found, although the music and progressive muscle relaxation groups had the highest mean score.

Burris-Meyer (1943) used worker samples within several different factories to study the influence of music on production rates. After installation of music, an increase of 4% to 11% in weekly production was found. Employee absences and early departures dropped from 2.5% to 0.8%. The results also indicated, through self-reports, that music made the work "seem to" go faster with employees profiting by the changes.

Kerr (1944) also did psychological research on the effects of industrial music by using questionnaires and measuring output differences with and without the music condition. The findings supported use of music during repetitive work. Music was also found to have a favorable effect on the quantity of production. Music-type preference varied with the different work groups. On measuring the effect of two types of music on feelings of unpleasantness and tiredness, the average person reported greater happiness and felt least tired with popular-vocal music than with waltz-instrumental music.

McGhee and Gardner (1949) used 142 women workers in a rug manufacturing setting as subjects for their investigation of the effects of music on worker production. They also examined the way the workers believed the music affected performance. The subjects were of a highly skilled, stable-level caliber, in a complex work situation, rather than one involving relatively simple industrial tasks. The amount of production with and without music was compared for five weeks. The results showed no increase in production in this relatively stable work situation, although the employees believed the music was beneficial. The failure of the music to increase production was hypothesized to be due to the already developed habit patterns and tempo of work, with the effects of music not strong enough to break these patterns.

Newman, Hunt and Rhodes (1966) investigated the effects of four types of music as well as no music, on the quantity and quality of production and attitude of the workers in a skate board factory. The five-week investigation used twenty-six assembly-line personnel. The four conditions included folk, show, pop, and no music. Data were taken each day on the total number of units produced and rejected, the number of personnel and the assembly-line running time. Although a questionnaire revealed the workers' attitude was very favorable to the music, the data showed no significant effect of the music on either the quality or quantity of production.

Wilson and Aiken (1977) used fifty-six students who expressed preference for rock music to investigate the effect of intensity levels upon physiological and subjective response to rock music. GSR, HR and respiration were measured and recorded on a four-channel physiograph system. Intensity of hard rock was compared to white noise of the same intensity. The music stimuli consisted of seven hard rock selections. The white noise was recorded from an unoccupied television station. Intensity levels of 95 decibels (db) and 79 db were used for both music and white noise. Significant results included decreased skin resistance, increased breathing rate and decreased HR suggesting a general arousal-attention state for both noise and music. HR was slightly faster for the loud intensity music and noise over that of the soft intensity music and noise although the results were not significant.

Effects of Music and Intensity on Endurance and Performance

Wolfe (1983) used 200 college students to examine the effect of music loudness on task performance. Subjects were divided into four groups: (a) task only; (b) task with background music at 60-70 db; (c) task with background music at 70-80 db; and (d) task with background music at 80-90 db. The task involved mathematics problems. The background music consisted of instrumental current motion picture soundtrack selections. Questionnaires were given to obtain self-reports of interference. The music had no significant effect on task performance although the majority of subjects in the group with the loudest music reported that the music caused distraction and felt that the loudness was a contributing factor.

Anshel (1976) used thirty-two physical education students to test endurance under three conditions on a bicycle ergometer: (a) synchronization to music; (b) background music which was asynchronous but followed the pace of a flickering light; and (c) flickering light only (no music). There was a significant increase in performance time for the synchronization condition over the other conditions. No significant difference was noted between the asynchronous and no music condition.

Vallegra (1958) investigated speed-force relationships using soft (45 db), medium (65 db), and loud (85 db) intensities of sound. Thirty-six males were used in two experiments to measure the speed of arm movement and force of muscular contraction. Speed was measured with a timed lateral arm swing voluntarily initiated by the sound. Upon hearing the sound, subjects performed a maximum contraction using a dynamometer. Subjects produced the fastest speed with loud intensity sound. During soft intensity sound, subjects produced a faster speed than during medium intensity. The greatest force was produced with medium intensity sound and the least force with soft intensity sound.

Nelson and Finch (1962) investigated the effect of selected sounds on an all-out 60-second bicycle ergometer test. Sixteen subjects were tested under four different conditions: fast sound, slow sound, white-noise sound of wind and water falls, and no sound. Earphones were turned on 15 seconds prior to the ride at a volume of 62 db. Total revolutions were measured. There was no significant difference in performance between any of the conditions.

Nelson (1966) studied the effects of selected music, pure tones, and various intensities on the performance of an all-out 90-second bicycle ergometer test. There were three different designs, each containing sixteen subjects. In the first design there were four treatments with sound intensity held constant: fast march, slow music, white-noise sound, and no sound. The second design used pure tones of constant intensity: fast rhythm, slow rhythm, non-rhythmical sound, and no sound. The third design used one fast march with four variations of sound intensity: low, changing from low to high, high, and no sound. Each subject listened to the sound for 60-seconds prior to starting. The score was recorded through assessment of total revolutions against 10 pounds of resistance. No significant differences were found although subjects reported feeling less fatigued with faster sounds and high intensity variation.

McCormick (1971) studied the effects of music on performance (total revolutions on a 10 min. cycle ergometer ride) with 1.5 kg resistance, using five different musical environments. There was no significant difference among the groups in the distance traveled, however, differences were noted in heart rate. During the third and ninth minute of exercise, the heart rates were significantly higher during the march, classical, and pop music treatments than during the electronic or no music treatments.

Chipman (1966) investigated the effects of music on endurance by measuring the number of bent knee situps performed with a music condition and a no-music condition. Thirty junior high boys performed situps to exhaustion with no set cadence or time limit. A slight difference was shown between the tests, with the higher score on the music condition. The difference was not significant.

Bates and Horvath (1971) used rats to determine if background music, either rhythmic or non-rhythmic, would effect the learning of a visual discrimination response. Six groups of rats learned a problem while listening to one of six conditions: Mozart; amelodic version; Schoenberg; melodic version; white noise; and quiet. Correct responses were measured. In the presence of the non-rhythmic, amelodic versions and white noise, the rats produced poorer performance. Possible reasons include: distraction, dislike, or lack of rhythm.

Mikol and Denny (1955) investigated the effect of music and rhythm on the performance of a paced, repetitive task. Eighty subjects practiced the task under one of five conditions: metronome synchronous, metronome asynchronous, music synchronous, music asynchronous and control (neither). The task was performed by keeping a stylus in a horizontal position and following the target. The total time on target was measured. The subjects' performance of the synchronous metronome condition was significantly superior to that of the other conditions.

Effects of Music on Physical Education Activities

Dillion (1952) used 240 intermediate swimmers in a three year study to determine the value of music as an aid in teaching swimming. Two groups were used: music and non-music. In the music group, background music was used at all times while the students were swimming. No music was used in the other group. The experiment involved testing for speed and form of the crawl and breaststroke, teaching, and retesting for improvement. Speed was measured by a stopwatch and form was evaluated by aquatic officials using a 10 point rating scale. The music group improved significantly in form over the control group, but speed improvement was not significant; although the mean speed was greater for the music group than for the control group.

Beisman (1967) tested the effect of rhythmic accompaniment during instruction on style and performance of selected motor skills. Two groups were used: an experimental group receiving accompaniment during instruction, and a control group with no accompaniment. Six hundred and seven subjects, grades one through six were pre- and post-tested on acquiring motor skills of jumping, leaping, throwing, catching, climbing, dodging, and bouncing. In 57 of the 66 analyses, measurements showed significant improvement of the experimental group as contrasted to the control group.

Brown (1981) studied two perceptual motor development approaches in four to six year old children. The experimental group received 24 sessions of integrated physical education/music instruction. The sessions were based on the concepts of Kodaly and Dalcroze which used folk music and nursery rhymes taught through singing games. The control group received sessions of movement exploration and self-testing instruction through game-like dramatics with dialogue between the students and teachers, but no music. Significant improvement occurred only in the music group.

Effects of Music and Sensory Stimuli on Rating of Perceived Exertion

Because perceptual effort ratings are needed to understand a person at work, Borg (1982) introduced the idea of rating of perceived exertion (RPE). Borg's scale was originated to integrate or provide a "gestalt" of information from local and central factors that signal the degree of physical strain felt during exercise. Although Borg's opinion is that perceived exertion is the single best indicator of the degree of physical strain, the RPE can be used to compliment HR and to quantify the subjective feelings during work (Borg, 1982).

Franks and Myers (1984) investigated the effects of talking on HR, RPE, and time to exhaustion in two treadmill studies. Experiment 1 tested 16 subjects (8 female, 8 male) twice: (a) without talking, and (b) while responding to 3 questions during each stage. Experiment 2 used independent groups (n=10 females each): (a) no talking early in the test (walking) but answering questions during later stages (running); and (b) answering questions during walking stages, but not during the running stages. In the first study, there was a lower HR response in light work when subjects responded to questions. RPE was higher with no talking during the walking stage, and while talking during the running stage. These results indicated an effect of a mild psychological stimulus on RPE and HR during light work.

Quarles (1984) used 24 subjects to examine the effects of background music on RPE, HR, and time to exhaustion during exercise. After establishing max HR in an accommodation run, subjects completed two tests consisting of 70% of max HR for 8 minutes, 85% of max HR for 8 minutes, then an increasing grade (2%/min.) until exhaustion. Treatments included popular music and no music (control). No significant differences for RPE and HR were found at either workload, however time to exhaustion was longer with music than with no music.

Barger (1979) investigated the effects of music and verbal stimuli on HR and subjective feelings. Subjective feelings were measured through a five point self-report scale as indicated by different figures. Eighty subjects were rotated in four conditions: (1) calming music; (2) suggestions of relaxation; (3) calming music and suggestions of relaxation; and (4) silence control. Arousal was induced by mental multiplication problems. Sound treatments were given in five two-minute sessions, preceded by one minute of arousal at the completion of which the subjects were asked how they felt. The math problems caused increased HR and subjective arousal indicated through self-reports, however, treatment variables were no more effective than silence in reducing HR, suggesting it was a lack of arousal that decreased HR.

Rejeski and Ribisl (1980) found support for the hypothesis that RPE is influenced by the expected duration of a physical task. Fifteen male subjects were used in a two-trial treadmill experiment at 85% max VO2. Both trials consisted of 20 minutes of running, however, in the second trial the subjects were told that the duration would be 30 minutes. RPE, HR, respiratory rate, and ventilatory min. volume were collected. RPE in the "30 minute" trial was lower than that in the 20 minute trial, possibly due to the delaying of fatigue or "cognitive pacing."

Morgan et al. (1976) tested five adult males on a cycle ergometer (100 watts, 60 rpm) using four different treatments of 20 minutes each: (a) control (suggestion of cycling on level grade for 1 mile); (b) suggestion of uphill work in walking state; (c) exercise under hypnosis with no suggestion; (d) suggestion of uphill work under hypnosis. The dependent measures were HR, VO2 (volume of oxygen$\cdot$min.$^{-1}$), VCO2 (volume of carbon dioxide$\cdot$min.$^{-1}$), ventilation, and RPE. There were no alterations in HR, VO2, or VCO2. Suggested heavy work caused significant increases in RPE, while suggested light work provoked a decrease in RPE. Ventilation was increased with the suggestion of heavy work in both waking and hypnotic states. This elevation continued for 5 minutes after completion of work even though RPE was less.

Physiological Gender Differences

Physiological and biochemical changes take place in both males and females following physical training programs (Fox & Mathews, 1981). The adaptations and improvement in the working capacities are comparable between sexes, (Fox & Mathews, 1981; Hanson & Nedde, 1974; and Massicott, Avon & Corriveau, 1979) however athletic performance in relation to gender, differs.

Dill et al. (1972) measured aerobic power of 10 female and 11 male students on a bicycle ergometer. Mean max VO2 of males was 45.2 ml/kg·min.$^{-1}$ and 35.9 ml/kg·min.$^{-1}$ for females. When related to lean body weight, males were still 15% greater in max VO2 than were females.

Wilmore and Brown (1974) measured body composition and cardiovascular endurance on 11 long-distance women runners. The mean percent body fat (15.2) was 50% lower than the normal population but over 100% above the percentage fat for the long-distance male runners. Max VO2 (approximately 59.1 ml/kg·min.$^{-1}$) was higher than for the normal population but 16% lower than men. This percentage was reduced to 7.8% when expressed as lean body weight (LBW). Differences in females after puberty were found to be partly social-culturally determined due to a more sedentary lifestyle after menarche.

Because of the discrepancies in the magnitude of sex differences in max VO2, Sparling (1980) comprised a meta-analysis of studies comparing max VO2 in men and women. The absolute max VO2 was 40-60% higher for males than females. Expressed relative to LBW, the men were only 12-15% higher than the women. This difference was due to the lower cardiorespiratory capacity of women because of the smaller heart size and lower hemoglobin content in the blood.

Cureton and Sparling (1980) used 10 males and 10 females to investigate the magnitude of differences in performance due to percent body fat. Submaximal and maximal treadmill runs as well as a 12-minute run were used to evaluate performance differences. Both males and females were studied at their natural weight. Males were also studies with external weight added to match the extra percent fat of the female (7.5%). The added weight reduced the gender differences for treadmill time by 32%, the 12-minute run distance by 30%, and max VO2 difference by 65%. However, males were still 23% better in treadmill time and 14% in the distance run in 12 minutes.

Corbin et al. (1983) determined the extent that male boastfulness or female lack of confidence accounted for the differences in motor performance estimates. Thirty male and 30 female students were asked to estimate how long they could endure a physical task prior to the performance. There was a significant difference in estimates with males being higher. Conclusions indicated that lack of female confidence accounted for gender differences in performance.

Wells and Plowman (1983) conclude that sex differences in physical performance are due to:

1. Variations in body size with men being heavier and taller with larger organs, including the heart for a larger stroke volume.

2. Body composition with women having less lean body mass and more fat weight.

3. Aerobic power being higher for men. Women must run at a higher percentage of max at any submaximal activity, therefore max VO2 is reached sooner.

Summary

This review of literature shows insufficient evidence to form definitive conclusions on the effects of music on cardiorespiratory function and performance. Johnson and Trawick (1938) failed to support Coleman's (1920) significant results in the accord of rates between the heart, footsteps, and breathing. Although HR response was not significantly influenced in the studies (Coutt, 1965; Ellis & Brighouse, 1952; Wilson & Aiken, 1977; Zimny & Weidenfeller, 1963) respiration rates and GSR were significantly influenced by music (Ellis & Brighouse, 1952; Wilson & Aiken, 1977; Zimny & Weindenfeller, 1963) indicating that music may act as an emotional stimulus.

Psychological responses such as anxiety and stress appear to be significantly affected by music. Fisher and Greenberg (1972) found exciting music produced the highest anxiety and aggression, which are forms of arousal, while Stoudenmire (1975) concluded that relaxing music reduced anxiety. Kibler and Rider (1983) concluded that sedative music is an effective stress reducer. With the variation of results between the extremes of music, the implication for training seems to be to use exciting, fast music for training of athletic events of maximal exertion, and calm, slow music for relaxation and sub-maximal exertion.

The results of the studies under work situations were not consistent. Two studies found significant increases in production (Burris-Meyer, 1943; Kerr, 1944). Other investigations discovered no significant increase in production, although each study found an increase in positive attitude or morale, with subjects expressing belief in the beneficial effects of music for industrial production (Burris-Meyer, 1943; Kerr, 1944; McGee & Gardner, 1949; Newman et al., 1966).

Investigations (Anshel, 1976; Bates & Harvath, 1971; Beisman, 1967; Mikol & Denny, 1955) involving rhythm have found that synchronization of the activity to music stimuli produced better performance than investigations using background musical stimuli (non-rhythmical). None of the background music studies showed significant increases in performance (Anshel, 1976; Bates & Horvath, 1971; Chipman, 1966; McCormick, 1971; and Nelson & Finch, 1962). Studies using intensity as a variable have found significant increases in performance with high intensity music compared to low intensity music (Nelson, 1963; Vallerga, 1958). Other effects of the high intensity music included feeling less fatigued through distraction (Nelson, 1963; Vallerga, 1958). Performance improvement has been reported in physical education and athletics events with the musical accompaniment (Beisman, 1967; Brown, 1981; Dillion, 1952), implying that music may be an important teaching aid to the learning of motor skills.

An additional indication of physical stress introduced by Borg (1982) is the RPE scale. This scale has been used in several studies to compliment HR and quantify subjective feelings during work. Psychological stimuli such as talking produced lower HR and RPE scores during submaximal exercise, but were unaffected during maximal work (Franks & Myers, 1984). Music produced no significant difference in HR or RPE response to exercise (Quarles, 1984; Barger, 1979) but subjects exercised longer with the music (Quarles, 1984). Lower RPE was found with suggestions of lesser work even when the work duration was actually longer than subjects expected (Morgan, et al., 1976; Rejeski & Ribisl, 1980), suggesting the importance of the mental component in the amount of work performed. These results indicate that an external stimulus, such as music, as well as the suggestion of exercising with music, may affect motivation and work performance.

Gender differences such as variations in body size, body composition, and aerobic power account for higher physical performances of men (Corbin, et al., 1983; Cureton & Starling, 1980; Dill, et al., 1972;

Sparling, 1980; Wells & Plowman, 1983; Wilmore & Brown, 1974). This suggests that males will respond with a lower HR and RPE to a fixed submaximal exercise bout and have a longer time to exhaustion compared to females.

CHAPTER III

METHODOLOGY

Selection of Subjects

Twenty-four of the twenty-nine college students from physical activity classes at The University of Tennessee, Knoxville, who volunteered, participated in a treadmill endurance event involving the listening to music. To reduce any learning or order effect of the treatments, an equal number of subjects (in equal fours) was randomly assigned to each of the possible treatment orders.

Testing Procedures

After two accommodation periods, subjects performed three multi-staged progressive walk/run maximum treadmill tests. The treadmill was motorized with automatic elevation and speed controls using Franks (1979) protocol (see Appendix B). Stage 1, a warm-up walk, started at MET level 5 at 5% grade and 80.4 $m \cdot min.^{-1}$ (3 mph). The treadmill increased 2-3 METS every 2 minutes until the subject reached voluntary exhaustion. At this point max HR was recorded and the treadmill was reset to return to stage 1 for a 2 minute cool-down. Portable light-weight headphones were securely adjusted on the subject's head prior to the test. Background music, the independent variable, was used during two tests, with the third test being a no-music control.

HR, RPE, and time to exhaustion were the dependent variables. HR was recorded at 0.50 of each minute and at max on a Hewlett-Packard 1500B electrocardiograph strip via a bipolar lead. Max HR and time to exhaustion were the maximal endurance variables used in this experiment. A decision was made not to use max VO2 because in a pilot study, max VO2 did not change significantly. Additionally, in the pilot study, subjects were viewed by the tester to be directing undue attention to the mouthpiece and nose clip rather than the music.

Time to exhaustion was recorded when the subject signaled the tester with an "ok," indicating they had gone as long as they possibly could. Once the test was over, subjects were seated in a chair facing Borg's 10-point RPE scale. RPE was recalled after the test as an indication of how difficult they felt the work was at five different points during the test: (1) midway through the walk (light work); (2) midway through the first half of the jog (low-moderate work); (3) midway through the second half of the run (high-moderate work); (4) at the point when the subject said "ok" (heavy work); and (5) midway through the cool-down. RPE was taken after the test to keep attentional focus from shifting (external to internal) during the exercise bout as well as to limit the arousal stimulus to that of music only. Subjects completed a questionnaire concerning the music that was played to indicate the validity of the chosen music.

Treatments

Music treatments were administered in two of the three maximal testing periods. One period was a control period with no music. The treatments included listening to two different types/intensities of music through light-weight headphones (Panasonic). Music was recorded on cassette tapes for uniformity of treatments. Music was turned on simultaneous with the start of the test and continued to play at the prescribed intensity for the remainder of the test. The music treatments included: (a) type A, high intensity (75-85 db) upbeat, fast, popular music (approximately 140 b/min.); and (b) type B, low intensity (60-70 db) slow, easy-listening, popular music (approximately 100 b/min.). Music selections were chosen because of their current popularity and students familiarity to the music. Selections are listed in Appendix D.

Intensity (sound level) remained constant, relative to the treadmill noise, throughout the duration of the test by manual monitoring of the volume control on the player according to the increasing sound intensity of the treadmill. Volume was increased 1 notch at stages 3 and 4, because of the increasing noise of the treadmill. In the present experiment, a change of 1 notch represented an increase of 5 db. In addition, there was a 15 db difference in the two music intensities. A Rion sound level meter was used prior to the experiment to determine the increasing sound level of the treadmill and the respective music intensity levels needed. The soft intensity was approximately 10 db below the sound of the treadmill at 60-70 db, and the loud intensity was placed at 5 db above the treadmill at 75-85 db. The intensity levels were determined via pilot testing. Headphones were used to emphasize only the music and to simulate the popular portable earphones commonly used for walking/jogging.

No verbal motivation by the tester was given to the subject before or during the test. During the no-music control session, subjects were told beforehand that the tester would not speak to them. Headphones were used in all three sessions for uniformity of the tests. Results were not discussed with the subjects until after the completion of all testing periods.

Organization of the Study

Students were approached during the physical activity classes and were given a timetable to sign up for the first appointment. The first two testing periods (out of total of 5) served as an accommodation period in order to familiarize the subjects with the equipment and testing procedure. Subjects were connected to the bipolar ECG lead and headphones (with no music) while each subject learned to walk/run on the treadmill up to a submaximal level of approximately stage 3 (see Appendix B).

Subjects were told of the similarity of the next three tests with the exception being that they would determine the stopping point with an "ok," and would continue moving on the treadmill throughout the cool-down. RPE was explained, as an indication of the difficulty of work during the test, and was taken after both accommodation periods. Subjects then signed up for the second (or third) of the five testing sessions.

Statistical Analysis

Differences between gender and experimental treatments were determined by a 2-way (2 by 3) ANOVA. Significant interactions and differences among music treatments were analyzed by Newman-Keuls post hoc analysis. Statistical significance was set at the .10 level.

CHAPTER IV

RESULTS

Effect of Music Treatments on Heart Rate

The mean, standard deviation, and results of a 2-way (2 by 3) ANOVA for the effect of gender and music with Type A (loud, fast), Type B (soft, slow), and control (no music) treatments on HR are presented in Table 1. In minute 1 and 6, the heart rates were significantly higher with the Type A and control treatments than with the Type B treatment. In the minute before test termination, the heart rates were significantly higher with the Type B treatment than with the Type A and control treatments.

Significant interaction effects between music and gender were found for max HR. Subsequent post hoc analysis revealed that male max HR was significantly less in the control treatment than in the Type A and Type B treatments. With the exception of max and the minute before max, female HR was significantly higher than male HR at each minute of light to moderate work.

Effects of Music Treatments on RPE

The mean, standard deviation, and results of a 2-way (2 by 3) ANOVA for the effect of gender and music treatments on RPE are presented in Table 2. Midway

TABLE 1

EFFECTS OF GENDER AND MUSIC ON HEART RATE

	Type A[a]				Type B[a]				Control[a]				Main Effects		Inter-action
	Female		Male		Female		Male		Female		Male		Gender	Music	
Minute	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$p <$	$p <$	$p <$[b]
1	116.5	7.5	105.3	12.9	112.4	6.8	101.1	8.6	119.9	8.8	103.2	12.5	.001	.010	.161
2	122.9	7.4	104.9	13.8	120.5	9.0	102.6	11.7	123.4	10.5	104.4	15.3	.001	.154	
3	141.2	10.8	120.2	10.9	140.9	10.4	121.0	8.7	144.6	11.9	117.6	13.2	.001		.116
4	155.8	10.8	129.4	15.0	153.9	12.9	127.0	11.2	157.5	11.1	126.7	15.3	.001		
5	168.7	7.6	142.7	14.6	166.4	11.2	141.6	10.5	169.5	9.0	140.4	12.0	.001		.334
6	176.0	6.1	149.7	15.1	172.5	11.3	145.7	14.8	176.0	7.1	147.9	13.21	.001	.055	
7	186.4	7.5	182.2	7.6	182.2	7.6	160.9	14.0	183.9	6.5	163.4	14.0	.001	.260	
PM[c]	190.3	6.3	188.3	9.7	189.9	6.2	190.9	9.8	188.9	5.9	186.5	7.4		.023	.137
M[d]	193.1	6.4	192.4	7.6	191.7	6.3	194.1	8.6	192.2	5.2	189.1	6.5		.005	.002
CD[e]	161.4	9.9	154.9	10.1	161.4	9.5	155.8	11.8	160.1	10.9	151.6	13.7	.094	.280	

[a]Type A = loud, fast, exciting, popular music
Type B = soft, slow, easy-listening popular music
Control = no music

[b]p not repeated for $f < 1.0$

[c]Minute before maximum

[d]At maximum

[e]Cool-down

TABLE 2

EFFECTS OF GENDER AND MUSIC ON RPE

	Type A[a]				Type B[a]				Control[a]				Main Effects		Inter-action
	Female		Male		Female		Male		Female		Male		Gender	Music	
Stage[c]	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$p <$	$p <$	$p <$[b]
Walk	1.50	0.98	1.09	0.89	1.50	0.98	1.36	1.00	1.65	1.20	0.91	0.89	.261		.122
Run 1	2.85	0.90	2.91	0.70	3.23	0.93	3.18	1.17	3.12	1.23	3.36	1.36		.184	
Run 2	4.69	1.38	5.00	1.61	4.77	1.42	4.45	2.02	4.92	1.12	5.55	1.03		.016	
Max	6.69	1.84	7.45	1.86	6.23	1.96	7.64	2.29	6.64	1.66	7.73	1.49	.120		.354
CD	2.29	1.18	3.05	1.65	2.42	1.04	2.82	1.33	2.29	1.03	2.64	1.12			

[a]Type A = loud, fast, exciting, popular music
Type B = soft, slow, easy-listening, popular music
Control = no music

[b]p not repeated for f < 1.0

[c]Subjects RPE was taken for midway through the stage except at max RPE

through the second half of the run, RPE was significantly lower for the two music treatments than for the control treatment. Although there was a higher RPE tendency for males than for females, there was no significant gender difference.

Effects of Music Treatment on Time to Exhaustion

Time to exhaustion was the point at which the subjects signaled readiness to discontinue running on the treadmill. During Type B music treatment, the time to exhaustion was also significantly longer than during control treatment (see Table 3). Time to exhaustion was also significantly longer for male subjects than for female subjects.

Validation of Design

Prior to the study, it was anticipated that an appropriate musical stimulus, one acknowledged as desirable by the students, would provide a motivational incentive, thereby enhancing performance. The results of the questionnaires, given subsequent to each testing session (see Appendix E) indicated that the majority of subjects responded favorably to the provision of music of a popular nature. Also, the subject's perception of the different music treatments was consistent with the treatments of: (a) loud, fast, exciting, and (b) soft, slow, easy-listening.

TABLE 3

EFFECTS OF GENDER AND MUSIC ON TIME TO EXHAUSTION

	Type A[a]				Type B[a]				Control[a]				Main Effects		Inter-action
	Female		Male		Female		Male		Female		Male		Gender	Music	
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$p <$	$p <$	$p <$[b]
Time	9.32	0.83	12.71	1.34	9.34	0.79	12.87	1.13	9.07	0.80	12.67	1.34	.001	.055	

[a]Type A = loud, fast, exciting, popular music
Type B = soft, slow, easy-listening popular music
Control = no music

[b]p not repeated for $f < 1.0$

Subjective Response to Conditions

In a final questionnaire, subjects were asked to rate how the music affected them while they ran on a scale of 1 (strong disagreement) to 5 (strong agreement). The statement which the subjects rated was: Music provided a soothing, relaxing effect. Table 4 indicates that the subjects felt more soothed/relaxed (2 by 2 ANOVA) with the Type B music than with the Type A music, with no significant gender difference or interaction between gender and type of music.

TABLE 4

SUBJECTIVE RATINGS OF THE RELAXING EFFECT OF MUSIC

	Type A[a]				Type B[a]				Main Effects
	Female		Male		Female		Male		Music
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$p <$
Rating (1-5)[b]	3.62	1.12	3.27	1.01	4.15	0.99	3.82	0.87	.007

[a]Type A = loud, fast, exciting, popular music
Type B = soft, slow, easy-listening, popular music

[b]1 = Disagree 5 = Agree

CHAPTER V

DISCUSSION

Summary of Results

It was hypothesized that during Type B music, the HR response to light and moderate work would be lower than with Type A music and control. This hypothesis was partially supported. HR was lower during minute 1 and 6. It was also hypothesized that during Type B music the RPE response to light and moderate work would be lower than with Type A music and control. This hypothesis was not supported. In light work there was no significant RPE difference between treatments. In moderate work there was a lower RPE response with music treatments (i.e., Type A and Type B) than with the control treatment.

It was also hypothesized that there would be a longer time to exhaustion with Type A music than with Type B music and control. This hypothesis was partially rejected. There was a significantly longer time to exhaustion with Type B music than control, with Type A being non-significantly different from both Type B and control.

It was hypothesized that male subjects would have lower HR and RPE responses in submaximal exercise than would female subjects. This hypothesis was partially supported. During submaximal exercise male subjects had a lower HR response than female subjects, except in the minute before maximal exertion where there was no significant gender difference. There was no gender difference in RPE response.

Finally, it was hypothesized that male subjects would have a longer time to exhaustion than would female subjects. This hypothesis was supported.

Discussion of Results

One of the dependent variables in this experiment was heart rate, recorded at 0.50 of each minute of exercise. It was hypothesized that during Type B music (soft, slow, easy-listening popular) the HR response to light and moderate work would be lower than during Type A music (loud, fast, exciting popular) and control. This hypothesis was partially supported. Because HR has been implicated as one physiological response to emotional arousal (Astrand & Rodahl, 1977; DeVries, 1974), it is possible that with the lower HR response with Type B music, there was less emotional stress. Previous studies (Franks & Myers, 1984; Kibler & Rider, 1983; Stoudermire, 1975) have also found a reduction in anxiety or stress with some psychological stimuli. Wilson and Aiken (1977) found a slightly lower HR for low intensity music than with high intensity music. Table 4 indicates that the subjects felt more relaxed/soothed with the Type B music than with the Type A music.

The results of this study are not consistent with those of Ellis and Brighouse (1952), Barger (1979), and Quarles (1984), in which no significant difference in HR response with music was found. Mental, rather than physical, tasks were used for independent variables in the first two studies (Barger, 1979; Ellis & Brighouse, 1952). Possibly the mental tasks could not be affected by the music. The internal processing of the mental tasks, may have restricted the external stimulation from the music.

In Quarles' (1984) study, current pop music, not specified as to type or intensity, was used. The lack of reduction in anxiety may have been due to the particular music selected. Furthermore, in the present study, the subjects were possibly more comfortable with the treadmill after receiving two accommodation periods before the actual testing began. With less anxiety due to running on the treadmill, music might be expected to provide a more potent external stimulus.

It was hypothesized that the RPE response to light and moderate work would be lower with Type B music than with Type A music and control. This hypothesis was not supported. There was no significant RPE difference between treatments in light work. In moderate work, the RPE response was lower with both music treatments than with the control treatment. Franks and Myers (1984) found similar results of a lower RPE during light to moderate work by talking to the subject.

In the present study, the music seemed to help the subjects feel relaxed once they started jogging. During light work, at the beginning of the test, subjects may have been concentrating more on the treadmill than on the music. The speed/elevation regulation was consistent in each testing period. Since the subjects were familiar with the protocol and stages, there may have been an anxiousness from the anticipation of the upcoming running stages. Once the running was started, in the moderate work, the anxiousness may have subsided. Consequently, the subject's attention to the music could have been greater.

In Quarles' (1984) study, there was no significant difference in RPE with music. Subjects were forced to shift attention from the music to themselves periodically due to the requirement of reporting RPE. RPE in the present investigation, was not reported until after the test, giving a higher probability of external focus on the music during the exercise. The present methodology was suggested by the results of Barger's (1979) study in which the presentation of verbal suggestions disturbed the listening of music.

In this study, subjects were not naive to the purpose of using music in the experiment. As in the case of previous studies of expected duriation or difficulty (Morgan, et al., 1976; Rejeski & Ribisl, 1980), the subjects may have been psychologically influenced to believe that music would increase performance. In moderate work, RPE was significantly higher with the no-music treatment than with the music treatments (see Table 2, page 37). The higher RPE may be dependent upon the subject's negative expectations of performance with no music.

Although Borg (1982) has found a strong linear relationship between HR and RPE, it has been demonstrated that the correlation is specific to certain situations. In this investigation, in moderate work, HR was lower with Type B music than with Type A music, yet RPE with the two conditions did not differ. This result was consistent with previous studies (Barger, 1979; Morgan et al., 1976) which found that HR and RPE may react differently to experimental manipulations.

The third variable measured was time to voluntary exhaustion, recorded at the point at which the subjects signaled that they could continue no longer. It was hypothesized that there would be a longer time to exhaustion with Type A music treatment than with Type B music treatment and control. This was partially rejected. There was a significantly longer time to exhaustion with the Type B music treatment than with the control treatment.

Although only one type of music was used in Quarles' (1984) study, the results indicated a significantly longer time on the treadmill with music than with no music. In Franks and Myers (1984) treadmill experiment with a psychological stimulus of talking/ answering questions, there was a lower time to exhaustion with than without the stimulus. This might be explained by the interference of breathing, due to talking at the near maximal stages.

In the present experiment, HR was lower in some of the lighter stages of exercise with the Type B music treatment. The less fatigued subject, indicated through a lower heart rate response with Type B music, would be expected to continue longer. During the testing, a difference was observed in running style with the two music types. Subjects appeared to run with more of a "bounce" with Type A music. If such differences in style were real, additional energy used, possibly because of the faster, more "peppy" music, might be expected to cause the subject to work closer to maximum.

The physiological response of lower HR, in addition to the positive psychological motivation of music, might increase tolerance time on the treadmill. As in the study of Pennebaker and Lightner (1980), the external attentional focus (on the music) may have attenuated internal sensations of exertion. This could explain a longer time to exhaustion with music than with control, however, it does not explain why subjects exercised longer with the Type B than with Type A music.

It is also feasible that the performance of some of the subjects was facilitated by their individual fitness level. One problem encountered was that all subjects were considered to be working at an absolute low, moderate, or high level of performance. The low fit subjects actually have been exercising at a high level of performance when the protocol was at the moderate level.

In the present experiment, males had a lower HR response in submaximal work than did females, although there was no gender difference in RPE. The male subjects had a longer time to exhaustion than did female subjects. The results of this study are consistent with those of other studies (Corbin, et al., 1983; Cureton & Starling, 1980; Dill et al., 1972; Sparling, 1980; Wells & Plowman, 1983; Wilmore & Brown, 1974) emphasizing gender differences accounting for higher male performances. Greater essential body fat of females is a major determinant of gender differences in the response to running performances.

The increased body fat of women increases the amount of energy required to run at the same intensity. At the same max VO2, the female is at a lower work load. Female HR is higher at the same absolute work rate and the pace cannot be maintained for as long.

Although females did not rate the exertion any differently than males, they may have felt inhibited to work at a near maximal condition. Due to the physiological responses such as high rate of respiration and excessive perspiration, females may have discontinued exercise earlier. Females in the normal population may have had less experience with heavy work, as well as being socialized that hard work and fatigue are not appropriate to their gender (Corbin et al., 1983).

Conclusions

Within the limitations of this study, the following conclusions were drawn:

1. Soft, slow, easy-listening popular music causes a reduction in HR response to light and moderate work.

2. Soft, slow, easy-listening popular music causes a lower HR response to light and moderate work than loud, fast, exciting popular music.

3. Music causes a reduction in RPE response to moderate work.

4. Soft, slow, easy-listening popular music causes an increase in treadmill endurance time.

5. Soft, slow, easy-listening popular music causes a subjective feeling of relaxation during exercise.

6. In light and moderate work, male subjects are able to exercise with a lower HR response and continue longer than female subjects.

Recommendations

In the present experiment, significant results were found with a soft intensity, slow, easy-listening type of popular music. HR was lower in light and moderate work with soft, slow, easy-listening popular music than with loud, fast, exciting popular music, possibly suggesting that the former combination of music constitutes a potentially strong external psychological stimulus. Future studies should attempt to determine which of the variables within the music, intensity or type, produced the treatment difference.

Subjects had to keep attention on the treadmill due to the fact that the speed and elevation were regulated. Future studies could use a more natural environment of endurance, such as a distance run on a track, in which the external stimulus of music could be more completely focused upon.

Another recommendation would be to investigate the effects of music on other variables other than cardio-respiratory endurance (e.g., strength/muscular endurance).

Highly trained subjects may reject external stimuli by focusing internally and attending to the stress in a positive way (Nideffer, 1979). The normal population may use the external stimulus (i.e., music) to take their attention away from the stress. Possible research could include comparing the effects of music on the work performance of athletes and non-athletes.

During the testing, it was observed that some subjects used more "bounce" in their running style with Type A music. Follow-up research that includes a bio-mechanical analysis of the possible difference in running style and running efficiency with the different music types would be potentially fruitful.

Finally, it is recommended that an individual protocol be used to meet the predetermined percentage of max HR for light, moderate, and heavy work. This would control for different individual fitness levels.

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APPENDIXES

APPENDIX A

CONSENT FORM

DESCRIPTION OF THE PROJECT

The purpose of this study is to determine your cardiovascular response while walking/running on a treadmill at increasing speeds to voluntary exhaustion as you listen to music with earphones.

You will participate in five treadmill testing sessions over a 4-5 week period. You will have heart rate monitored during the test and will give your rating of perceived exertion after the test. The first two sessions will be accommodation walk/runs of submaximal intensity to familiarize you with the treadmill.

POTENTIAL RISKS AND DISCOMFORTS

The work required in the later stages of the exercise tolerance test is sufficient to produce some degree of fatigue. The risks involved with exercise include the possibility of a heart attack, but this risk is very small for someone without known cardiovascular disease.

I have read the statement above and understand my role in the experiment and the risks involved. I have had the procedures explained to me. In addition, I am aware that:

(1) My name and scores will remain confidential;

(2) I am entitled to have any further inquiries answered regarding the procedures;

(3) I may withdraw my consent and discontinue participation at any time without penalty or prejudice toward me.

(4) In the event of physical injury because of this study financial compensation is not available and medical treatment is not provided free of charge.

(5) I do not expect any personal benefit beyond a report of my maximal capabilities in exercise.

Signature:______________________________ Date:________________

Witness:________________________________ Date:________________

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APPENDIX B

TABLE 5

PROGRESSIVE MAXIMUM TEST PROTOCOL

Stage	Speed (MPG)	Percent Grade	METS
1	3	5	5
2	3.4	10	8
3	6	1.75	11
4	7	3	13
5	7	7	15
6	7	11	17
7	7	15	19
8	7	19	21
9	7	23	23
10	7	27	25

APPENDIX C

BORG CATEGORY-RATIO SCALE

0	Nothing at all
0.5	Very, very weak (just noticeable)
1	Very weak
2	Weak
3	Moderate
4	Somewhat strong
5	Strong
6	
7	Very strong
8	
9	
10	Very, very strong (almost max)

APPENDIX D

MUSIC SELECTIONS

I. TYPE A

The Glamorous Life	Shelia E.
Let's Go Crazy	Prince
Dynamite	Jermaine Jackson
Lucky Star	Madonna
Get Me Tonight	Shannon

II. TYPE B

She's Mine	Steve Perry
Drive You Home Tonight	The Cars
Just Called to Say I Love You	Stevie Wonder
Hard Habit to Break	Chicago
Almost Paradise	M. Reno and A. Wilson

APPENDIX E

QUESTIONNAIRE

I. RATE THE MUSIC HEARD TODAY 1 = least 5 = most
Circle One

		Least				Most
1.	Today's music was fast, exciting-pop.	1	2	3	4	5
2.	Today's music was slow, easy-listening-pop.	1	2	3	4	5
3.	Today's music was loud.	1	2	3	4	5
4.	Today's music was soft.	1	2	3	4	5
5.	How did you like the music?	1	2	3	4	5

VITA

Brenda L. Copeland was born in Hixon, Tennessee, on December 14, 1961 to Mr. and Mrs. Robert M. Copeland. She attended schools in Knoxville, Tennessee, Jonesville, Virginia, Weber City, Virginia and was graduated from Gate City High School in June, 1979. She entered Emory and Henry College in August of that year. She participated in varsity volleyball and track and received a Bachelor of Arts degree in Health and Physical Education from that institution in June, 1983.

In September of 1983 she accepted a graduate teaching assistantship and began studies at The University of Tennessee, Knoxville. There she completed the requirements for the Master of Science degree with an emphasis in the area of exercise physiology.