ABSTRACT

ZILONKA, E. M. Effect of music programming on walking velocity. MS in Adult Fitness/Cardiac Rehabilitation, December 1999, 26pp. (C. Foster)

Commercially available musical tapes purport an ability to program walking velocity. One set of tapes was evaluated to examine if listeners walked at indicated velocities. Subjects (N = 15) were healthy, female, university students (age 18-37), with a mean VO_{2peak} of 37.7 ± 5.0 ml/kg/min. Each performed 4 randomly ordered walking bouts of 30 min (3 with tapes, 1 without). Personal preference determined musical style (classical, broadway, or march), and programmed velocities ranged from 3.6-4.0 mph. Average velocity was measured by videotaping sessions on a 200 m indoor track. HR was measured by radiotelemetry. For programmed velocities of 3.6, 3.8, and 4.0 mph and unprogrammed trials, the observed average velocities were 3.85 ± 0.33, 3.81 ± 0.20, 3.69 ± 0.35, & 3.89 ± 0.30 mph respectively. Mean overall programmed vs. actual velocity was not significantly different. However, the correlation between programmed and observed velocity was r = 0.22, and the regression line was nonparallel to the line of identity. An "enjoyment" index obtained after each bout indicated that walking was more enjoyable with tapes (3.0 ± 1.0, 3.2 ± 0.8, 3.1 ± 0.9, & 3.7 ± 1.0 for 3.6, 3.8, 4.0 mph, and unprogrammed respectively). It is concluded that programmed walking tapes do not elicit the indicated speed from listeners; however, they may make walking more enjoyable.

EFFECT OF MUSIC PROGRAMMING ON WALKING VELOCITY

A MANUSCRIPT STYLE THESIS PRESENTED

TO

THE GRADUATE FACULTY

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Candidate: Elaine M. Zilonka

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The candidate has successfully completed the thesis final oral defense.

Thesis Committee Chairperson Signature — Date: 6/8/99

Thesis Committee Member Signature — Date: 6/8/99

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Thesis Committee Member Signature — Date: 6/8/99

This thesis is approved by the College of Health, Physical Education, and Recreation.

Associate Dean, College of Health, Physical Education, and Recreation — Date: 6-21-99

Director of University Graduate Studies — Date: 6-21-99

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TABLE OF CONTENTS

LIST OF APPENDICES

INTRODUCTION

Music is widely used in conjunction with exercise by physical activity participants. This is evidenced by the music that is played on speaker systems in fitness centers as well as by those who exercise with personal cassette players. Music has several uses in exercise including creating a pleasing environment, acting as a motivational tool, and as a technique to prevent boredom. As the fitness industry continues to grow, the consumer is continually presented with new products. One recent line of products to enter the market are musical cassette tapes that are purported to elicit a specific velocity during walking by users. In order to determine whether such tapes are, in fact, useful to the general population, the relationship between music and exercise needs to be further investigated.

Music has been said to elicit changes in several physiological and psychological v··iables during exercise. Studies have shown that when submaximal exercise was combined with music, a greater work output was accomplished with fewer reports of fatigue, and the music narrowed the listener's attentional focus (9). However, the relationship between heart rate, rating of perceived exertion (RPE), and music during exercise is not clearly defined. One study demonstrated that slow music was associated with a higher peak heart rate, lower RPE, and longer exercise times than when listening to fast music or no music (5). In contrast, other investigations have shown no

relationship between heart rate, RPE, and music (1, 6, 10, 12). There are numerous factors that effect one's walking pace including height, step length and frequency, orthopedic limitations, and intrinsic motivation and attentional demand. Studies have shown a positive correlation between height and walking velocity (3, 7). In addition to physical characteristics, variations in walking velocity have been attributed to greater changes in step length as compared to step frequency (8).

Few studies have been completed to evaluate the possibility that music can elicit a particular speed from its listener. The previously cited studies conflict in important ways relative to the effects of music on exercise. If for no other reason than creating a pleasing environment, music remains a popular adjunct to exercise. If a relationship does exist where the tempo of music could be used to program walking pace, then music could become an essential training tool for all who participate in exercise activities.

Accordingly, the intent of this study was to evaluate the ability of commercially available walking tapes to "program" a walking pace in fitness walkers. It was hypothesized that because there are numerous factors influencing one's walking velocity, programmed walking tapes would not be able to elicit the indicated velocity from the listener.

METHODS AND PROCEDURES

Fifteen women with a mean age of 22 ± 5 were recruited to participate in the study. All were apparently healthy, based on the AHA/ACSM questionnaire designed to identify occult health problems (2). All subjects provided informed consent prior to

participation, and the study had been approved by the University of Wisconsin-La Crosse Institutional Review Board (see Appendix A). In order to characterize the subjects, each performed incremental treadmill exercise to determine VO_{2peak} (37.7 ± 5.2 ml/kg/min) and maximal heart rate (193 ± 10 bpm). Leg length was also obtained by subtracting sitting height from standing height, and the mean was 82 ± 4 cm (11).

Testing was conducted on an indoor track. Three sets of musical cassette tapes were obtained from Sports Music, Inc. (Roswell, GA) for use in this study. There were three genres of music (classical, march, and broadway), and each subject chose a musical genre that conformed to their personal taste. Each musical genre had three tapes, purported by the manufacturer to program walking velocities of 3.6 mph (1.61 m/s), 3.8 mph (1.70 m/s), and 3.9 mph (1.74 m/s), or 4.0 (1.8 m/s). The subjects were not informed that the tapes were pre-set to correspond to a certain velocity. Instead, they were informed that the researcher was testing the music's effect on the enjoyment of walking. They also completed a questionnaire with Likert scaling concerning this aspect of music and walking.

Each subject walked for 30 minutes at a self-selected pace either without music or while listening to one of the three tapes. The order of presentation of the four trials was random. Heart rate was recorded throughout each bout using radiotelemetry (Polar XL). Ratings of perceived exertion (RPE) was also recorded at 5 minute intervals during the walk using the category ratio scale of Borg (4).

Each subject was videotaped at 5 minute intervals to determine average velocity. A video camera was placed 19.5 m from the first lane in the center of a 200 m indoor track. When analyzing the videotapes, the time elapsed between two external reference points was recorded. This time was divided into the distance between these two external points (29.7 m) to obtain the subjects' velocity.

The videotapes were also used to calculate step frequency. The number of steps was counted and recorded during a 10-11 second interval. The exact time, to hundredths of a second, was recorded. When counting and timing, the first step started with the heel strike of the left foot and was recorded as zero. The last step and the end of the 10-11 second time interval also ended with a heel strike with the left foot. Lastly, in order to maintain the deception required to test the ability of the tapes to program walking velocity, a questionnaire inquiring about the enjoyment of each bout was administered (see Appendix B).

For data analysis, a two-tailed, paired t-test was used to compare the programmed tape velocity with the actual velocity of the walker. Correlations were also used to establish the relationship between the cassette tapes and the subjects' actual velocity.

RESULTS

Table 1 summarizes the subjects' mean values for actual velocities, step frequencies, percentages of maximal heart rate, step lengths, RPE, and enjoyment as compared to the programmed velocity on the cassette tapes. The velocities of the subjects as they walked and listened to the tapes did not correlate to the programmed

velocity (r = 0.220). Additionally, Figure 1 shows that the regression line between programmed and observed walking velocity produced a line nearly 90 degrees away from the line of identity. Results of a paired, two-tailed t-test indicated that there was no significant difference ($p > 0.05$) between the average velocity (3.785 ± 0.089 mph) over all trials and that which is programmed on the cassette tapes (3.789 ± 0.025 mph).

Table 1. Programmed Velocity and Measured Variables

Variables	Programmed Velocity			
	3.6 mph 1.61 m/s	3.8 mph 1.70 m/s	3.9/4.0 mph 1.74/1.80 m/s	No Music
Actual Velocity (mph)	3.85 ± 0.33	3.81 ± 0.20	3.69 ± 0.35	3.89 ± 0.30
Actual Velocity (m/s)	1.72 ± 0.04	1.70 ± 0.09	1.65 ± 0.16	1.74 ± 0.13
Step Frequency (steps/min)	63.6 ± 3.0	62.9 ± 3.3	62.4 ± 2.9	63.8 ± 3.9
Step Length (m/step)	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1
% HR max	64.9 ± 4.8	64.9 ± 4.5	64.3 ± 4.4	66.3 ± 6.1
RPE	11.5 ± 1.7	11.9 ± 1.8	11.8 ± 2.0	11.8 ± 1.9
Enjoyment (Scale: 1-7)	3.0 ± 1.0	3.2 ± 0.8	3.1 ± 0.9	3.7 ± 1.0

There was no difference in RPE and step length throughout the walking trials with and without music. Percentage of maximal heart rate and step frequencies were not

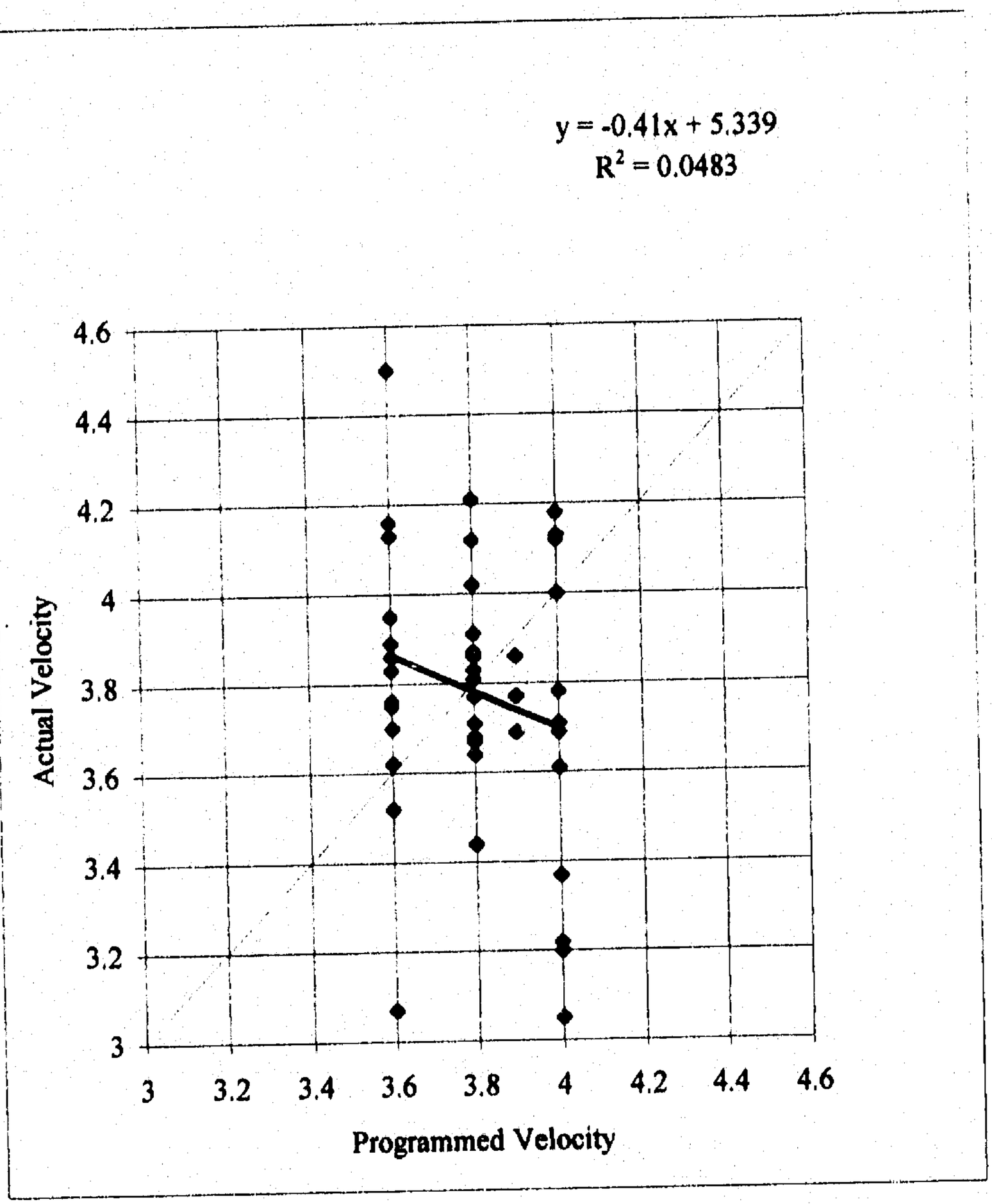

Figure 1. Regression of Programmed and Actual Velocities

statisitcally different in all trials. The enjoyment questionnaire, with a scale of one to seven, showed that walking with music was more enjoyable (3.1 ± 0.1) than when walking without music (3.7 ± 0.9). Thus, the main finding of this study was that velocity of programmed musical cassette tapes does not elicit the indicated velocity from its listeners. However, they do provide a more enjoyable walking experience for the user.

DISCUSSION

The subjects' walking velocity did not correlate with the programmed tape velocities, and the other variables were essentially unaffected by the musical cassette tapes. The music trials did not elicit higher heart rates than non-music trials and RPE was unchanged, in agreement with previous findings (1, 6, 10, 12). However it does contrast with one study which indicated that music can elicit higher peak heart rates and lower RPE (5). It should also be noted that step length did not change. Step frequencies are not statistically different, but they do follow the pattern of velocity changes that occurred in the walking trials. This contrasts with previous investigations that indicated changes in walking velocities can be attributed to step length (8).

Walking with programmed musical cassette tapes does elicit a more enjoyable walk for the listener. This may be similar to previous results which state that music can decrease reports of fatigue and narrow attentional focus (9).

There are several factors that could have influenced the outcome of this study. There may be error in the calculation of velocity and step frequency because of the

variability that can occur in timing with a stop watch. To obtain velocity, the use of electronic eyes or step pads would be advised for future research. It should also be noted that there are several corporations that market programmed walking tapes, and only one line of products was tested in this investigation. A comparison between all products in the market, and an analysis of characteristics such as tempo, would be advised before drawing definitive conclusions.

In summary, programmed cassette tapes do not accomplish what they purport. Consumers of these tapes are misled to believe that when listening to the tape, they will walk at the indicated velocity. Additionally, other variables such as percentage of maximal heart rate and RPE seem to be unaffected by music. Although programmed cassette tapes do not elicit the indicated speed from all of listeners, they may be useful when one simply desires a more enjoyable walking experience.

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APPENDIX A

INFORMED CONSENT

THE EFFECT OF MUSIC ON PROGRAMMING WALKING VELOCITY

I, _____, give my informed consent to participate in a study conducted to examine the relationships between music and walking. I have been informed that I will be walking for a total of 30 minutes on four different occasions. During some of these sessions, I will choose music of my preference from tapes pre-selected by the researchers.

I have been informed that throughout the study, my identity and the results of my performance will be kept confidential. I am aware that the possibility of publication exists, and in this case, my personal information and identity will also be kept in confidence.

During my participation in this study, I have been informed that my heart rate will be recorded by using a monitor that will be strapped to my chest. Minor discomfort is a possibility from the strap on the monitor; however, it should not impair my ability to walk. I have been informed that I will be walking on an indoor track on four separate occasions. I will be free to walk at a self-selected speed for 30 minutes during each of the four sessions. I have been informed that during three of the four sessions I will be able to choose music of my own preference from a set of tapes selected by the researcher. When listening to the music, I will use a personal cassette player supplied by the researcher, and the music will be set at a comfortable volume. I am also aware that I will be videotaped during my walking, and I will also take a sub-maximal aerobic capacity test on a treadmill. Video tapes of me, without individual identification, may be used in the presentation and dissemination of results.

I have been informed that there are risks involved in this study. I am aware that it is possible that I may experience dizziness, shortness of breath, orthopedic discomfort, and theoretically, major complications such as a heart attack, may occur during the testing process. The risk of serious complications is expected to be less than one per 10,000 tests. To my knowledge, I am not aware of any disabilities of health problems that would interfere with my participation in this study.

While I expect no personal benefits from the study, I have been informed that the information gained may be useful in helping to understand how music may be best used to facilitate exercise programs.

I am aware that all testing sessions will be scheduled at my convenience. I am also aware that I may choose to end my participation in the study at any time without any

penalty. I have been informed that the study is being conducted by Elaine Zilonka, a graduate student at the University of Wisconsin-Lacrosse, and she can be contacted at (608) 785-0590.

I have read the above statements and understand them entirely. All questions of which I have concern have been answered fully. I am aware that further questions may also be directed towards the faculty advisor for this project, Dr. Carl Foster, at (608) 785-8687. Questions regarding the protection of human subjects may be addressed to Dr. Garth Tymeson, UW-La Crosse Institution Review Board at (608) 785- 8155.

_____ Date:_____
Elaine Zilonka, Researcher

_____ Date: _____
Participant

APPENDIX B

ENJOYMENT QUESTIONNAIRE

Enjoyment Evaluation

Please answer the following survey in regard to the extent to which you enjoyed your walking session. After each statement, there will be numbers representing your agreement with what has been stated. For example, if you strongly agree with the statement, circle number one. If you are indifferent or have no opinion, then circle number four.

1. Walking with music would be more enjoyable than walking without music.

1	2	3	4	5	6	7
strongly agree	agree	somewhat agree	no opinion	somewhat disagree	disagree	strongly disagree

2. At the end of the thirty minute session, I was not bored.

1	2	3	4	5	6	7
strongly agree	agree	somewhat agree	no opinion	somewhat disagree	disagree	strongly disagree

3. I felt like I had a good walking rhythm.

1	2	3	4	5	6	7
strongly agree	agree	somewhat agree	no opinion	somewhat disagree	disagree	strongly disagree

4. I was able to concentrate on my exercise session.

1	2	3	4	5	6	7
strongly agree	agree	somewhat agree	no opinion	somewhat disagree	disagree	strongly disagree

5. I found myself undistracted during the session.

1	2	3	4	5	6	7
strongly agree	agree	somewhat agree	no opinion	somewhat disagree	disagree	strongly disagree

Rating of Perceived Exertion

In the following scale, please circle the number that best represents "how hard you worked" during this exercise session. The number 6 would be similar to sitting and watching television, and the number 20 would be running at full speed.

6
7 very very light
8
9 very light
10
11 light
12
13 somewhat hard
14
15 hard
16
17 very hard
18
19 very very hard
20

APPENDIX C

RELATED LITERATURE

Introduction

The effects of music on exercise have been studied since the turn of the 20th century. There is, however, controversy concerning the psychophysiological effects that music can have on one who engages in aerobic activity. Additionally, the factors that affect one's self-selected walking speed have been greatly researched. Unfortunately, little research has been conducted on the overall relationship between music, exercise, and self-selected walking speed. The following review of literature related to these areas will examine the possible relationships that exist between these variables.

Relationship Between Music and Exercise

The relationship that exists between music and exercise has been greatly investigated within the past 20 years. Several areas have been researched concerning this relationship including psychological and physiological factors that result concerning the implementation of music to an exercise session.

Psychological Effects

Several studies have concluded that music can have a profound psychological impact on its listener. One of the major conclusions by one study was that music can narrow the listener's attentional focus and actually divert attention away from outside distractions and sensations of fatigue (8). It was also stated that at any given moment in time, the amount of information processed by an individual is extremely

limited. In addition to narrowing one's focus, it was stated that music can inhibit certain psychological feedback that would signal fatigue in those who exercise. Furthermore, another study stated that during high intensity activities, physiological signs from one's body most greatly influences their performance (10). However, at a lower, submaximal intensity, the external cues from the environment, such as music, can have a greater effect on one's performance.

An individual's personal interpretation of music, rather than the aspects of the musical piece itself, can largely determine the psychophysiological responses of a person (8). Though little has been researched concerning one's interpretation of music and its relation to exercise, it has been stated that the degree to which one is familiar with a particular piece of music will have a large influence upon the arousal level that the music elicits from the listener.

Music and rhythm's influence on human movement was studied as early as 1902 by MacDougal. In his investigation, (as cited in Anshel & Marisi) it was stated that rhythms are appealing to individuals because it is similar to the forms that are naturally seen in physical activity (1). It was also noted that the human body is predispositioned to have a need for rhythmical movement. Since MacDougal's publication, it has been shown that rhythm is a necessity when acquiring motor skills and performing them with accuracy. However, there has been little investigation as to the effects of rhythm, as supplied by music, on exercise.

Physiological Effects

Music has been researched in several studies to determine its effect on physiological variables such as Rating of Perceived Exertion (RPE) and heart rate. Copeland and Franks studied 24 students using three different types of music categories while exercising on a treadmill to voluntary exhaustion (4). It was determined that slow music elicited a higher peak heart rate, lower RPE, and allowed the subjects to exercise longer than when listening to fast music or no music. The researchers further stated that their study could imply that music, if slow, can cause individuals to exercise for longer periods of time than fast music or no music. However, the findings of an increased peak heart rate with slow music are contradicted by other studies.

Abraham and Thomas studied female college students who listened to music and walked on a treadmill at a self-selected, submaximal intensity (2). The subjects performed three, 45 minute duration walking trials while listening to no music and fast and slow tempo music. Music did not alter heart rate, RPE, or self-selected treadmill speed and grade. However, music did elicit a higher intensity, expressed as a percentage of VO_{2max}.

Two thesis studies have been conducted concerning music and exercise, and they will be discussed due to the lack of published research on this topic. Ferguson examined two different types of music on exercise to investigate their effects on heart rate and blood pressure (5). A bicycle ergometer was utilized during a submaximal test on college-aged students, and he tested the subjects without music, and with sedative and

stimulative music. Blood pressures and heart rates were recorded throughout the sessions and during recovery. It was concluded that the music did not have an effect on heart rate during exercise or recovery. Additionally, diastolic blood pressures showed no change from the music; however, systolic blood pressure was slightly higher during exercise and recovery when subjects were exposed to the sedative music.

Lee conducted a thesis study on the effects of no music, upbeat music, and baroque music on college-aged students (9). The upbeat music was set at 152 bpm, and the baroque was set at 60 bpm. Additionally, the music was free of lyrics in an attempt to avoid further distractions that could affect the outcome of the study. The subjects ran at 70% of their maximum aerobic capacity for 25 minutes while experiencing one of the aforementioned musical conditions. Heart rate, stride rate, and RPE were recorded throughout the testing. Lee concluded that heart rate and stride rate were not influenced by the varying musical tempos. It was also stated that RPE did not change when the subjects were exposed to the different musical conditions.

A similar study was conducted to investigate the effects of fast tempo music and no music on a submaximal bicycle ergometer test (11). The subjects were 20 college-aged men and women, and during the testing, the researchers recorded values for VO_2, heart rate, and blood lactate. None of the tested variables, including exercise duration, changed significantly as a result of the music. It was concluded that music does not alter performance or physiological parameters, and it was suggested that music has no value as an ergogenic aid for those engaging in exercise training.

The aforementioned studies are in obvious conflict over the effect of music on heart rate responses and other physiological variables. This may be due to the wide variety of music that is available and differences in experimental designs. However, it remains unclear as to the true effects of music on different physiological responses during exercise.

Factors Affecting Self-Selected Walking Pace

There are numerous factors that affect one's walking pace including height, stride length and frequency, orthopedic limitations, and even intrinsic motivation and attentional demand. For example, Kurosawa (as cited by Sekiya, Nagasaki, Ito, and Furuna) investigated various speeds in walkers and concluded that a self-selected pace results in minimal attentional demand as compared to slower and faster paces (12). Some of these factors will be discussed in greater detail according to research that has investigated these variables.

Stride Rate and Stride Length

Walking speed is affected by one's stride length and stride rate. The stride rate is the frequency at which steps are taken when walking. The aforementioned study by Lee examined the relationship between no music, up-beat, and baroque music on stride rates or strides per minute (9). His study concluded that the varying tempos of the different musical genres did not have a significant effect on the subjects' strides per minute. Additionally, when different trials were implemented, the values obtained for strides per minute failed to change significantly between the trials.

A study was also conducted to examined step rate, width, and length without using music as a variable (12). In this study, subjects were instructed to walk at a preferred speed, (fast, fastest, slow, and slowest) and ink pads were placed on the soles of their shoes in order to indicate the step length during walking. Step rate, length, and width were recorded. The study concluded that step length and rate increased with increasing speed; however, the step width remained constant. These results have important implications in understanding what factors influence the speed at which one walks.

Imms and Edholm examined the gait characteristics of 71 subjects ranging in age from 60-99 years old (7). The stride length was measured by metal contacts placed on the bottom of the subjects' shoes. The outcome showed that there were greater fluctuations in the length of the stride as compared to stride rate. It was further concluded that the variations seen in walking speeds in older adults can be attributed to greater changes occurring in stride length as compared to stride rate.

Physical Characteristics

Individual characteristics, such as height or age, can have a large influence on one's self-selected walking pace. A study tested 149 females and 289 males, ranging in age from 20 to 95 years of age, in order to examine the effects of height and age on heart rate and the speed of walking (6). The subjects were asked to walk at three different self-selected paces, and it was concluded that after the age of 62, age accounted for the

variability in walking paces. The researchers also concluded that an individual's height is positively correlated with their speed during walking.

Bassey, McDonald, and Patrick evaluated the relationship between self-paced walking and body composition, sex, and age (3). In the study, 277 subjects, ranging in age from 20 to 65 years of age, walked at three different self-selected paces. Variances in speed among subjects was attributed to height, weight, and sex, and the influence of height and age was greatest at faster paces than slower paces.

Summary

A thorough review of the literature related to music tempos and walking revealed that much research is still needed in this area. When investigating the relationship between walking and music, the researcher must be aware of many variables including psychological and physiological responses, stride rate and length, physical characteristics such as age and height, musical preference, and tempo.

It has been shown that music has an effect on the listener's psychological functioning. Music was shown to narrow one's attentional focus, and it can even divert attention from fatigue at submaximal exercise levels. Off-setting fatigue is a goal of many athletes and recreational exercisers; thus, music may be an asset during training. Additionally, it has been said that human movement is predisposed to have a certain rhythmic element, and perhaps music can aid one's search for rhythm while exercising.

The physiological relationship between walking and music is still unclear. Some researchers concluded that slow music can elicit a higher peak heart rate while a lower

RPE still resulted. Others have found that there is no significant relationship between heart rate and RPE and differing tempos of music. Interestingly, it was said that systolic blood pressure is higher during exercise and recovery when listening to sedative music. It was apparent that more research needs to be conducted in this area for a clear answer regarding the relationship between music and physiological responses.

Research concerning other factors that can affect one's self-selected walking pace was consistent. It has been shown that stride length and stride rate will increase with an increasing walking speed. Within a certain walking pace, it was said that there will be greater fluctuations in stride length as compared to stride rate. Few studies have examined music and step rate and step length; however, it appeared that there was no relationship between these step variables and different tempos. Additionally, research has concluded that taller individuals will have a faster self-selected walking speed than those who are shorter. Age, another factor that affected walking speed, influenced one's variability within a self-selected pace when the individual was greater than 62 years of age.

Isolating one of the aforementioned variables became difficult when an experimental design was examined. The research in this area recognized these limitations, and it was often offered as an explanation for conflicting results. In conclusion, more research is needed concerning music and its impact on every aspect of walking.

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