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Effects of Selected Music Environments on Performance of an Endurance Event

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EFFECTS OF SELECTED MUSIC ENVIRONMENTS ON PERFORMANCE OF AN ENDURANCE EVENT

BY

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PERFORMANCE OF AN ENDURANCE EVENT

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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C.E.M.

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CHAPTER I

INTRODUCTION

Significance of the Study

In physical education and athletics, countless situations occur in which an individual is required to work to exhaustion. And to achieve excellence in most games and sports, it is necessary for the individual to surpass the initial discomfort of fatigue and work toward his physiological capacity.[1]

During prolonged physical activity, the most influential variable upon total work output is endurance which is a measure of the ability to stave off fatigue.[2] Karpovich discusses the relationship between endurance and fatigue.

> It is obvious that the state of fatigue determines the limit of endurance. Therefore, all the factors which delay the onset of fatigue also increase the endurance.[3]

Because of this direct relationship between fatigue and endurance, many aids and incentives have been utilized to reduce or eliminate the feelings of fatigue thereby prolonging or

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[1]Robert E. Wilkinson, "Effect of Motivational Conditions Upon the Muscular Performance of Boys of Different Age Levels," (unpublished Doctor's dissertation, Springfield College, 1965), p. 11.

[2]Sarah R. Riedman, The Physiology of Work and Play, (New York: Henry Holt and Company, Inc., 1965), p. 516.

[3]Peter V. Karpovich, "Fatigue and Endurance," Research Quarterly, 12:419, May, 1941.

increasing performance. Hartrick discusses the necessity of the use of incentives during performance.

> Unless the athlete or subject can be sufficiently motivated to continue performance or exercise beyond what he believes to be his limit of endurance, he will ordinarily cease to perform at the earliest onset of the discomforts of fatigue. Very few individuals appear to be capable of extending themselves enough to approach their actual physiological capacity for endurance without the addition of a very strong incentive.[4]

Ergogenic aids are used above and beyond training effects and incentives to help improve athletic performance. This is done by "either improving the capacity of the muscles to do work or by removing inhibitory mechanisms" which adversely affect work. These aids include drugs, nutrients, diets, special foods and oxygen.[5]

Many claims have been made about the use of music and its effect upon the individual. In recent years, music has been used to increase production in industry,[6] to help in the rehabilitation of mentally ill and physically handicapped individuals,[7] to boast

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[4]Frederick John Hartrick, "The Effects of Various Incentives on Performance in an Endurance Exercise," (unpublished Master's thesis, Pennsylvania State University, 1960), p. 1.

[5]Herbert A. de Vries, Physiology of Exercise for Physical Education and Athletics (Dubuque: Wm. C. Brown Company, 1966), p. 391.

[6]Harold Burris-Meyer, "Music in Industry," Mechanical Engineering, 65:32, January, 1943.

[7]C. Skelly and G. Haslerud, "Music and the General Activity of Apathetic Schizophrenic," Journal of Abnormal and Social Psychology, 47:188, 1952.

team spirit,[8] and to relieve the tension and the pain of dental and medical patients.[9] If this last claim is valid that the administration of music during dental and medical procedures will reduce or eliminate pain, it is conceivable that music could also reduce the pain and discomfort associated with the onset of fatique thereby allowing an individual to persist in an endurance event beyond that level previously achieved.

The present study was conducted to objectively investigate the effects of music upon human performance during an endurance event. If a regulation of human performance can be established, music could be an invaluable aid for use during physical activity.

Statement of the Problem

The purpose of this study was to determine the effects of different types of music upon performance of an endurance event.

Hypotheses

The following two hypotheses were investigated:

1. There is no significant difference among the five treatments on distance performance of an endurance event.
2. There is no significant difference among the five treatments on heart rate before and during an endurance

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[8]Ronald Hyatt, "Music in the Dressing Room," Athletic Journal, 41:28, May, 1961.

[9]Doron K. Antrim, "R_X on Wax," Today's Health, 38:57, February, 1960.

event.

Limitations and Delimitations

1. Twenty-six college women who were randomly selected from volunteers enrolled in basic freshmen physical education classes at South Dakota State University during the 1971 spring semester participated in this study.
2. Tests were administered five times with two weeks separating each testing period.
3. Treatments were limited to four types of music and a no music environment.
4. There was no attempt made to regulate the subjects' diet, sleep or living habits.
5. Only endurance, as measured by the distance pedaled on a bicycle ergometer, and pulse rates were measured.

Definition of Terms

1. Ergogenic aids. "Ergogenic aids are defined as special work producing aids which function by either improving the capacity of the muscles to do work or by removing or reducing inhibitory mechanism."[10, 11]

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[10]Peter V. Karpovich, Physiology of Work and Play (Philadelphia and London: Wm. B. Saunders Company, 1965), p. 41.

[11]de Vries, loc. cit.

2. Tempo. "Tempo is the rate of speed at which music is played."[12]

3. Endurance. "Endurance is the capacity for protracted work and is a measure of the ability to stave off fatigue."[13]

4. Type "A" music. This type of music was a selection of vigorous march music with a dominant tempo above 125 beats per minute.

5. Type "B" music. This type of music was a selection of slow, classical music with a tempo between 40 and 80 beats per minute.

6. Type "C" music. This type of music included high intensity electronic music with no defined tempo.

7. Type "D" music. This type of music consisted of the top six songs on the current popular music charts for the first week in February, 1971.

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[12]Jane A. Harris, Anne Pittman and Marlys S. Waller, Dance A While (3d ed.; Minneapolis: Burgess Publishing Company, 1955), p. 32.

[13]Riedman, loc. cit.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter reviews the related literature in two main areas that are pertinent to this study. These areas include: (1) literature reviewing the use and effects of music upon human performance in the fields of psychology, psychiatry and industry, and (2) literature reviewing the effects of music upon human performance in physical education and athletics.

Literature Related to the Use and Effects of Music upon Human Performance in the Fields of Psychology, Psychiatry and Industry

Heckel, Wiggins and Salzberg studied the effects of fast and slow tempo music upon the rates of speech of psychiatric inpatients. Fast music with a tempo of 172 beats per minute and slow music with a tempo of 60 beats per minute were administered in the background during a select group counseling session. Recordings were made and analyzed to determine rates of speech during the music treatments. The results showed a 22 percent increase in the rates of speech during the fast tempo music over that period of slow tempo music.[1]

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[1] R. V. Heckel, S. L. Wiggins and H. C. Salzberg, "The Effect of Musical Tempo in Varying Operant Speech Levels in Group Therapy," Journal of Clinical Psychology, 19:129, January, 1963.

The effect of music upon the physical activity of patients suffering from apathetic schizophrenia was studied by Skelly and Haslerud. A significant increase was found in the general physical activity of the patients during administration of music. These effects, however, were only temporary in 35 out of the 39 cases studied. Upon termination of the music, most of the patients returned to their original level of physical inactivity.[2]

Reardon and Bell studied the effects of sedative and stimulative music upon the activity levels of severely retarded boys. The behavior of eleven boys between the ages of six and seventeen years was observed and subjectively evaluated during eight experimental sessions. Four experimental conditions were included: sedative sound (Bach chorals), stimulative music (rock and roll), spoken sound (male recording of Pinnochio) and no-recording. Each experimental condition was randomly administered twice during the eight sessions. Results of the study showed that the auditory stimulus in general elicited less activity than no auditory stimulus. These results supported the hypothesis that external stimulus would reduce stereotyped behavior of retardates and the greater the stimulus the greater the reduction

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[2]C. Skelly and G. Haslerud, "Music and the General Activity of Apathetic Schizophrenics," Journal of Abnormal and Social Psychology, 47:190, 1952.

in stereotyped activity.[3]

The American Machine and Foundry company conducted a study on the effects of music on work production and employee absenteeism. The results showed that music increased production nearly three percent during the four month test period. Also, the on-time record was increased by 30 percent and one-half of the workers in the study set new production records.[4]

Burris-Meyer also studied the influence of music upon production rates in the factory. In four samples studied, an increase of 4.07 percent to 11.4 percent in weekly production was found after installation of music. Also employee absences and early departures dropped from an average of 2.52 percent to 0.845 percent and Monday morning absenteeism dropped from 22.75 percent to 2.85 percent.[5]

McGehee and Gardner studied the effect of music upon the amount of production in complex industrial jobs which took from two to four years to master. The results showed that music had no significant effect upon work production. However, a questionnaire indicated

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[3]Diane McGunigle Reardon and Graham Bell, "Effects of Sedative and Stimulative Music on Activity Levels of Severely Retarded Boys," American Journal of Mental Deficiency, 75:156, September, 1970.

[4]"Tune in Greater Productivity," Mill and Factory, 74:80, February, 1964.

[5]Harold Burris-Meyer, "Music in Industry," Mechanical Engineering, 65:32-33, January, 1943.

improved employee attitudes, increased morale, better interpersonal relationships and increased job satisfaction.[6]

Newman and others investigated the effects of four types of music upon the quality and the quantity of production in a skateboard factory. The study covered a period of five weeks in which four different music treatments and one no music treatment were administered to low skilled assembly-line workers. The results showed no significant change in number of units produced or percentage of rejects. Neither the types of music or music versus no music had any effect upon production. However, the attitude of the workers was highly favorable toward music.[7]

Kerr investigated the effect of music upon work place preference, subjective feelings, morale and efficiency. From his study, he concluded that:

> Music should be provided for work areas that involved manual and monotonous work and that industrial music should be regarded as a factor to quantity of production in the typical repetitive operation of modern industry.[8]

Summary

Studies generally agree that music effects increased physical

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[6]William McGehee and James E. Gardner, "Music in a Complex Industrial Job," Personnel Psychology, 2:405, Winter, 1949.

[7]Richard I. Newman, Jr., Donald L. Hunt and Fen Rhodes, "Effects of Music on Employee Attitude and Productivity in a Skateboard Factory," Journal of Applied Psychology, 50:493-496, 1966.

[8]W. A. Kerr, "Psychological Research in Industrial Music and Plant Broadcasting," The Journal of Psychology, 17:260, 1944.

activity of retarded and mentally ill individuals.[9, 10, 11] However, studies on the effects of music upon the production of factory workers have conflicting results. During low skilled assembly line work, studies have found that music effects increases in production while complex skills were not affected by music.[12, 13, 14, 15, 16]

Literature Related to the Effects of Music upon Human Performance in Physical Education and Athletics

Dillion investigated the use of music as a teaching aid for swimming. Over a period of two years, she studied the effect of music upon swimming form and speed of two standard strokes. The music group improved significantly in swimming form over the control group but the improvement in speed was not significant. In all cases, however, the mean improvement in speed was greater for the music group than the no music group.[17]

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[9]Heckel, loc. cit. [10]Skelly and Haslerud, loc. cit.

[11]Reardon and Bell, loc. cit. [12]American Machine, loc. cit.

[13]Burris-Meyer, loc. cit. [14]McGehee and Gardner, loc. cit.

[15]Newman and Hunt and Rhodes, loc. cit.

[16]Kerr, loc. cit.

[17]Evelyn K. Dillon, "A Study of the Use of Music as an Aid in Teaching Swimming," Research Quarterly, 23:1, March, 1952.

Beisman studied the effects of rhythmical accompaniment during instruction upon the style and performance of selected motor skills. Six hundred and seven subjects from grades one through six participated in the study for a period of ten weeks. The subjects were divided into experimental and control groups with the experimental group receiving accompaniment during instruction. Subjective and objective measurements showed significant improvement of the experimental group over the control group in 57 out of 66 analyses.[18]

To determine whether rhythm and sound intensity had any effect upon human performance, a study was conducted by Nelson using selected music, pure tones and varied music intensities during an all-out 90 second ride on a bicycle ergometer. No significant differences were found among any of the experimental conditions but significant differences did occur between scores of some of the subjects.[19]

Brubaker studied the ergogenic effects of sound reinforcement upon the pedaling performances of a group of 38 college men. The sound reinforcement consisted of a pistol shot fired during performance. The results showed that sound reinforcement caused significantly greater amounts of work completed by the experimental group over that of the control group. Also, significant decreases in respiration rates

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[18]Gladys Lang Beisman, "Effect of Rhythmic Accompaniment Upon Learning of Fundamental Motor Skills," Research Quarterly, 38:172, 1965.

[19]Dale O. Nelson, "Effect of Selected Rhythms and Sound Intensity on Human Performance as Measured by the Bicycle Ergometer," Research Quarterly, 34:484, December, 1963.

were found in the experimental group after one-to-two minutes of pedaling which did not occur in the control groups' respiration rate.[20]

Nelson and Finch studied the effect of selected sound on an all-out 60 second ride on a bicycle ergometer. The sounds used were fast march music, slow music, white sound (wind and water falls sound) and no sound. Sixteen male physical education majors participated in the test which produced acute gross motor fatique. The test was an all-out 60 second ride at ten pounds resistance on a bicycle ergometer. The criterion measured was the total number of revolutions cycled. The subjects were tested in a closed environment while listening to music through earphones which was turned on fifteen seconds prior to the ride at a volume of 62 decibels. No significant differences were found between any of the experimental variables.[21]

Chipman studied the effect of "The Stars and Stripes Forever" by Sousa being played upon the number of bent leg situps performed by thirty junior high school boys. The situps were done to exhaustion with no set cadence or time limit. A slight difference was found between the tests, in that more situps were done with music than

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[20]Clifford Brubaker, "Ergogenic Effects of Sound Reinforcement," (unpublished Doctor's dissertation, University of Oregon, 1968), p. 4.

[21]Dale O. Nelson and Lewis W. Finch, "Effect of Audio-Analgesia on Gross Motor Performance Involving Acute Fatique," Research Quarterly, 33:588, December, 1962.

without music, but the difference was not significant.[22]

Berger studied the effect of music in delaying or accelerating the production of fatigue by muscular activity. The extensor digitorum was selected for the tests and a weight ergograph was constructed which measured distance and number of movements initiated by this muscle. The subjects had to perform as many movements as possible to a set cadence over a selected distance. Five different selections of music were used during performances. No significant differences were found between the different selections or between the music and no-music groups. There was, however, an indication that the music tended to delay the onset of fatigue.[23]

Stone also investigated the influence of march tempo music on the riding time of an all-out ride to exhaustion on the bicycle ergometer. Twenty six male volunteers rode to exhaustion twice on the bicycle ergometer at a work load of three kiloponds at 120 beats per minute. March music was added to the experimental group. No significant difference was found between the experimental and control groups, but vast individual differences in response to the music was found.[24]

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[22]Leroy Chipman, "The Effects of Selected Music on Endurance," (unpublished Master's thesis, Springfield College, 1966), p. 2.

[23]Norman Berger, "The Effect of Music on Fatigue Produced by Muscular Activity," (unpublished Master's thesis, International Young Men's Christian Association College, 1952), p. 8.

[24]William J. Stone, "The Influence of Music on Aerobic Work," Arizona Journal of Health, Physical Education and Recreation, 14:19, Fall, 1970.

Hyatt subjectively analyzed the effects of music in the locker room upon high school football players. He felt that music helped relax the players, helped develop a higher level of morale and tended to develop team spirit. He also noted a higher level of enthusiasm.[25]

Morehouse and Miller discussed the environmental stimulus of cheering upon performances of individuals. They concluded that "cheering strengthened movement and extended endurance by raising the threshold of sensitivity to fatigue."[26]

Coutts investigated the after effects of music on pulse rates and work output of short duration. Fifteen male subjects participated in his study for a duration of five weeks with testing three days per week. Treatment included three periods, two music periods and one no-music period. Treatments preceeded an all-out ride on a frictional bicycle ergometer with the tester timing each performance. No significant effect was found on either pulse rates or work output.[27]

Vallerga investigated the effects of varied sound intensities upon the net speed of arm movement and the force of muscular contraction. Sound intensities of 45, 65 and 85 decibels were administered to 36 subjects. Each subject made thirty responses to each of the sound intensities. During the responses, speed of lateral

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[25]Ronald Hyatt, "Music in the Dressing Room," Athletic Journal, 41:28, May, 1961.

[26]Laurence E. Morehouse and Augustus T. Miller, Physiology of Exercise (5th ed., Saint Louis: C. V. Mosby Company, 1967), p. 238.

[27]Curtis A. Coutts, "Effects of Music on Pulse Rates and Work Output of Short Duration," Research Quarterly, 36:17, 1965.

arm movement and force of contraction were measured. The results indicated that the loud intensity sound produced the fastest speed of movement but the soft sound produced a faster time than the medium sound. However, the medium sound produced the greatest force of muscular contraction while the loudest sound produced the second greatest force and the soft sound produced the least force.[28]

Zimny and Weidenfeller investigated the effects of music upon galvanic skin response and heart rate. Eighteen subjects listened to six minute portions of three music selections judged as exciting, neutral and calming. Each subject listened quietly to the three different selections at which time galvanic skin response and heart rate were recorded. No significant change in heart rate was found during any of the selections, but a significant difference in galvanic skin response was noted between exciting and calming music and between exciting and neutral music. The authors concluded that exciting music had an emotional impact upon individuals.[29]

Ellis and Brighouse studied the effects of three musical selections upon the heart rate and respiration of 36 college students. A treatment-by-subjects design was followed and a 24 hour period

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[28]John M. Vallerga, "Influence of Perceptual Stimulus Intensity on Speed of Movement and Force of Muscular Contraction," Research Quarterly, 29:93-101, March, 1958.

[29]George H. Zimny and Edward W. Weidenfeller, "Effects of Music Upon GSR and Heart-Rate," American Journal of Psychology, 76:311-314, June, 1963.

separated each 30 minute testing period. Each subject sat quietly listening to each of the musical selections during which heart rate and respiration were recorded. The results showed that significant increases occurred in respiration while listening to exciting music but no significant change occurred in heart rate.[30]

Summary

The relationship between music and physical performance is not conclusive. Some studies have found significant changes in strength, speed, learning of motor skills, form and work output with use of music.[31, 32, 33, 34] Many studies show no significant relationship between music and endurance.[35, 36, 37, 38, 39, 40] However, these same studies noted slight increases in endurance performance with music and vast individual responses to music.[41, 42, 43, 44]

Studies related to the physiological responses to music indicate significant changes in galvanic skin response and respiration

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[30] Douglas S. Ellis and Gilbert Brighouse, "Effects of Music on Respiration and Heart-Rate," The American Journal of Psychology, 65:39-47, January, 1952.

[31] Vallerga, loc. cit.

[32] Beisman, loc. cit.

[33] Dillon, loc. cit.

[34] Brubaker, loc. cit.

[35] Nelson, loc. cit.

[36] Nelson and Finch, loc. cit.

[37] Chipman, loc. cit.

[38] Berger, loc. cit.

[39] Stone, loc. cit.

[40] Coutts, loc. cit.

[41] Nelson, loc. cit.

[42] Chipman, loc. cit.

[43] Berger, loc. cit.

[44] Stone, loc. cit.

during administration of music but no significant change in heart rate.[45, 46]

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[45]Zimny and Weidenfeller, loc. cit.

[46]Ellis and Brighouse, loc. cit.

CHAPTER III

METHODS AND PROCEDURES

Source of the Data

The investigator met with basic instruction classes of physical education for women for the 1971 spring semester at South Dakota State University, explained the purpose of the study and called for volunteers to participate in an endurance event employing various types of music. Only volunteers who were not participating in classes which might improve their endurance status were accepted as possible subjects. Fifty freshman women volunteered for the study and by entering the table of random numbers, twenty six were chosen for subjects in this study.

Organization of the Study

An orientation period was held prior to the five testing periods to familiarize the subjects with the test and testing procedure. The study was explained to each subject and a sample bout on the bicycle ergometer was administered. At the same time, each subject signed up for a specific day of the week and time of the day for testing which was to be given two weeks later.

Five testing periods, each separated by two weeks, were scheduled beginning February 15, 1971 and ending April 28, 1971.

A treatment-by-subjects design was followed with each subject receiving each treatment. When the subject reported to the human performance laboratory, she was randomly assigned one of the

TABLE I

PHYSICAL CHARACTERISTICS AND TREATMENTS FOR EACH SUBJECT

Subject	Age	Height	Weight	Tests 1	2	3	4	5
N. D.	19	5'6"	126	A*	D	C	B	X
C. F.	18	5'5"	129	C	D	A	X	B
G. G.	19	5'8"	142	C	D	X	B	A
J. S.	19	5'2"	102	A	X	B	D	C
S. R.	19	5'4"	112	A	X	D	B	C
B. P.	19	5'4"	112	B	D	X	C	A
D. B.	20	5'6"	134	A	B	X	C	D
J. J.	19	5'5"	131	C	B	A	X	D
P. P.	18	5'1"	101	B	D	X	C	A
J. S.	19	5'2"	101	C	X	D	B	A
K. W.	19	5'3"	111	B	C	D	A	X
D. R.	19	5'6"	119	D	B	X	C	A
D. M.	18	5'6"	123	A	B	X	C	D
B. B.	20	5'6"	117	A	B	C	D	X
M. H.	19	5'4"	157	D	B	C	A	X
J. H.	19	5'6"	129	D	C	B	A	X
P. T.	19	5'3"	109	A	D	C	X	B
M. A.	18	5'9"	163	C	X	D	B	A
J. K.	20	5'4"	103	B	C	A	D	X
P. P.	19	5'2"	102	B	C	A	D	X
D. F.	19	5'5"	130	B	C	X	A	D
D. L.	20	5'1"	128	X	B	D	A	C
T. W.	18	5'3"	105	C	X	A	B	D
L. P.	19	5'4"	127	D	C	X	B	A
D. D.	18	5'4"	132	B	A	C	D	X
L. E.	19	5'7"	141	C	B	A	D	X

*Treatment A---march music
Treatment B---classical music
Treatment C---electronic music
Treatment D---popular music
Treatment X---no music control

treatments by the "Track Pillbox" method. The random rotation of treatments and two week separation of consecutive testing periods were utilized to prevent and/or nullify any learning which may have occurred between tests. Table I indicates the order in which the subjects took the treatments as well as physical and chronological characteristics.

Administration of Treatment

Music treatments were administered during four of the five testing periods. One period was a control period with no music. The treatments consisted of listening to four different types of music while performing an endurance test on a bicycle ergometer. These types included type "A", type "B", type "C", and type "D" music. A complete description of the types of music used in this study appears in Appendix C.

Type "A" music included selections of march music with a dominant tempo above 125 beats per minute; these selections were Sousa's "Stars and Stripes Forever," Paisiello's "Marche du ler Consul," the "Salut des Aigles," and the "Pas candence des Sana-Culottes."

Type "B" music included classical selections with a tempo between 40 and 80 beats per minute. These were "Moonlight Sonata" by Beethoven, "Andante from Concerto No. 21" by Mozart and "Air of the G String from Suite No. 3 in D Major" by Bach.

Type "C" music included high intensity electronic music with no definite tempo. Selections from "Night Music" by Richard Maxfield and "I of IV" by Pauline Oliveros were used.

Type "D" music consisted of the top six songs on the current popular music charts; they were "Lonely Days" by the Bee Gees, "Stoney End" by Barbra Streisand, "My Sweet Lord" by George Harrison, "Black Magic Woman" by Santana, "Knock Three Times" by Dawn and "One Less Bell To Answer" by The 5th Dimension.

Collection of Data

The purpose of this study was to determine the effects of four different types of music upon performance of an endurance event. The endurance event chosen was riding a Monark bicycle ergometer for a ten minute period with a resistance of 1.5 kilograms at a rate determined by each subject. The criterion was the distance covered in the ten minute period.

A Huret odometer was used to measure the distance pedaled. The units on the odometer were recorded prior to and following the endurance ride. Distance was determined by calculating the difference between the pre-ride and post-ride units.

The music was pre-recorded on 271 magnetic tape cassettes with a Sony 127 stereo cassette recorder at a recording volume of 50 decibels. During administration of the music, the music was played back through a Newcomb stereo at a volume of 25 decibels. The speakers were located behind and off to either side of the subject. The same volume and location were maintained throughout the study.

When the subject reported to the laboratory, the investigator randomly selected the music treatment by the "Track Pillbox" method

and adjusted the bicycle seat to a height so that the legs of the subject were completely extended at the bottom of the cycle. The same seat height and bicycle ergometer were used during each testing period. The investigator then instructed the subject to mount the bicycle and remain seated with her feet on the foot rests until instructed to begin pedaling. The investigator turned on the selected music and waited two to three minutes before instructing the subject to "ride as far as you can in ten minutes after I say "GO". The investigator counted the subjects' pulse at the carotid artery for fifteen seconds prior to the ride. Upon cessation of the pulse count, the subject was instructed to begin pedaling with the command "GO". The investigator immediately set the resistance on the bicycle ergometer at 1.5 kilograms and took a seated position behind the subject. The investigator remained out of the subject's view during the entire ten minute endurance ride. During the ride, pulse counts were taken for fifteen seconds at the end of the third, sixth and ninth minutes of exercise. Upon completion of the last pulse count the subject was instructed to stop pedaling with the command "STOP" and place her feet back on the foot rests.

There was no motivation of the subject in any form before, during or after the performance. The subject did not gain knowledge of the results until after completion of all testing periods. The odometer was covered so that the subject could not tell how far or how fast she was going. Only the investigator and the subject were in the laboratory during the testing period.

CHAPTER IV

ANALYSIS AND DISCUSSION

Organization of the Data

The purpose of this study was to objectively determine the effects of four different types of music and no music upon selected parameters during performance of an endurance event.

The data presented in this chapter were organized in a manner which facilitated the analysis of the differences for selected parameters which occurred between the means of each of the five treatments. An F ratio was computed to determine the significance of the difference among the groups. The computational procedure followed to determine each F ratio was a Treatment-by-Subjects Design.[1] When an F ratio was significant, a T value was computed using Tukey's method for comparing all pairs of means to find where the differences were located.[2] An F ratio was considered significant when it met the .05 level of confidence.

Analysis of the Data

The raw data from the selected parameters on each of the five treatments were used to compute the means for each of the treatments (Table II).

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[1]James L. Bruning and B. L. Kintz, Computational Handbook of Statistics (Glenview, Illinois: Scott, Foresman and Company, 1968), pp. 44-47.

[2]Jerome C. Weber and David R. Lamb, Statistics and Research in Physical Education (Saint Louis: The C. V. Mosby Company, 1970), pp. 109-111.

TABLE II

TABLE OF MEANS

Parameter	Treatments* A Mean	B Mean	C Mean	D Mean	X Mean
Distance (kilometers)	3.88	3.66	3.80	3.90	3.86
Pre-test Heart Rate (per 15 seconds)	20.88	21.15	20.38	20.38	20.65
Three minute Heart Rate (per 15 seconds)	39.34	38.69	36.88	39.57	37.00
Six minute Heart Rate (per 15 seconds)	46.19	43.96	39.84	44.11	39.42
Nine minute Heart Rate (per 15 seconds)	49.65	48.42	42.38	50.07	41.88

*A refers to march type music
B refers to classical type music
C refers to electronic type music
D refers to popular type music
X refers to no music control

TABLE III

ANALYSIS OF VARIANCE OF THE CHANGE IN TREATMENT MEANS OF SELECTED PARAMETERS BETWEEN TREATMENTS A, B, C, D AND X

Parameter	Source	SS	df	ms	F*
Distance (kilometers)	Total	90.71	129	--	--
	Subjects	78.79	25	--	--
	Treatments	.93	4	.23	2.09
	Error	10.99	100	.1099	--
Pre-test Heart Rate (per 15 seconds)	Total	1,160	129	--	--
	Subjects	685	25	--	--
	Treatments	12	4	3.00	.647
	Error	463	100	4.63	--
Three Minute Heart Rate (per 15 seconds)	Total	5,368	129	--	--
	Subjects	3,852	25	--	--
	Treatments	172	4	43	3.19
	Error	2,242	100	13.44	--
Six Minute Heart Rate (per 15 seconds)	Total	9,049	129	--	--
	Subjects	5,903	25	--	--
	Treatments	902	4	225.50	10.05
	Error	1,344	100	22.42	--
Nine Minute Heart Rate (per 15 seconds)	Total	11,180	129	--	--
	Subjects	6,414	25	--	--
	Treatments	1,682	4	420.50	13.63
	Error	3,084	100	30.84	--

*$F_{.05}$ (4/100) = 2.48

$F_{.01}$ (4/100) = 3.51

Table III indicates that there was no significant difference among the treatments in distance pedaled during each of the performance tests. Also, Table III indicates that there was no significant difference among the treatments in the heart rates taken before the endurance rides.

TABLE IV

TUKEY'S METHOD OF DETERMINING THE LOCATION OF SIGNIFICANT DIFFERENCES BETWEEN TREATMENTS A, B, C, D AND X IN THREE MINUTE HEART RATE

Means	36.88	37.00	38.69	39.43	39.57
(D) 39.57	**2.69	**2.57	.88	.14	--
(A) 39.43	**2.55	*2.43	.74	--	
(B) 38.69	*1.81	1.69	--		
(X) 37.00	.12	--			
(C) 36.88	--				

**$T_{.01}$ = 2.52

*$T_{.05}$ = 1.78

Table III indicates that there was a significant difference in three minute heart rate among the five treatments at the .05 level of confidence. The Tukey method for comparing all means located the significant differences.[3] The heart rate during the third minute of exercise for treatments D and A was significantly higher at the .01

[3] Ibid.

level of confidence than the heart rate for treatments C and X. The three minute heart rate during treatment B was significantly higher at the .05 level of confidence than the heart rate during treatment C.

TABLE V

TUKEY'S METHOD OF DETERMINING THE LOCATION OF SIGNIFICANT DIFFERENCES BETWEEN TREATMENTS A, B, C, D AND X IN SIX MINUTE HEART RATE

Means	39.42	39.84	43.96	44.11	46.19
(A) 46.19	**6.75	**6.33	2.21	2.06	--
(D) 44.11	**4.69	**4.27	.15	--	
(B) 43.96	**4.54	**4.12	--		
(C) 39.84	.42	--			
(X) 39.42	--				

**$T_{.01}$ = 3.81

Table III indicates a significant difference in six minute heart rate among the five treatments beyond the .01 level of confidence. Table V locates those differences between treatments A, D and B and treatments X and C, in that treatment A was significantly higher than treatments C and X, treatment D was significantly higher than treatments C and X, and treatment B was significantly higher than treatments C and X.

TABLE VI

TUKEY'S METHOD OF DETERMINING THE LOCATION OF SIGNIFICANT DIFFERENCES BETWEEN TREATMENTS A, B, C, D AND X IN NINE MINUTE HEART RATE

Means		41.88	42.38	48.42	49.65	50.07
(D)	50.07	**8.19	**7.69	1.65	.42	--
(A)	49.65	**7.77	**7.27	1.23	--	
(B)	48.42	**6.54	**6.04	--		
(C)	42.38	.50	--			
(X)	41.88	--				

**$T_{.01}$ = 3.81

Table III indicates a significant difference among the five treatments in nine minute heart rate beyond the .01 level of confidence. Table VI locates the significant differences between treatments D, A and B and treatments C and X, in that treatment D was significantly higher than treatments C and X, treatment A was significantly higher than treatments C and X, and treatment B was significantly higher than treatments C and X.

Discussion of Results

The first criteria measured was the distance performed during administration of music and no music treatments. The results indicated that no significant differences occurred between any of the treatments. Chipman, Nelson, and Nelson and Finch also found that music did not

increase or change performance during endurance type activities.[4, 5, 6] It is interesting to note that this present study as well as other similar studies approached significance when total work output was compared between music and no music environments.[7, 8, 9]

The second criteria measured was heart rate, which was taken during the last fifteen seconds of the third, sixth and ninth minutes of exercise and during the fifteen seconds immediately preceding the endurance event. The results showed no significant differences in pre-test heart rate among the music and no-music treatments. This tends to support the findings of Zimny and Weidenfeller, and Ellis and Brighouse who found that listening to music in a quiet environment had no significant effect upon heart rate.[10, 11] However, during the third,

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[4]Leroy Chipman, "The Effects of Selected Music on Endurance," (unpublished Master's thesis, Springfield College, 1966), p. 2.

[5]Dale O. Nelson, "Effect of Selected Rhythms and Sound Intensity on Human Performance as Measured by the Bicycle Ergometer," Research Quarterly, 34:484, December, 1963.

[6]Dale O. Nelson and Lewis W. Finch, "Effect of Audio-Analgesia on Gross Motor Performance Involving Acute Fatigue," Research Quarterly, 33:588, December, 1962.

[7]Chipman, loc. cit.

[8]Evelyn K. Dillon, "A Study of the Use of Music as an Aid in Teaching Swimming," Research Quarterly, 23:1, March, 1952.

[9]Norman Berger, "The Effect of Music on Fatigue Produced by Muscular Activity," (unpublished Master's thesis, Springfield College, 1952), p. 8.

[10]George H. Zimny and Edward W. Weidenfeller, "Effects of Music Upon GSR and Heart-Rate," American Journal of Psychology, 76:311-314, June, 1963.

[11]Douglas S. Ellis and Gilbert Brighouse, "Effects of Music on Respiration and Heart-Rate," The American Journal of Psychology, 65:39, January, 1952.

sixth and ninth minutes of exercise, the heart rates were significantly higher during treatments A (march music), B (classical music) and D (popular music) than treatments C (electronic music) and X (no music).

Although, there was no significant difference in distance performance during music or no music treatments, there was significant increases in heart rates during music environments with tempo over heart rates during no tempo music (electronic) and no music environments. This difference between performance and heart rates, in that there was no change in distance performed but significant differences in heart rates suggests that endurance performance within a musical environment is inefficient. An explanation for this occurrence may be found in Vallerga's study; he found significant increases in muscular contractions with administration of medium intensity music.[12]

Since there was no significant difference in distance performance between the five treatments, the hypothesis that "there is no significant difference among the five treatments on distance performance of an endurance event," is accepted. And since there was a significant difference in heart rates during performances with treatments A, B and D over treatments C and X, the hypothesis that "there is no significant difference among the five treatments on heart rate before and during an endurance event," is rejected.

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[12]John M. Vallerga, "Influence of Perceptual Stimulus Intensity on Speed of Movement and Force of Muscular Contraction," Research Quarterly, 29:93-101, March, 1958.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to determine the effects of different types of music upon performance of an endurance event. The treatments included (1) march music, (2) classical music, (3) electronic music, (4) popular music and (5) no music.

Twenty six college women were randomly selected from volunteers from freshmen physical education classes. A treatment-by-subjects design was followed and all subjects took all five treatments. The order in which each subject was administered the treatments was randomly assigned.

Distance measured in kilometers and heart rate were the two variables measured in this study. These variables were measured during an endurance event which consisted of riding a bicycle ergometer for ten minutes with 1.5 kilograms of resistance.

The study was completed over a ten week period beginning February 15, 1971 and ending April 28, 1971. Each subject's testing period was separated by two weeks.

Analysis of variance was computed to test the significance of differences among the treatment means. And Tukey's method for comparing means was used to locate significant differences when the F ratio was significant at the .05 level of confidence.

The results revealed that there was no significant difference in mean kilometers pedaled among the five treatments. However, the results approached significance. There was no significant difference in pre-test heart rate among the treatments. However, there was a significant difference in heart rate among the groups' response during the third, sixth and ninth minutes of exercise with treatments A (march music), B (classical music) and D (popular music) having higher heart rates during exercise than treatments C (electronic music) and X (no music).

Conclusions

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

1. Music does not effect differences in endurance performance at the intensity and duration of exercise and the selection of treatments employed in this study.
2. Because of the significantly higher heart rate during exercise in a rhythmical music environment, tempo or rhythm seemingly decreases the efficiency of endurance performance.

Recommendations

The following recommendations are made for further study.

1. Similar studies could be undertaken in which tempo and no tempo environments are investigated.
2. Similar studies could be completed in which the effects of

music upon strength and force of muscular contraction are investigated.

3. Similar studies could be completed with different endurance intensities and longer endurance events.
4. A similar study made employing a longer orientation period.

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APPENDIXES

APPENDIX A

TABLE VII
INDIVIDUAL SCORES FOR TOTAL KILOMETERS PEDALED DURING TREATMENTS A, B, C, D AND X

Subject	A	B	C	D	X
L.E.	3.00	2.75	3.25	2.80	2.95
D.D.	4.05	3.95	4.40	5.10	5.00
L.P.	5.05	4.65	3.90	3.40	4.25
T.W.	3.50	3.70	3.80	3.70	3.65
D.L.	3.65	3.30	3.75	3.75	3.75
D.F.	4.75	4.70	4.70	4.90	4.65
P.P.	3.85	3.05	3.25	4.30	4.00
J.K.	5.00	4.30	4.80	4.95	5.10
M.A.	3.20	3.50	3.25	3.40	3.95
P.T.	4.00	4.00	3.50	3.95	4.40
J.H.	5.10	5.10	4.60	4.10	4.25
M.H.	3.95	3.50	3.70	4.40	4.20
B.B.	3.20	2.70	2.90	3.20	2.80
D.M.	3.50	3.70	3.75	4.20	3.75
D.R.	4.20	3.50	4.25	3.60	3.25
K.W.	3.30	2.60	3.70	3.70	3.15
J.S.	2.10	2.30	2.05	2.20	2.00
P.Pr.	2.60	2.95	3.05	2.75	2.55
J.J.	2.80	2.50	2.60	2.70	2.70
D.B.	4.45	3.75	5.10	5.05	5.00
B.P.	3.40	3.05	3.30	3.65	3.95
S.R.	3.55	3.30	3.35	2.80	3.30
N.D.	4.55	4.75	4.70	4.85	5.00
G.G.	4.55	4.50	4.30	4.70	4.30
C.F.	5.80	5.50	5.20	5.50	5.40
J.S.	3.90	3.70	3.75	3.70	3.30
Means	3.88	3.66	3.80	3.89	3.85

APPENDIX B

TABLE VIII
INDIVIDUAL SCORES FOR PRE-TEST HEART RATES FOR TREATMENTS A, B, C, D AND X

Subject	A	B	C	D	X
L.E.	17	17	16	18	25
D.D.	17	23	16	20	21
L.P.	24	25	27	24	26
T.W.	21	19	19	17	16
D.L.	20	23	19	21	20
D.F.	22	21	18	16	18
P.Pr.	23	24	23	21	26
J.K.	21	19	18	17	17
M.H.	20	20	20	20	20
P.T.	22	25	21	20	18
J.H.	20	18	17	20	19
M.H.	23	23	26	22	22
B.B.	18	23	20	23	21
D.M.	22	20	21	21	20
D.R.	17	19	20	19	19
K.W.	25	20	26	24	21
J.S.	21	22	22	22	21
P.P.	24	22	20	18	16
J.J.	14	15	14	14	14
D.B.	23	23	25	23	23
B.P.	26	24	20	27	24
S.R.	22	21	20	23	20
N.D.	18	25	23	23	23
G.G.	22	23	18	22	21
C.F.	19	19	21	17	28
J.S.	22	17	20	18	18
Means	20.88	21.15	20.38	20.38	20.65

APPENDIX B

TABLE IX
INDIVIDUAL SCORES FOR THREE MINUTE HEART RATES FOR TREATMENTS A, B, C, D AND X

Subject	A	B	C	D	X
L.E.	29	30	29	28	34
D.D.	46	50	42	49	48
L.P.	63	46	41	41	47
T.W.	38	34	41	35	34
D.L.	46	51	42	44	40
D.F.	44	41	39	43	41
P.Pr.	41	41	36	46	38
J.K.	40	30	35	34	37
M.H.	32	32	31	33	35
P.T.	45	48	35	42	40
J.H.	49	51	40	46	42
M.H.	34	41	34	38	35
B.B.	30	36	31	41	33
D.M.	31	32	35	41	31
D.R.	38	38	40	37	36
K.W.	34	33	39	42	37
J.S.	30	30	29	35	33
P.P.	38	30	36	30	28
J.J.	28	27	27	25	21
D.B.	42	38	39	47	39
B.P.	40	36	38	47	39
S.R.	38	34	36	37	34
N.D.	41	49	42	42	43
G.G.	41	45	40	49	40
C.F.	41	46	43	42	43
J.S.	44	37	39	35	34
Means	39.34	38.69	36.88	39.57	37.00

APPENDIX B

TABLE X
INDIVIDUAL SCORES FOR SIX MINUTE HEART RATE FOR TREATMENTS A, B, C, D AND X

Subject	A	B	C	D	X
L.E.	31	35	31	30	36
D.D.	57	52	42	55	45
L.P.	66	46	46	50	49
T.W.	43	39	45	40	40
D.L.	58	51	43	54	43
D.F.	58	46	43	53	45
P.Pr.	46	42	38	51	40
J.K.	48	32	39	36	39
M.H.	32	35	37	34	42
P.T.	57	62	41	50	45
J.H.	54	59	46	52	44
M.H.	37	53	35	49	36
B.B.	39	39	34	46	35
D.M.	34	37	38	40	34
D.R.	44	44	43	37	36
K.W.	40	34	44	44	40
J.S.	30	36	34	31	33
P.P.	36	36	36	32	28
J.J.	29	32	26	27	28
D.B.	49	42	43	49	42
B.P.	61	48	42	51	43
S.R.	44	39	39	35	37
N.D.	54	62	44	58	46
G.G.	55	50	42	57	40
C.F.	49	46	45	45	43
J.S.	50	46	40	41	36
Means	46.19	43.96	39.84	44.11	39.42

APPENDIX B

TABLE XI
INDIVIDUAL SCORES FOR NINE MINUTE HEART RATE FOR TREATMENTS A, B, C, D AND X

Subject	A	B	C	D	X
L.E.	36	35	34	34	38
D.D.	61	61	44	55	49
L.P.	60	59	52	58	51
T.W.	47	46	44	50	39
D.L.	61	62	43	47	43
D.F.	56	55	44	64	47
P.Pr.	55	45	42	57	40
J.K.	51	38	44	41	40
M.H.	35	39	41	37	48
P.T.	55	69	43	62	53
J.H.	60	61	50	60	46
M.H.	44	57	38	51	39
B.B.	44	38	40	45	37
D.M.	44	50	41	56	38
D.R.	46	44	44	48	37
K.W.	45	34	45	59	40
J.S.	36	45	37	36	39
P.P.	42	36	38	35	29
J.J.	35	32	26	29	29
D.B.	54	41	47	55	44
S.P.	51	50	43	60	45
S.R.	53	50	42	36	39
N.D.	58	64	46	60	47
G.G.	50	52	44	70	41
C.F.	61	53	47	60	48
J.S.	54	43	43	37	44
Means	49.65	48.42	42.38	50.07	41.88

APPENDIX C

MUSIC SELECTIONS USED IN STUDY

Type "A" Music

1. "Stars and Stripes Forever." Eugene Ormandy and the Philadelphia Orchestra. Columbia. MS 6934. 33.33 rpm.

2. "Salut des Aigles." The Brass and Percussion Ensembles of Gardiens De La Paix De Paris. Nonesuch Records. H-71075. 33.33 rpm.

3. "Marche du 1er Consul." The Brass and Percussion Ensembles of Gardiens De La Paix De Paris. Nonesuch Records. H-71075. 33.33 rpm.

4. "Pas cadence Sana-Culottes." The Brass and Percussion Ensembles of Gardiens De La Paix De Paris. Nonesuch Records. H-71075. 33.33 rpm.

Type "B" Music

1. "First Movement from Sonata No. 14 in C-Sharp Minor, Op. 27, No. 2." Philippe Entremont. Columbia. MG 30074. 33.33 rpm.

2. "Andante from Concerto No. 21 in C Major." Robert Casadesus. Columbia. MG 30074. 33.33 rpm.

3. "Air on the G String from Suite No. 3 in D Major." The Marlboro Festival Orchestra. Columbia. MG 30074. 33.33 rpm.

Type "C" Music

1. "Night Music." Richard Maxfield. Odyssey. 32 16 0160. 33.33 rpm.

2. "I of IV." Pauline Oliveros. Odyssey. 32 16 0160. 33.33 rpm.

Type "D" Music

1. "Knock Three Times." Dawn. Bell Records. 9762. 45 rpm.

2. "Black Magic Woman." Santana Abrazas. Columbia. 4-45270. 45 rpm.

3. "My Sweet Lord." George Harrison. Apple Records. 2995. 45 rpm.

4. "Stoney End." Barbra Streisand. Columbia. 4-45236. 45 rpm.

5. "Lonely Days." Bee Gees. Atco Records. 45-6795. 45 rpm.

APPENDIX C (continued)

6. "One Less Bell." The 5th Dimension. Bell. 940. 45 rpm.