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How Including Music While Exercising Enhances and Affects the Total Well-Being of an Individual

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HOW INCLUDING MUSIC WHILE EXERCISING ENHANCES AND AFFECTS THE TOTAL WELL-BEING OF AN INDIVIDUAL

A Research Paper

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts

Darci Fuelling

University of Northern Iowa

December 2009

Abstract

This review of literature summarizes findings from 1989-2009 regarding the effects of the inclusion of music during exercise. A few articles included were beyond the 20-year period because the information proved to be relevant and beneficial to this review of literature. The purpose of this paper is to answer the following questions: (1) Why does music affect exercise? (2) How should music be selected in order to gain the most ergogenic potential? (3) Do synchronous and asynchronous movement to music result in similar exercise responses? (4) What is the effect of music on aerobic and anaerobic exercise? (5) What is the psychological effect of music on exercise? Implications for practice and future research are presented.

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Research has shown that physical activity is crucial in maintaining a healthy lifestyle and total well-being. Individuals who participate in regular physical activity benefit in many ways. Hill (2000) states that physiological and cognitive functioning, along with emotional well-being can be improved from frequent fitness activities.

Studies have indicated that individuals exercise harder, spend more time exercising and find it more enjoyable while listening to music than working out in its absence. When music and movement work in unison, the result is an optimal workout experience. Music has shown to be an important "ingredient" in an exercise program. For many it is the heartbeat that stimulates and motivates movement. Exercisers of all ages are able to "lose themselves in the music" and are able to enjoy and engage in the exercise experience. The exerciser has fun and at the same time improves his/her physical fitness. It becomes a win/win situation. It appears that music and movement are a natural combination. We as educators should encourage others to get grooving and moving to the beat!

Iowa state guidelines mandate participation in physical education for every student in the public school system. This mandate, in part, is to encourage students to maintain a healthy lifestyle, which includes lifelong physical activity and fitness, in order to ensure the well-being of an individual. Many students appear to enjoy the physical education experience, but if music were included in the physical education classroom on a regular basis, would it enhance students' experiences (more pleasurable experiences and improved ratings, scores and/or results), ultimately encouraging students to lead lives that include physical activity?

Research has shown that in most cases music can enhance the physical exercise experience. At low and moderate exercise intensities, listening to music can dissociate the feelings of fatigue, discomfort from pain and heavy breathing, enabling the individual to endure for longer periods of exercise (Karageorghis & Priest, 2008). Exercising to music has also shown to improve mood states, lower ratings of perceived exertion (RPE) and increase physical work output (Elliott, Carr, & Savage, 2004; Szabo, Small, & Leigh, 1999; Copeland & Franks, 1991).

Kravitz (1994) states that fitness teachers and coaches may boost their students' and athletes' performance by playing music that will represent the intensity of the upcoming workout or game while the students are entering the workout area. For example, if a team is celebrating an unexpected win, the coach may choose to play music such as "Celebration" by Kool and the Gang or "We Are the Champions" by Queen while the athletes enter the gym and begin to warm-up. On the other hand, if a team is entering the practice space for the final time before an important event, the coach might opt for "I Believe I Can Fly" by R. Kelly or "When You Believe" by Mariah Carey.

The basic question initiating this literature review is: Can music be used as an effective tool in the physical education classroom to increase and enhance an individual's motivation and pleasure while increasing psychological and physiological responses?

Purpose and Scope of the Investigation

The purpose of this literature review was to research and obtain information regarding the effects of including music while exercising. Music may be an untapped source of motivation for sport and exercise participants. Currently, there are exercisers

who are cognitively aware of the effects of music on physical activity – both leisure and competitive sport activities. There are exercisers, however, who may not be aware of the possible benefits to be achieved from the use of music. Further, there are exercise participants who approach the use of music in a haphazard manner, perhaps because they are uneducated in the ways to maximize the ergogenic potential of music. With the knowledge of this research, those unaware may take advantage of the findings and incorporate them into their physical activities in the physical education classroom and during one's personal workout.

The following questions were addressed in this literature review:

- Why does music affect exercise?
- How should music be selected in order to gain the most ergogenic potential?
- Do synchronous and asynchronous movement to music result in similar exercise responses?
- What is the effect of music on aerobic and anaerobic exercise?
- What is the psychological effect of music on exercise?

For each question an opening paragraph summarizes the main findings regarding the question and is followed by the details from the research.

Method

This review of literature includes an analysis and synthesis of published research on the effect of including music on the psychological and physiological responses of participants during physical activity. The articles researched were published over a 20-

year period (1989-2009). A few articles beyond the 20-year period were also included because the information proved to be relevant to this review of literature. Articles in this literature review were included if they met the criterion of associating the inclusion of music with any form of physical activity.

The search for articles commenced with the Educational Resources Information Clearinghouse (ERIC) because it is known as a reliable and valid source for acquiring research. Google and Google Scholar were also used to obtain articles. The descriptors used were: music and exercise, how does music affect exercise, aerobic activity and music, music and the relationship to exercise, music and physical activity and motivation to exercise. The reference lists of articles identified by the ERIC search were used to identify additional articles. A specific search for articles by Costas Karageorghis articles, an author who has done extensive research on the inclusion of music with physical activity, was also performed.

Definition of Terms

Aerobic Exercise - in the presence of oxygen; exercise that can be sustained for longer periods of time

Anaerobic Exercise –"without oxygen;" exercise that demands more oxygen than the heart and lungs can supply

Asynchronous Movement to Music – movement with music without a conscious effort to move to the beat; movement that is performed with background music

Beat of Music – the basic unit of time in music; the pulse

Beats Per Minute (bpm) - a unit typically used as either a measure of tempo in music, or a measure of one's heart rate; a rate of 60 bpm means that one beat will occur every second

Endurance - the ability to maintain exercise and resist fatigue

Ergogenic Aid - any external influence which can positively affect physical or mental performance

Motivational Music – a piece of music that inspires or stimulates physical activity; components of motivational music include a fast tempo (>120 bpm) and strong rhythm, which increase energy and induce bodily action

Oudeterous Music – music that is neither motivating nor demotivating; music that lacks motivational qualities. *Oudeterous* means "neutral" in Greek

Physical Activity – movement of the body that uses energy; for health benefits, physical activity should be moderate or vigorous and add up to at least 30 minutes per day

Physical Exercise – any activity that enhances or maintains physical fitness and overall health

Physical Fitness - a state of health and well-being

Rating of Perceived Exertion (RPE) - a subjective assessment of how hard one is working

> *Central Rating of Perceived Exertion* – derived from sensations of ventilatory rate and depth and cardiovascular function
>
> *Overall Rating of Perceived Exertion* – derived from all musculoskeletal and cardio-respiratory sensations
>
> *Peripheral Rating of Perceived Exertion* – derived from the force and rate of muscular contractions in the leg muscles

Stimulative Music - buoyant music that may prompt the body into joining the rhythm

Synchronous Movement to Music – a conscious effort to move to the beat of the music

Tempo of Music– the rate of speed or pace of the music; the fastness or slowness of music

How Including Music While Exercising Enhances and Effects the Total Well-Being of an Individual

Why does music affect exercise?

Studies have revealed at least five reasons why including music while exercising has increased work output, increased endurance and lowered ratings of perceived exertion. They include increased motivation, task engagement, dissociation (taking one's mind off of the physical discomfort of exercise), arousal regulation (psych-up and psych-down prior to exercising) and synchronized movement with music.

Increased Motivation

Music has been shown to motivate students and bring enjoyment while participating in physical activity. Priest, Karageorghis and Sharp (2004) tested motivational music in exercise settings by asking the participants to identify the importance of music on a 7-point Likert-type scale. Of the 532 volunteer participants (307 females; 223 males and 2 not indicating gender; ages ranging from 12 to 79 years), results showed that 91% of the participants indicated they felt more motivated to exercise while exercising to music. Increased motivation while exercising often leads to increased work output. In a 2004 study by Elliott, Carr and Savage, the effects of motivational music on work output were measured while participants performed three 12-minute exercise sessions on a cycle ergometer. The participants (eight males and ten females) exercised under conditions of motivational music, oudeterous music and no music (music conditions displayed tempos of approximately 130 bpm). Results of this study found that participants cycled significantly farther when listening to motivational music. Lastly, a 2009 study examined the impact of motivational and oudeterous synchronous music of

100 volunteer sport science undergraduates (15 men, 15 women) who walked on a treadmill to voluntary exhaustion (Karageorghis, Mouzourides, Priest, Sasso, Morrish, & Walley). Selection of music began with 30 rock and 30 pop songs which were then ranked by the authors' music-rating panel. The nine highest rated pop and rock tracks were used for motivational music, and the nine lowest rated rock and pop tracks were used for the oudeterous music condition. Results indicated an increase in endurance in both music conditions compared to the no music control group.

Task Engagement

Although physical education teachers have been known to use music to keep students on task, is it really beneficial? Ward and Dunnaway (1995) conducted a study to determine if music could help increase the number of laps students ran in a high school physical education class. Four students were selected as the subjects from a high school physical education class of thirty-six. Data was collected daily for 14 days for the 20-minute running tests. Music was played via a cassette player for the whole class to hear, but data was recorded only for the four subjects. The researchers discovered there was a direct association between music use and increased levels of exercise, as subjects on average ran .5 mile per lesson prior to the study and ran 2 miles per lesson at the end of the study.

Dissociation

Exercisers may listen to music to divert attention from the sensations of discomfort, pain and fatigue that often accompany exercise. This diversionary technique is referred to as dissociation, also known as parallel attentional processing model (Rejeski, 1985). During sub-maximal exercise dissociation occurs when the music

narrows the individual's attention and diverts the mind from sensations of fatigue and discomfort (Karageorghis & Priest, 2008). The theory of narrowed attention states that the nervous system can only attend to a few environmental stimuli at any one moment and therefore must ignore other stimuli perhaps unrelated and unpleasing. Anshel and Marisi (1978) attributed the theory of narrowed attention to the effects of music on physical activity. They concluded that the pleasant auditory sounds of music allow a person to endure a physical task longer and/or at a higher intensity because the music blocks the feelings of discomfort, fatigue and heavy breathing, among others. The music narrows the person's attention to a pleasant stimulus.

Music was also used as an effective distracter in a 2000 study by Potteiger, Schroeder and Goff. The authors sought to determine the influence of music on ratings of perceived exertion (RPE) during 20 minutes of moderate intensity exercise on a cycle ergometer. Twenty-seven physically active participants, aged 18-30 years, were randomly assigned to one of four conditions: fast upbeat music, classical music, self-selected music or no music. Data indicated that each type of music reduced peripheral, central and overall ratings of perceived exertion, compared to the no music condition. The authors attributed the lower RPEs to music's ability to be an effective distracter while exercising, making the exerciser feel the work is not as difficult compared to exercising without music.

Arousal Regulation

Arousal regulation is a motivational technique used to psychologically arouse and mentally prepare an individual for an activity. There are many methods used to encourage and inspire a person's arousal, one of which is music. Music can be used prior

to an activity as either a stimulant to psych-up or as a sedative to psych-down by those preparing to workout or compete. United States Olympic Gold Medalist Michael Phelps uses the heavy, pulsating beats of rap and hip-hop music to pump himself up before a race. In contrast, it has been documented where the use of soft, slow music is used to help with relaxation and concentration. Marathon runner Julia Clark uses music for this purpose. She listens to music via an mp3 player to focus on relaxing muscle rigidity in efforts to avoid wasting energy through unwanted muscular tension (*Run to the Beat).*

Synchronized Movement with Music

Many forms of exercise provide the opportunity to synchronize movements with the music. In most such situations movement is synchronized with the beat of the music. Running, rowing, aerobic dance, walking, cycling and sit-ups are a few examples of fitness activities that can be executed in-synch with music (Karageorghis & Priest, 2008). Matching the tempo of the music and the rate of the exercise enables one to regulate the movement resulting in increased efficiency, less effort, lowered ratings of perceived exertion and a reduction in the amount of oxygen required. The individual is therefore able to endure the task significantly longer with increased levels of work output (Anshel & Marisi, 1978; *Run to the Beat,* 2009*;* Karageorghis & Priest, 2008; Karageorghis, Mouzourides, Priest, Sasso, Morrish, & Walley, 2009). Thirty-six Caucasian male volunteers (aged 20.5, +/- 1.2 years) participated in a 400-meter sprint performance research study. Participants' stride rates were measured and they were then grouped according to similar stride rates. Each group was then assigned music that corresponded to its stride rate. Results indicated that when the participants synchronized their steps to the beat of the music, running times were shorter in the motivational and oudeterous

synchronous conditions compared to the no-music condition (Simpson & Karageorghis, 2006). With synchronous movement and music participants decreased their time on average by about a half-a-second.

How should music be selected in order to gain the most ergogenic potential?

Adding music to a fitness regimen appears to make the exercise session more enjoyable, distorts the sense of time, promotes flow state (be "in the zone"), alleviates fatigue and improves mood and confidence. Ultimately, because music has been shown to be beneficial to the overall exercise experience, music may encourage one to adhere to a fitness plan (Crust & Clough, 2006; Gfeller, 1988; Karageorghis & Priest, 2008). But is any style, genre or tempo of music valuable? Over the last 10 years research has shown that when music is incorporated into physical activity sessions, both physiological and psychological responses are enhanced. Based on the research recommendations have been established to maximize the ergogenic potential of listening to music while exercising. Currently it is common to see individuals using music while exercising. They often, however, are uneducated as how best to use music to their advantage to obtain a maximum performance. One should consider the following criteria when selecting music for sport and exercise: type of activity, intensity of activity, delivery of music and selection procedure.

Type of Activity

Karageorghis, Priest, Terry, Chatzisarantis, and Lane (2006) state that an athlete or exerciser seeking music to be included in his/her training or competition should consider the context in which he/she will be exercising. For example, some activities such as warm-ups, weight training, circuit training and stretching lend themselves well to

musical cues that are repetitive in nature. For other activities the authors suggest that the individual select music with a rhythm and tempo that will match the type of activity. For instance, when leisure walking a person listens to slower-tempo music that enables him/her to relax and enjoy the activity. For power-walking, a person typically listens to music with an upbeat tempo that encourages a steady, fast pace that will promote and increase cardiovascular benefits.

For exercisers who have a difficult time selecting appropriate, motivational music for various exercise activities, there is an assessment tool available to assist in the music selection. Motivational qualities of music can be measured by an assessment tool called the Brunel Music Rating Inventory (BMRI) or its updated version, the BMRI-2 (Karageorghis, Terry, & Lane, 1999; Karageorghis, Terry, & Lane, 2006). The BMRI-2 is a six-item questionnaire for researchers and participants to rate music for exercise. The six items addressed are rhythm, style, melody, tempo, instruments and beats.

Intensity of Activity

As a general guideline fast, upbeat music is most appropriate for high intensity exercise, as demonstrated in aerobic dance or running, whereas slow, soothing music would be fitting for lower-intensity activities such as yoga or Pilates. For aerobic activities the individual should take into account the intensity of the activity. Consecutive tracks of music should begin at a desired warm-up tempo, followed by a gradual increase in tempo to match the intended exercise heart rate (Karageorghis & Priest, 2008). For instance, if one's targeted heart rate in the warm-up is 120 bpm, the song(s) selected for that portion of the workout should have a musical accompaniment tempo of approximately 80-130 bpm. The exerciser should then plan the music's beats

per minute for the rest of the workout to correspond to his/her desired heart rate. Another example is that when aiming to exercise at around 70% aerobic capacity, mid-tempo music (115-125 bpm) is more effective than faster music (135-145 bpm) (Karageorghis, Jones, & Low, 2006; Karageorghis, Jones, & Stuart, 2008).

Becker, Brett, Chambliss, Crowers, Haring, Marsh, and Montemayor (1994) conducted a study which tested the effects of listening to mellow and frenetic music prior to participating in three 2-minute exercise sessions. Sixty volunteers from three age groups (children 9-11 years, adults 18-55 years, senior 60-80 years) were the subjects. Each group had 10 males and 10 females and was classified as either physically active or inactive. The participants listened to one minute of mellow music (an excerpt from "Fire and Rain" by James Taylor), frenetic music (an excerpt from "Every Little Thing She Does is Magic" by The Police) or white noise (mechanical noises generated by rolling the blank tape) and then exercised for two minutes on a bicycle ergometer. The researchers found that the children and adults traveled significantly farther with both mellow and frenetic music as opposed to white noise. The senior group showed no significant effect.

Karageorghis & Priest's (2008) research also found that exercisers tend to match bursts of effort with those specific segments of a musical track the person finds to be especially motivating. This trend is referred to as segmentation. Segmentation is especially strong if the exerciser knows the musical track well and can anticipate the surge of extra energy the music offers.

Delivery of Music

The delivery of music should be taken into account if the music will be heard by more than one person, such as when a teacher or coach chooses to use music for a

physical education class or a team of athletes. Because individuals respond to music in different ways, the person choosing the music must be careful to select appropriate music and deliver it at an appropriate volume, for the maximum benefit of all the class or team members. Karageorghis and Priest (2008) recommend using a boom box in a gym or loud speakers in a stadium to deliver music if the intent of the songs is to unify or inspire a group or team. For example, a basketball team preparing for its final days before a first game of the season may listen to "The Final Countdown" to motivate the players. On the other hand, if one song is not appropriate for the entire group or would serve as a distraction for some, Karageorghis and Priest (2008) suggest that an mp3 player for each individual be used. For instance, a track team has athletes preparing for a variety of events such as long jump, high jump, sprints, long distances, shot put and discus. In all situations, however, Karageorghis and Priest (2008) note that music should be set at a high volume, but not too high as to cause discomfort or leave ringing in the ears.

Selection Procedure

When selecting music to accompany fitness activities, Karageorghis and Priest (2008) suggest meeting six criteria regarding the choice of music. Additionally, Karageorghis goes into further depth, detailing four specific factors of motivational music (*Run to the Beat*).

1.) Strong, energizing rhythm - This criterion has been named by exercisers and athletes as the most prominent characteristic in establishing how a person acts in response to musical accompaniment. Music labeled by runners as having "good rhythm" often has a pronounced, deliberate beat which promotes an automatic

physical response to want to move, promotes increased energy levels and encourages a positive, aroused state of mind to accomplish.

2.) Lyrics with positive associations to movement - This criterion involves transferring the message of the lyrics to the mind and body to encourage oneself to exercise with more intensity, strength, vigor and increased endurance. Phrases in the musical accompaniment such as "keep your body moving," "born to run" or "I believe" tend to motivate the person, resulting in an enhanced workout.

3.) Rhythmic music patterns that replicate the movement pattern – This criterion involves finding the correct tempo of music, more specifically the beats per minute (bpm), which corresponds to the desired exercise pace. For example, if a person has a fast running pace, the ideal tempo of music for that running pace is 130-150 bpm. A person should build a playlist with consecutive tracks of roughly the same beats per minute for the entire workout, matching the tempo of the music to the pace of the desired exercise.

4.) Uplifting melodies and harmonies – This criterion states that the music should comprise bright, enjoyable melodic and harmonic musical lines which enhance mood and overall feelings of oneself. Karageorghis suggests opting for music in a major key (sounds "happy") as opposed to selecting an accompaniment in a minor key (sounds "sad") (*Run to the Beat*).

5.) Associations to sport, exercise, triumph or overcoming adversity – This criterion entails creating a motivational image associating the music to the exercise. For example, the soundtrack from the "Rocky" movie series or the Olympic theme song may provoke an image for an individual persevering in face

of adversity. As another example, the lyrics of the song "Push It" by Salt-N-Pepa encourage a shot put thrower to "push" the shot, instead of throwing it, which is a common error amongst novice shot putters.

6.) Musical style or idiom suited to an athlete's taste and cultural upbringing – This criterion states that an individual should choose music that is reminiscent of his/her childhood, adolescence, early adulthood or any time in life that brings to mind positive feelings. Additionally, music from a genre with which one grew up or with which one can identify, such as pop, rock, dance or urban, is also recommended.

Costas Karageorghis from Brunel University in West London, the first author of the suggested six criteria, has gone further in depth regarding the motivational qualities of music. Karageorghis is a leading researcher in the area of incorporating music into the exercise setting. He identified four characteristics – two internal and two external - that contribute to the motivational qualities of music appropriate for exercise. Internal features are rhythm response and musicality and the external aspects are cultural impact and extra-musical association *(Run to the Beat).*

As previously stated, rhythm has been identified as the most significant factor in determining how an individual responds to music. Tempo, defined as how fast or slow a piece of music is, is the key component of rhythm and is measured in beats per minute (bpm). Results of Karageorghis, Jones, and Low's (2006) study to determine the relationship between exercise heart rate and music tempo found that participants' preference ratings for both fast and medium tempi were higher than ratings for slow tempo music at low, moderate and high exercise intensities. Further, participants

preferred medium and fast tempo music at low and moderate exercise intensities and favored fast tempo music while exercising at high intensity. The authors' results additionally suggested that slow tempo music was least preferred and deemed inappropriate for repetitive exercises regardless of exercise intensity. They added that slow tempo music may reduce the quality of the exercise experience (2006). Karageorghis, Jones and Stuart (2006) conducted a study and found that when participants exercised on a cycle ergometer at around 70% aerobic capacity, medium tempo music (115-125 bpm) was preferred over fast tempo music (135-145 bpm) and it also yielded a higher level of intrinsic motivation. In a 1988 study by Gfeller 96% and 94% of respondents stated that tempo and rhythm, respectively, were the characteristics of music most beneficial while exercising. These results were due to their ability to cue the rate of movement with music, allowing participants to be more precise in their movement.

As stated in the article "Run to the Beat," musicality refers to the rhythmical aspects of music, including melody (the recognizable part of the music), harmony (the way different notes sound together when played at the same time) and the musical instruments that are used. It further states that motivational music has memorable melodies and a bright, inspiring and heartening harmonic structure and sound.

The first of Karageorghis' two external factors of motivational music is cultural impact within society and is similar to the sixth criterion previously discussed (Karageorghis & Priest, 2008). The cultural impact of a piece of music increases with repeated exposure to a particular song via radio or when heard and associated with a certain TV commercial. Moreover, personal music preferences are dependent upon an

individual's cultural background. The community in which one grew up and the type of music listened to in childhood affects a piece of music's motivational qualities. For instance, a teenager who grows up in an urban environment is more likely to be motivated by rap music than a middle-aged person who resides in the country.

The second external factor, extra-musical association, affects the cultural connections related to a piece of music. An example of this factor can be witnessed from the 1998 Olympic Winter Games in Japan. Great Britain's bobsled team used music to inspire them in an effort to seize the gold medal. Dr. Terry Peter told them the Olympic Games of 1998 was their moment in time. The four-man team, therefore, listened to Whitney Houston's "One Moment in Time" on their drive to the bob track each day of training and competition. As they listened, they visualized themselves calmly and decisively capturing the gold. The bobsled team accomplished winning the gold medal, the first time in over 30 years (Terry & Karageorghis, 2006).

Do synchronous and asynchronous movement to music result in similar exercise responses?

Studies have been conducted to investigate the effects of both synchronized music and asynchronized music while exercising. The synchronous use of music involves exercising in time with the tempo of the music's beat. The asynchronous use of music involves exercising when music is simply played in the background; there is no conscious effort to move in time with the underlying beat of the music (Terry & Karageorghis, 2006). While the ergogenic effects of exercising when using music synchronously have consistently revealed an enhanced workout, the results of research using music asynchronously while exercising are inconsistent.

Synchronized Movement to Music

Anshel and Marisi's (1978) research was one of the earliest studies noting the effects of exercising to music. In their study 16 male and 16 female undergraduate physical education students exercised on a cycle ergometer in three conditions: synchronous movement to music, asynchronous movement to music and no music. In all instances participants were told to cycle with the rate of a flickering light set at 100bpm. In addition, to test synchronous movement to music, music was set at 100bpm; to test asynchronous movement to music, background music was set at 125-135 bmp. Results showed that subjects were able to endure the task significantly longer under the synchronous conditions than under the asynchronous conditions or in the absence of music. In Uppal and Datta's 1990 study an increase in work rate was reported with calisthenic-type exercises synchronized to music during physical education classes when compared to no music. Additionally, a 60-minute bench stepping exercise was completed to evaluate the effect of music on the mood of 16 middle-aged women (aged 49.9, +/- 7.53 years) during exercise (Hayakawa, Miki, Takada, & Tanaka, 2000). Results of the study showed that participants reported feeling significantly less fatigue with synchronous music (aerobic dance music) than with asynchronous music (Japanese traditional folk music) or no music. A fourth example is Simpson and Karageorghis' (2006) study which assessed the effects of motivating and oudeterous synchronous music compared to no music on a 400-meter sprint performance by 36 Caucasian male subjects. The findings of the study showed that synchronous music, both motivating and oudeterous, resulted in better (faster) performance times than did the absence of music. Next, in a study in which participants cycled in time to music, participants needed 7% less oxygen to do the same work load compared to cycling under asynchronous music

conditions (Bacon et al., 2008). Lastly, as previously mentioned, a 2009 study examined the impact of motivational and oudeterous music while walking synchronously to the beat of the music on a treadmill to voluntary exhaustion (Karageorghis et al.). Results indicated an increase in endurance in both music conditions compared to the no music control group.

A notable example by a trained athlete demonstrating the benefits of synchronous movement to music is Ethiopian distance runner Haile Gebreselassie. In February 1998 he broke the indoor 2000-meter world record when he ran in stride to the rhythmical pop song "Scatman" (Simpson & Karageorghis, 2006).

Asynchronized Movement to Music

Whereas exercising synchronously to music has consistently shown positive ergogenic effects, results of exercising asynchronously to music are not as consistent. First, to prove the benefit of moving asynchronously to music was a 1991 study by Copeland and Franks. They tested the effects of exercising asynchronously to music while subjects performed a treadmill endurance test. Twenty-four volunteer participants (13 female and 11 male) from physical activity classes performed the test. The study provided support that soft, slow background music increases endurance performance while exercising on a treadmill. Further confirmation of the benefits of exercising asynchronously to music was demonstrated when 14 subjects (4 female and 10 male) executed a karate drill exercise. Results indicated an improved score when listening to music compared to white noise. After completion of executing the karate drill, participants assessed their performance based on a 7-item, 5-point scale (Ferguson, Carbonneau, & Chambiss, 1994). Exercising asynchronously to music was also shown

to be beneficial in a study of 58 participants (41 men and 17 women, aged 22.3 +/- 6.4 years) who performed an isometric weight-holding task. Participants held the weight significantly longer while listening to background music compared to listening to white noise (Crust & Clough, 2006). In another study involving 24 Caucasian male volunteers (aged 20.3, +/- .9 years) Karageorghis and Deeth (2002) found that motivational asynchronous music elicited higher scores in perceptions of flow in a running task compared to the no music control. Lastly, results of a 2004 study with eight male and ten female subjects found that participants cycled significantly farther in three 12-minute tests when exposed to motivational background music as opposed to oudeterous and no music. The study also revealed the music brought forth significantly higher levels of positive affect than the no-music condition (Elliott et al., 2004).

Although some studies have demonstrated that exercising asynchronously to music may be effective in enhancing a workout, other studies have demonstrated contradictory results. Several studies have shown no effects or negative effects of asynchronous music in various settings. Pearce (1981) conducted a study to determine the effects of grip strength of the participants while listening to background music. Subjects included 33 male and 16 female undergraduate students. Results indicated that sedative music reduced grip strength in comparison to stimulative music and no music. Further results indicated that stimulative music did not increase strength relative to no music. In another study participants' stride rates during treadmill running were tested by Lee (1989) to determine the effects of stimulative and sedative music in comparison to the absence of music. No significant differences were found, providing evidence that background music may be inconsequential. Schwartz et al. (1990) also reported no

differences in endurance time while listening to stimulative music and no music during a cycle ergometer task. Furthermore, results of a dart-throwing task which tested the effects of stimulative music, sedative music and no music indicated that music did not have an effect on the performance of the 30 participants (Dorney et al., 1992). Finally, 15 college students (twelve men and three women) were subjects in a study to assess the influence of asynchronous music on the Wingate Anaerobic Test. Music selections of approximately 120 bpm were heard via headset and fell into the categories of new wave, hard rock and pop rock. Subjects cycled on a bicycle ergometer asynchronously to music with resistance set at 7.5% of body weight in kilograms. The results showed no significant differences in the music condition versus the no music condition (Pujol and Langenfeld, 1999)

What is the effect of music on aerobic and anaerobic exercise?

Aerobic exercise is defined as a level of activity (60%-90% maximum heart rate) which a person can sustain for an extended period of time and includes activities such as walking, jogging, swimming and cycling. To participate in such activities one requires continued replenishment of oxygen to make the energy required for the prolonged exercise. The term "anaerobic" means "without oxygen." Anaerobic exercise uses muscles at a high intensity and high rate of work for a short period of time. Examples of this type of exercise include heavy weight lifting, sprinting or any rapid burst of hard activity. Because oxygen is not used for energy in this type of exercise, the human body is unable to perform anaerobically for long periods of time (*Anaerobic Exercise).*

Aerobic Exercise

Music's effectiveness in aerobic exercise has been evidenced on numerous occasions. One of the first studies chronicled relating music and exercise showed that music increased endurance time for 32 male and female subjects (aged 19-22 years) on a bicycle ergometer performance test at a submaximal level of intensity (Anshel & Marisi, 1978). In addition, Beckett (1990) determined that music had a significant effect on aerobic exercise, as 32 volunteer subjects (aged 18-22 years) walked significantly farther while listening to music compared to its absence. Thirdly, Elliott, Carr and Savage (2004) conducted a study which tested the effects of motivational music (as identified by rating procedures of the BMRI; Karageorghis et al., 1999) on work output and affective responses during sub-maximal cycling. While cycling at a rate of perceived exertion of '13' (Borg, 1971) during a cycle ergometer test, 18 participants (eight males and ten females) cycled farther with music accompaniment compared to no music. Further, Copeland and Franks (1991) found that soft, slow background music (asynchronous movement to music) increased endurance performance for 24 volunteer college students (13 female and 11 male) who were subjects for a submaximal treadmill test. The study, however, failed to support the authors' hypothesis that fast, loud background music increased physiological endurance.

In contrast, no significant differences were found with 12 female collegiate basketball players in a 1995 study conducted to determine the effect of up-beat music on endurance performance (exhaustion time, heart rate and RPE) while running on a treadmill at 80% VO2max (Ciccomascolo, Finn, Barbarich, & Rinehardt). In another study the rating of perceived exertion of 24 volunteers (untrained undergraduate females) was tested on a cycle ergometer at light, moderate and heavy workloads (Boutcher &

Trenske, 1990). Results showed that there were no significant differences regarding RPE in the no-music control versus the music condition.

Anaerobic Exercise

Tenenbaum, Lidor, Lavyan, Morrow, Tonnel, Gershgoren, Meis, and Johnson (2004) conducted a test in which participants ran on a treadmill at 90% of their maximal oxygen uptake to determine if music would affect running perseverance. The 15 male participants regularly ran fewer than three times per week. Results indicated that music did not increase the participants' ability to sustain the run longer compared to without music. Next, a study involving twelve men and three women was conducted by Pujol and Langenfeld (1999) to test the effects of music on a Wingate Anaerobic Test. Subjects cycled to fatigue on a bicycle ergometer with resistance set at 7.5% of body weight in kilograms. Results concluded that music had no significant effect on mean power output, maximum power output, minimum power output, fatigue index or time to fatigue. Lastly, Karageorghis, Drew and Terry (1996) conducted a study which investigated the effects of stimulative and sedative music on the grip strength of 50 volunteer sport science undergraduates (25 men and 25 women). Results showed that slower tempo music (usually >100bpm) tended to induce relaxation as it decreased grip strength compared to the no music control group (Karageorghis, Drew, & Terry, 1996).

The rationale behind music's inability to affect anaerobic activity is primarily attributed to Rejeski's parallel attentional processing model (1985). Rejeski's paradigm states that attention can be diverted away from internal sensations of fatigue and discomfort allowing the individual to concentrate on an external stimulus, in this case, music. Researchers who study the effects of music on exercise refer to this phenomenon

as "dissociation" (Lim, Atkinson, Karageorghis, & Eubank, 2009). It seems, however, that music can only divert attention in aerobic activities. Rejeski's model does not appear to pertain to anaerobic activities. Lim et al. (2009) state that at higher intensity exercise, internal cues predominate over the psychophysical response; exercisers are not able to concentrate on anything but completing the exercise.

Affective responses (personal feelings) of music, however, have emerged with the presence of music even at high-intensity exercise. In their 2004 study 15 males subject participated in a treadmill exercise in which they ran at 90% of their maximal oxygen uptake, once each with rock, dance and inspirational music and once without music. For 30% of the participants results indicated that although the music did not prove to increase endurance, it was helpful at the beginning of the run. The participants perceived the music to be beneficial overall because it directed their attention to the music and motivated them to continue. Additionally, significantly greater levels of affect were shown at a heavy workload with music compared to its absence during a cycle ergometer test with 24 women subjects (Boutcher & Trenske, 1990). The implication is that music does little to influence *what* the exerciser feels at the anaerobic level of exercise, but it is considered to be influential in *how* the person feels.

One recent study, however, had a differing conclusion than previously mentioned studies. In an effort to assess the effects of motivating and oudeterous synchronous music on an anaerobic 400-meter sprint performance, Simpson and Karageorghis (2006) found that synchronous music improved running times compared to no music in a study with 36 Caucasian male volunteer subjects. Thus, the possibility does exist that music may be an ergogenic aid in anaerobic exercise in some circumstances.

What is the psychological effect of music on exercise?

The final question investigates the effects music has on the psychological well-being of an individual during exercise. It appears that music can serve as a great motivator when exercising as it positively affects the mental attitudes of individuals, decreases ratings of perceived exertion, induces relaxation and distracts an individual's feelings of discomfort while exercising.

Gfeller (1988) conducted a study that examined the attitudes of 70 college students (35 male, 35 female) regarding the influence of music on exercise. Ninety-one percent of the participants responded that not only did music help keep them motivated, but it also provided a distraction from discomfort and fatigue and took their minds off of the physical work. This study supports the belief that the use of music can enhance mental fortitude to keep moving and pushing forward in physical activity. In another study Boutcher and Trenske (1990) examined the effects of music on perceived exertion of 24 untrained female undergraduate volunteers while cycling on an ergometer at light, moderate and heavy workloads. Results showed that RPE responses were significantly lower in the music condition compared to the no music group; the participants perceived the exercise to be easier when they listened to music. Additionally, participants stated that they felt better in the moderate and heavy exercise conditions when exercising to music than when exercising without it. Lastly, a study investigated the effects of stimulative and sedative music on the grip strength of 50 volunteer sport science undergraduates (25 men and 25 women). Results showed that slower tempo music (usually >100bpm) tended to induce relaxation as it decreased grip strength compared to the no music control group (Karageorghis, Drew, & Terry, 1996).

Music has been used in the exercise environment to help with practice productivity. Hume and Crossman (1992) conducted a study to determine if music, used as a reinforcer, would increase productive behavior and decrease nonproductive behavior in a group of six competitive swimmers aged 12-16. Music was played for one group of three swimmers (variable group) only when productive behaviors were displayed. The other group of three swimmers (control group) was able to listen to music regardless of training productivity. The authors found there were significant improvements in the percentage of productive behaviors in the variable group, thus concluding that music may be a successful reinforcer and intrinsic motivator when introduced with productive behavior.

Exercisers report positive affective feelings when listening to music. Thirty volunteers performed five 10-minute exercise sessions on a treadmill while listening to background music. Each of the five sessions consisted of music selections that were fast/loud, fast/quiet, slow/loud and slow/quiet and no music. Results indicated that regardless of the tempo or volume of the music, participants enjoyed what they were doing more when allowed to listen to music compared to when music was absent (Edworthy & Waring, 2006). Subjects in Boutcher and Trenske's 1990 study stated they felt better during moderate and heavy workloads when music was played in contrast to without music. Many participants running on a treadmill at 90% of their maximal oxygen uptake reported they found the music helped to make the run more enjoyable and motivating and that it also diverted their attention away from the physical discomfort of running (Tenenbaum, Lidor, Lavyan, Morrow, Tonnel, Gershgoren, et al., 2004).

Discussion

The purpose of this literature review was to research and obtain information regarding the effects of including music while exercising. Based on the research one can conclude that it often is beneficial to include music while exercising.

Why does music affect exercise?

Research has shown that including music in the exercise settings may increase one's motivation, better engage exercisers in specific tasks, dissociate the feelings of discomfort and fatigue, help arousal regulation and synchronize movements with the beat. All these attributes lead to increased work output, increased endurance and lowered ratings of perceived exertion.

How should music be selected in order to gain the most ergogenic potential?

When selecting music for exercise it is important to consider the type of activity, the intensity of activity and the means of delivery of music. One should keep in mind the scientific findings for optimum ergogenic aid and choose accordingly. Ultimately, the exerciser should choose his/her music, because personal preference is one of the key components in selecting musical accompaniment that will be beneficial to his/her workout.

Do synchronous and asynchronous movement to music result in similar exercise responses?

When a person moves synchronously to music, the workout is almost always physiologically enhanced. However, when exercising asynchronously to music, the results are not as consistent. Synchronizing steps to music can be used in many areas of aerobic activity. In doing so a person can maintain a steady pace, allowing for ease of

movement and better efficiency while also increasing the probability that the exerciser will endure longer with greater intensity. Moving asynchronously to music has proven to be favorable in some exercise settings but not in others. In fact, in one instance, listening to sedative background music proved to decrease participants' performance of grip strength compared to listening to no music while performing the skill (Pearce, 1981). However, through this review of literature, Pearce's study is an exception to the general consensus. It is recommended to include music while exercising because in most circumstances it demonstrates its effectiveness positively.

What is the effect of music on aerobic and anaerobic exercise?

As a general rule results are consistent in that music is advantageous during aerobic activities. Studies have shown that exercising aerobically to music increases physiological endurance. Regarding anaerobic activity, results generally state that the music does not affect performance. The rationale is because exercisers are not able to concentrate on anything but completing the demanding and physically exhausting task.

What is the psychological effect of music on exercise?

Not only can music boost the before-mentioned physical exercise performance, it can also add to the overall sense of well-being of a person during exercise. Music positively affects the mental attitudes of individuals, decreases ratings of perceived exertion, induces relaxation and distracts the person from the feelings of discomfort and fatigue while exercising.

Limitations of Study

For several years, researchers have been investigating the effects of music on exercise performance. Results have been mixed, most likely due to the different research

protocols and tools used to collect the data. For example, Dr. Karageorghis and his fellow researchers have done extensive research to determine the style, genre and tempo of music most beneficial for different types of exercise. Research has shown that the most valuable music is that which participants choose. For research studies, however, that is not always a feasible option. In most of the studies covered in this paper, it appears that authors haphazardly chose music for the entire group. This haphazard selection of music may have contributed to and accounted for the differences in outcomes of studies. Karageorghis' studies were an exception. He conducted extensive research that focused on the appropriate style, genre and tempo of music in order to gain the most ergogenic potential from the music. In addition, all of the studies conducted that included Karageorghis as an investigator used The Brunel Music Rating Inventory-2 (BRMI-2) to assess the motivational qualities of music on exercise. Differences in outcomes of similar studies may be because other researchers did not use this testing instrument.

Two studies outlined in this paper (Ward & Dunnaway, 1995; Hume & Crossman, 1992) used fewer than ten subjects (four and six subjects, respectively) which does not seem to be a sufficient sample size. Results could have been skewed because of a small, insufficient sample size.

Considerations for Implementation

Key generalizations and statements about the benefits of including music while exercising have been generated from this literature review. They support what many fitness professionals and educators have intuitively come to realize when they have included music in their classes. Music can motivate and inspire and with the appropriate music selection one can receive positive psychological and physiological benefits during

an exercise session. The findings of this review show the following suggestions for including music in exercise settings:

- The use of music has shown to increase motivation, dissociate feelings of fatigue and discomfort and interest arousal.
- The selected music should match the intensity and type of exercise activity. For example, faster music for activities such as running and weight lifting, and slower music for yoga and Pilates.
- The most ergogenic benefits will occur if the following are considered in the selection of music: a strong, energizing rhythm; positive lyrics having associations with movement; rhythmic patterns well matched to movement patterns of the athletic activity; uplifting melodies and harmonies; associations with sport, exercise, triumph or overcoming adversity; and a musical style or idiom suited to an athlete's taste and cultural upbringing
- Optimally, the exerciser should choose his/her music. When that is not possible, the teacher/coach should take care in selecting appropriate music that will target the entire population.
- Music should be selected so that movements can be synchronized to its beat. Aerobic dance, running, bench-stepping and walking, among others, lend themselves well to moving in-synch with the beat.
- The use of music during aerobic exercise increases physiological endurance, time and distance. In situations of anaerobic exercise, music does little to influence *what* the exerciser feels, but it is considered to be influential in *how* the person feels.

- Use music whenever possible while exercising. Music has been shown to increase one's overall well-being. Participants seem to enjoy exercising more when music is included.

Recommendations for Future Research

Consistent Measuring Tools

Future research can be conducted to refine previous studies by using different or consistent measuring tools. Inconsistencies could easily exist in the studies referred to in this literature review because of the manner in which music was selected. A universal means of analyzing and measuring motivational music would make the results more reliable and consistent.

Sample Groups

In future studies, sample groups should include equal numbers of male and female participants and a minimum sample size of twenty. Equality in the number of male and female subjects avoids the possibility of discrepancies due to physiological differences in genders. A sample size larger than twenty is more credible as it represents an average population of a class.

Participant Survey

A survey or interview of students in the physical education class would be beneficial in learning more in depth about students' perception of music while exercising and their preferences of music. Incorporating music more consistently into the physical education classroom could prove to be a valuable teaching aid toward the goal of lifelong physical fitness.

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