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Effects of Music and Sensory Deprivation on Ratings of Perceived Exertion and Exercise Affect

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Effects of Music and Sensory Deprivation on Ratings

Of Perceived Exertion and Exercise Affect

(TITLE)

BY

James Chinery

THESIS

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ABSTRACT

Music as an ergogenic aid is a novel concept, and one that has been sporadically researched. The purpose of this thesis was to study the effects of music and sensory deprivation on ratings of perceived exertion during exercise.

Eleven active males (i.e. they exercised at least 3 times a week), were tested in three different conditions (music, sensory deprivation, control). They exercised in each condition, at workloads corresponding to 50, 70 and 90% of their maximal oxygen consumption. The sessions and workloads within each session were randomized.

No significant differences were found for heart rate between conditions. Significantly lower perceived exertions were reported between the sensory deprivation and music condition (heavy condition), and the sensory deprivation and control condition (heavy condition). This is inconsistent with previous research which found differences between the light and moderate workloads for RPE.

Of the eleven subjects, 5 failed to complete the last minute of exercise (sensory deprivation and heavy workload), and 2 of those 5 didn't complete the last 2 minutes of the same stage. During the control condition, 3 subjects weren't able to complete the last minute of heavy exercise. All subjects completed each workload during the music condition.

It was concluded that music's effects on exercise decreased ratings of perceived exertion during a heavy workload. When comparing sensory deprived and control

conditions to the music condition. Music was also found to be a contributing factor in motivating a person to finish the heavy workload. This is evident by the percentage of people finishing the heavy workload in the music group (100%), compared to the sensory deprivation (55%), and the control (73%).

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LIST OF ABBREVIATIONS

ANOVA:	Analysis of variance
BPM:	Beats per minute
FS:	Feeling scale for exercise effect
HR:	Heart rate
SD:	Sensory deprivation condition
VO_{2max}:	Maximal oxygen uptake
RPE:	Ratings of perceived exertion
SNK:	Student-Newman-Keuls post-hoc test
LCC:	Limited concentration channel

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CHAPTER I

INTRODUCTION

Methods used to improve one's performance have traditionally been referred to as ergogenic aids. Drugs are the most commonly used ergogenic aids by college and professional athletes, whereas nutrition supplementation and warm-up procedures are typical of individuals who train for fitness and sport activities (McCardle, Katch & Katch, 1991). Music isn't classified amongst the more popular ergogenic aids, but it's effects on performance are proven (Rejeski, 1985). What then is stopping us from adding it to the list of commonly used performance enhancing methods?

Part of the problem is the inherent difficulty in studying music's physiological and psychological effects. On May 15, 1992 a group of scientists met in Salt Lake City, Utah to discuss music's spectrum and other mechanical properties. The basic conclusion of the symposium was that it is easier to appreciate music than to fathom its tortuous acoustical complexities (Browne, 1992).

Music's effects are mainly tested using ratings of perceived exertion, which is subjective in nature (Rejeski, 1985). These effects are different for each person, so it is difficult to apply one theory to every person. Music responses seems to be unique to the individual with the physiological and psychological responses remaining unclear.

(Borg, 1982; Hardy & Rejeski, 1989).

Although music's effects remain somewhat ambiguous, the effects of other erogenic aids such as steroids or carbohydrate drink's are relatively easy to chart, i.e. maximal oxygen uptake ($V0_{2max}$), time in the mile, strength output, etc. Music's effects go beyond merely physiological, with most of it's effects being psychological in nature. Psychological effects have been widely suspect, and have been difficult to investigate (Hardy & Rejeski, 1989).

Music is more complex, and requires more than merely charting it's physiological effects (Rejeski, 1985). Exercise has both objective and subjective components. While most exercise scientists understand the objective findings, it is still unclear as to what their relation to the subjective symptoms are (Borg, 1982; Rejeski, 1985; Copeland & Franks, 1991). In other words, what people think they are doing is as important in establishing an appropriate exercise intensity as the actual metabolic costs of the activity (Rejeski, 1985). The key seems to be linked to information processing during exercise. Music may effect the differeing levels of thought, which will in turn effect a person's attentional focus.

Internal and external attentional focus have been shown to have significant effects on a person's perception and actual performance (Smith & Morris, 1976; McCaul & Malott,

1984; Copeland & Franks, 1991). For many runners, it is more exciting to run outdoors than on an indoor track. Outdoors, their attention is focused on the pavement, oncoming cars or other distracting noises. Awareness is focused externally, allowing the internal, fatigue facilitating senses to be blunted. An indoor track is repetitive and redundant. Attention becomes focused on sore feet and labored breathing, which has been shown to decrease exercise performance (Smith & Copeland, 1975).

Attentional focus is only one of many effects that music has on exercise. Music has been shown to effect the exercise response in many ways, including: (a) distraction from the exercise to an external source (Pennebaker & Lightner, 1980; Sutherland, Newman & Rachman, 1982; McCaul & Malott, 1984), (b) increasing arousal (Smith & Morris, 1976; Boutcher & Trenske, 1990) and/or (c) increasing relaxation and/or decreasing anxiety (Hardy & Rejeski, 1989; Boutcher & Trenske, 1990).

Although all of these means have been shown to have an effect on exercise, the problem of clearly delineating the mechanism still exists. Researchers are in argument as to the exact means by which music can effect the exercise response. Also in question are the levels of exercise at which music is most appropriate and when, if at all, music should be implemented during exercise. The Gestalt of music's effects on exercise have been studied, and the time

has come when more precise findings are needed.

Purpose of the study

The purpose of this study was to investigate the effects of sensory deprivation and music on ratings of perceived exertion (RPE), exercise affect, and heart rate (HR) during three different levels of submaximal exercise on a cycle ergometer. A sensory deprived and music state were both selected, for they represent opposite sides of the external-internal focusing spectrum. Music represents the external, while sensory deprivation facilitates the internal. It was felt that these two conditions, coupled with a control condition, would be a reliable measure of the different conditions effects on exercise.

Hypothesis

Music when compared to control and sensory deprivation will have the following effects on submaximal exercise:

1. During sub-maximal exercise, music will result in lower ratings of perceived exertions.
2. Music will also result in higher affective scores.
3. Heart rate will not be significantly different among the three conditions.

Delimitations

The study was delimited under the following parameters.

1. 11 healthy college males who exercised regularly (at least three times a week for 2 months prior to the study).
2. The sub-maximal tests consisted of three levels of exercise, at 50, 70, and 90% of their VO_{2max}.
3. Each test was conducted under three different conditions, (control, sensory deprivation, music).
4. All tests were conducted on a Monark cycle ergometer in the Eastern Illinois University Human Performance Laboratory.

Limitations

1. Due to the relatively small sample size, the probability of a Type II error, or failure to reject a false null's hypothesis is increased. A higher N would increase the significance of any conclusions drawn by this study.

2. The amount of control over external variables was poor. Control of their lifestyle outside of the laboratory was not possible, and errors may have ensued.

3. The music was not controlled for, i.e. the subjects brought whatever music they wanted. Although the justification is that the response to preferred music type is greater than the effect of that music, research has shown different physiological responses to different types of music.

4. Although the goggles and earplugs eliminated some of the sight and hearing, subjects still reported being able to hear somewhat.

Definition of Terms

Ratings of Perceived Exertion (RPE). An indicator of exercise intensity where subjects are asked to rate on a numerical scale from 6 to 20, how they feel in relation to their level of exertion (Borg, 1982).

Exercise Affect. While participating in exercise it is quite common to experience changed in mood (Rejeski, 1985). Some individuals find exercise pleasurable, whereas others find it to be excruciating and bothersome. Additionally, feeling may fluctuate across time. Exercise affect is a term used to chart a person's feelings during exercise.

Feeling Scale. Exercise affect is presented in an 11-point bipolar good/bad scale, ranging from $^{+}5$ to $^{-}5$. Verbal anchors are provided at the 0 (neutral point), and at all odd integers; $^{+}5$ = very good, $^{+}3$ = good, $^{+}1$ = fairly good, 0 = neutral, $^{-}1$ = fairly bad, $^{-}3$ = bad, and $^{-}5$ = very bad (Rejeski, 1985; Hardy & Rejeski, 1989; Boutcher & Trenske, 1990).

CHAPTER II

REVIEW OF THE LITERATURE

Perceived Exertion

For the past two decades, knowing what people think they are doing during exercise has become synonymous with responses to Borg's (1982) ratings of perceived exertion (Hardy & Rejeski, 1989). Ratings of perceived exertion (RPE) has often been viewed as the direct result of sensory cues(e.g. muscular strain). Sensory cues only make up a part of RPE, and Morgan (1973) has noted that roughly one-third of the variance remains unexplained after consideration of physiological input.

Many variables outside of our actual physical exertion effect our perceived exertion such as cognition of the activity, motivation and/or emotion at the time of the exercise. This has led Rejeski (1985) to argue that RPE is best viewed as a social psychophysiological phenomenon, the result of active parallel processing involving physiological, cognitive, and affective input.

At this point in exercise science, there is substantial agreement that RPE has practical purposes in exercise prescriptions. More specifically, it has become equally important to recognize what people think they are doing as does the measurement of the metabolic costs of the activity (Rejeski, 1985; Hardy, Hall & Prestholdt, 1986).

Exercise Affect and the Feeling Scale

Although RPE has been demonstrated as a valid measure of exercise perceptions, many exercise physiologists believe that an understanding of how one feels may be as important as what one feels (Hardy & Rejeski, 1989; Frijida, 1988). For example, two individuals may rate a given workload as hard, 15 on the RPE scale, yet one may feel good and the other bad about such a level of exertion (Hardy & Rejeski, 1989). In lieu of this, Rejeski developed a feeling scale (FS) to assess affective responses during exercise. Rather that dealing with various categories of emotion (e.g. anger, depression, joy), the scale was designed to evaluate the core of emotions: pleasure vs. displeasure (Frijida, 1988).

Traditionally, Borg's Scale (RPE) has been the only device used to measure the psychological variable during exercise. This is a proven measure of perceptions, but it seems that the time has come to increase our awareness about exercise. This has led some to believe that ratings of perceived exertion, as a separate entity isn't a viable enough measure to get the entire psychological variable necessary during exercise. Ratings of perceived exertion only charts one's perception without regard to their actual feeling of that level.

One value of the FS is to identify those who respond positively to demanding workloads. This would allow a person to operate at a higher percentage of their work

capacity while exercising or training. They are then able to cope more effectively with the physiological strain of competition or everyday exercise. These investigations continue to validate the theoretical import and measurement of ongoing affect within the context of exercise (Hardy & Rejeski, 1989; Boutcher & Trenske, 1990).

Preconscious Processing

Measurement of music's effects during exercise are validly measured by Borg's Scale (RPE) and Rejeski's 11-point bipolar scale (FS). In order to explain the psychological effects that may influence RPE and affective responses, Rejeski (1985) developed a parallel informational processing model used initially with pain research (Levanthal & Everhart, 1979; Boutcher & Trenske, 1990). This model suggests that sensory and emotional information are preconsciously processed parallel to each other (Boutcher & Trenske, 1990). The introduction of music to exercise then has the ability to drown out sensory input that may decrease performance, particularly at light and moderate workloads (Rejeski, 1985).

Another processing hypothesis involves a concept known as the limited concentration channel (LCC). It is theorized that this channel allows only small pieces of information to be processed at a time (Stallings, 1991). This includes both perceptual and motor information. Can music than work

to occupy this space, normally taken up by physical cues such as a sense of heart rate, sore feet or side cramps?

In Rejeski's (1985) adapted model, preconscious processing is seen as an active process that allows information to be filtered through to focal awareness. Thus, sensory information (e.g. effort sense) or affective information (apprehension caused by an exercise load) can form the object of attention and determining RPE or affective states during exercise (Boutcher & Trenske, 1990). The preconscious processing model shows that it is difficult to focus attention on multiple sources, with only one piece of information being processes at a time. This is compatible with the LCC model. Both theories agree that it is difficult to analyze two pieces of information at the same time. Therefore, any external stimulus that may be introduced into the system may actually decrease the onset of fatigue by blunting the perceptions of fatigue.

Effects of stimulative and sedative music

It has been an accepted fact that music effects a person's emotional state. Some researchers have even shown that stimulative or fast music produces higher levels of anxiety, arousal and aggression as compared with sad, calm and sedative music (Smith, 1976; Copeland & Franks, 1991). Some evidence supports the notion that sedative music decreases the physiological response to exercise, therefore

resulting in a longer time to exhaustion on a cycle ergometer (Copeland & Franks, 1991).

Typically, many athletes listen to music before or during exercise to give them that needed "motivational push" that may enhance their performance. Weight rooms across the country are filled with men and women lifting weights to music. Outside the laboratory, weight room, or locker room, sedative music has been used to decrease the pain and anxiety experienced by mental patients during dental procedures (Jacobson, 1956).

It was also found that stimulative music worked to increase anxiety, and decrease concentration (Smith & Morris, 1977). The anxiety caused by the stimulative music may also hinder a performer if it's effects are too great. This may be the reason that sedative music is preferred in "study atmospheres. Sedative music has been stressed in previous research to relax and sooth, basically decreasing a persons preoccupations. Stimulative music viewed in a negative sense may increase worry, but it may also work to increase alertness, activation and attentiveness. This would clearly benefit the athlete who is looking for that edge, but also may work against him in activities that would demand a high level of concentration mixed with arousal.

Soft music's effects on performance go beyond the psychological. Some support has been provided that soft or sedative music reduces physiological arousal during

submaximal exercise and increases endurance performance (Copeland & Franks, 1991). In their study those who performed under soft background music on a maximal consumption test did better than those who cycled during fast music.

Competition of Internal and External Information in an Exercise Setting

Most people have experienced a cut or a bruise and failed to feel any pain until their wound became the focal point of their concentration. Most athletes will also agree that injuries or fatigue are always worse after the competition as opposed to during (Pennebaker & Lightner, 1980; Hardy and Rejeski, 1989). It follows from the principles of perception that in a setting in which both internal and external sources of information are potentially available, our brains will only be able to process one, leaving the other unnoticed.

Pennebaker and Lightner (1980) found that paying attention to distracting sounds tended to decrease perceptions of fatigue and accompanying symptoms. Forced attention to body, on the other hand magnified these perceptions. It was concluded that when a person is concentrating on their body during exercise, perceptions of fatigue worsen compared to if their attention was focused elsewhere.

In another study done by Pennebaker & Lightner (1980), it was found that external focusing was evidenced in faster times on a cross-country course compared to a lap-course. Again, a cross-country course offers many visual as well as auditory "distractions." Running laps in a gym may force the individual to concentrate on breathing and the soles of their feet, increasing perceptions of fatigue.

Effects of Music on Perceived Exertion and Affect

While a person is exercising, he/she may only focus on a very limited amount of stimuli. Information processing models give us the concept of a limited concentration channel (LCC). This processing unit in only capable of dealing with one piece of information at a time. Concentration on internal sensations increases anxiety and perceptions of fatigue. External focus works to decrease anxiety and perceptions and feeling about fatigue. It is therefore accepted that external focusing may improve both a person's perceptions, but may serve to increase their performance (McCaul & Malott, 1984).

Boutcher & Trenske (1990) found that both RPE and exercise affect measurements in 24 women were influenced by music when compared to a sensory deprived state. Significantly lower perceived exertions were reported at the low and moderate workload, while affect was significant at the moderate and heavy workloads. More specifically, music

worked to lessen perceptions of fatigue and feelings about fatigue when compared to people in a sensory deprived state.

Distraction and Coping with Pain

Perceptions and feelings about exercise are directly related to a person's pain tolerance and coping strategies. People with a low pain tolerance will perceive a given workload as more straining that a person with a higher pain tolerance. Pain coping strategies are seen in all aspects of life from lamaze classes to old westerns when cowboys were told to "bite the bullet." Both of these techniques work towards "distracting" a persons focal point away from the pain and onto the chosen stimulus. Distraction will be broadly defined as directing one's attention away from the sensations or emotional reactions produced by a noxious stimulus (McCaul and Malott, 1984).

For stimuli of increasing intensity, (e.g. treadmill test) the best coping strategy would be to begin with distraction when the stimulus is of mild intensity and then shift to a different distraction as the stimulus begins to draw attention from the first strategy (ibid).

Individual differences have been shown to allow some people to find distraction more beneficial than others. Epstein & Fenz (1967) suggest a repressor-sensitizer model. Repressors are people who prefer to cope with stress by avoiding the event; sensitizers prefer to attend to

information about the stressor. A study done by Horwitz & Shipley (1977) compared sensitizers and repressors in a painful medical procedure (endoscopy). They found that repressors evidenced less discomfort while listening to music relative to those in the control condition while sensitizers showed the opposite effect. The discomfort was recorded by nurses and doctors observing the patients during the procedure.

CHAPTER III

PROCEDURES

Setting

The test was administered in the Eastern Illinois University Human Performance Laboratory, at a temperature of 25 = 1 centigrade. Noise level was regulated by posted signs asking people who passed by to refrain from making any loud noises.

Instruments

The following instruments were used in the study:

Monark Bicycle Ergometer.

Borg's Rating of Perceived Exertion Scale.

11-point bipolar scale for exercise affect.

Vantage Heart Rate Monitor.

Goggles and earplugs.

Headphone tape player.

Subjects

11 active college male students were recruited by word of mouth from the Eastern Illinois University campus in Charleston, IL.

Treatment

Preliminary testing

Subjects were asked to refrain from eating and exercise 3 hours prior to testing. They were also asked to schedule all sessions at approximately the same time of day. The initial session consisted of completing consent forms as well as a maximal oxygen consumption test (performed on a cycle ergometer). During the maximal oxygen consumption test, subjects practiced using Borg's scale and Rejeski's 11-point bipolar feeling scale for affective responses.

At this time their height, weight, and age were measured. Each person then received a daily log book in which they recorded activities, and hours of sleep each day. This was done in an attempt to control things which would alter their RPE and FS scores between each submaximal test, such as alcohol consumption, lack of sleep or an unusually strenuous day. Subjects were then asked to schedule three testing sessions, each consisting of approximately 45-60 minutes, at approximately the same time of day.

Experimental tests

Before each session, the subjects were told that they were going to perform three 6-minute sets of cycle exercise with a ten minute rest between each stage.

The order of the separate sessions (sensory

deprivation, music, control) was different for each person. Each subject was able to select the music they listened to during the music condition.

Each subject was fitted with a Polar heart rate monitor which was fastened to their chest, just below the pectoralis major. The bicycle seat was adjusted to 109% of their inseam. For each session, the Borg's scale and the 11-point bipolar affect scale was approximately three feet in front of the subjects, at eye level. RPE and FS scores were verbally assessed after each 6 minute stage. HR was recorded every minute throughout each exercise.

Each subject had a 3 minute warm-up, followed by three 6-minute randomized sessions corresponding to workloads of 50% (light), 70% (moderate), and 90% (heavy) of their maximal oxygen consumption. There was a ten minute rest between each stage for each condition. Sensory deprivation groups were fitted with goggles and earplugs, depriving them of both sight and sound. This was done to create a situation where the person is forced to focus all attention on internal cues. During the music condition, subjects exercised while listening to music on a headphone tapeplayer.

While exercising, the sensory deprivation group's cadence was monitored by touches on the shoulder. One touch to speed up and two touches to slow down. The goggles were removed at the proper times to collect the RPE and FS data.

Treatment of Data

Collection of Data

Manual recordings of RPE, FS and HR were obtained at the time of the tests. RPE and FS data were recorded at the end of each 6 minute stage and HR was recorded from the heart rate monitor watch every minute.

Analysis of Data

After the data was collected, a 3 x 3 (condition: control, sensory deprivation, music vs. work intensity: light, moderate, heavy), multivariate analysis was applied to the resultant data, with Student-Newman-Keuls post hoc test. The alpha level was .05 (see Appendix D, pp. 34-36).

CHAPTER IV

RESULTS

Subjects

Subjects were asked to keep daily diaries, charting hours of sleep and activity levels. There were no apparent changes in their daily routines that would have altered their experimental variable scores (RPE, FS, and HR), or their ability to finish a timed trial. Five of the eleven people weren't able to complete the last minute of exercise during the sensory deprivation and heavy condition, with 2 of those 5 people failing to complete the last 2 minutes. Three subjects weren't able to complete the last minute during the heavy exercise. All the subjects finished in the music condition.

Experimental Variable Results

Ratings of Perceived Exertion

RPE was significantly higher in the sensory deprivation and control conditions during the heavy workload when compared to the music condition (Table 1). Music was shown to be the contributing factor in decreasing a person's perceived level of exercise during the heavy (90%) workload.

Table 1: Means (= standard deviation) values for RPE compared to each condition

	Light	Moderate	Heavy
Control	10.46 (1.04)	13.82 (1.72)	*16.55 (1.64)
SD	10.91 (1.45)	14.09 (1.38)	*16.91 (1.14)
Music	10.09 (1.30)	12.91 (1.76)	15.18 (1.54)

* = Significantly different when compared to the music condition at the heavy workload ($p < 0.05$).

Exercise Affect Scores (Feeling Scale)

The music group had higher FS scores, suggesting that they felt better during that condition compared to the sensory deprivation and control groups. These differences were not found to be significant (Table 2).

In the light and moderate conditions, subjects reported more positive or higher affective scores during the control when compared to the sensory deprived group. At the heavy workload however, the sensory deprived group was more positive.

Table 2: Mean (= standard deviation) values for 11-point bipolar feeling scale

	Light	Moderate	Heavy
Control	3.37 (0.93)	0.09 (1.98)	-1.91 (1.81)
SD	3.09 (1.58)	0.55 (1.63)	-2.64 (1.58)
Music	4.00 (1.27)	1.18 (1.72)	-0.64 (1.03)

Heart Rate

Heart rates did not differ significantly between the groups (Table 3). Heart rate data for each condition was correlated with FS data, and an r of -.92 was revealed, suggesting that subjects felt worse as each condition continued.

Table 3: Mean (= standard deviation) values for heart rate taken at the end of each 6-minute stage of exercise for each condition.

	Light	Moderate	Heavy
Control	135.0 (18.6)	167.7 (14.1)	181.6 (8.4)
SD	140.2 (19.9)	169.3 (13.7)	183.5 (9.6)
Music	133.7 (15.0)	166.9 (13.1)	185.2 (7.5)

CHAPTER V

DISCUSSION

The study of the effects of music and sensory deprivation didn't fully support the original hypothesis that music would be significant at all levels to decrease perceptions of fatigue, and result in higher affective scores. Partial statistical support was found during the heavy condition, when RPE values were compared between SD and control, and SD and music at the heavy (90%) workload (Table 1).

Early studies dealing with RPE reported lower scores when music was listened to during submaximal exercise at the light and moderate levels (Boutcher & Trenske, 1990). No study up to date has shown music to be effective on RPE at a high workload (85-95% of maximal oxygen consumption). This was attributed to the overflow of sensory input created at high intensity workloads. It was thought that during the heavy workload, the sensory input was so great that it overcame any benefits that a distraction technique may have offered (Boutcher & Trenske, 1990). The findings in this study differ from this hypothesis, but don't necessarily contradict it.

The basic finding for RPE was that music was only effective at lowering RPE at the heavy workload. This implies that the sensory input was not greater than the

music's effects, and in fact music was successful in decreasing the RPE and also allowing the subject to finish the workloads. It was noted before that five out of the eleven subjects weren't able to finish the sensory deprivation and control conditions at the heavy workload. Again, music was shown to be beneficial because all subjects finished their respective workloads during the music condition. The general findings dealing with RPE lended support only to the induction of music during strenuous exercise to show marked decreased in fatigue perceptions.

Feelings fluctuate throughout exercise, and different people deal with higher workloads in different ways (Hardy & Rejeski, 1989; Frijida, 1988). Previous studies found significant differences between moderate and high workloads when comparing a music group to a sensory deprived group (Boutcher & Trenske, 1990). Although the music group showed more positive FS scores compared to the control and sensory deprivation groups, no significant differences were found (Table 2).

It was mentioned before that the incorporation of the FS during exercise would be beneficial in that it may identify those who respond positively to more demanding workloads (Rejeski, 1985). This suggests the high variability that may exist amongst individuals. This would indicate an inherent problem in the study. The variability would make it difficult to compare results between such a

highly different group. Further research should compare different groups such as college athletes and sedentary people, with FS data. Further validity of the FS could help in either identifying individuals who can work successfully at high workloads, or diagnose those athletes who may have a problem with the same workload. Then, proper distraction techniques could be incorporated.

Heart rate was found to be slightly higher in the SD condition, however this may be attributed to the anxiety that was caused by having goggles and ear plugs on during testing (Table 3, p. 21). During the SD condition, subjects were cued by taps on the shoulder. It was revealed that during the SD condition the subjects were very anxious, or they felt very vulnerable. Since they were internalized, light taps on the shoulder startled. One subject was so startled that he almost fell off the cycle. This anxiousness created by the SD condition was probably the cause of the slightly elevated heart rates, but again no statistical significance was noted.

These findings give partial support to the ideas of Rejeski (1985), and Boutcher & Trenske (1990), stated earlier in the paper that music is successful in shifting attentional focus. Previous research showed differences at light and moderate workloads, and these findings reported significant differences during the heavy workload for RPE. The inherent variability in the FS were thought to be the

cause of the findings.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The findings of this study suggest that music is effective at high levels of exercise (90%) in decreasing a person's perceptions of fatigue. Music may also be a factor in "helping" a person finish a heavy bout of exercise. There was support for the SD and music and SD and control at the heavy workload (90%) for RPE, but all other variables failed to show statistical significance.

The present work has practical implications both for physical fitness in general and cycling in particular. The literature review presented increased performance and satisfaction with exercise when music or other distraction techniques were introduced. Beyond an exercise setting, this study points out the relative importance that music can play during a bout of exercise. Many individuals discontinue exercise because they find it either too straining or displeasurable (Frijida, 1988; Hardy & Rejeski, 1989; Boutcher & Trenske, 1990). By incorporating music, the person will perceive the bout as being less strenuous than if music was not introduced. This would increase the probability that the exercise would be repeated and

continued.

Finally, the study would be remiss in mentioning the implications that the FS may have in exercise testing. The FS in not free from criticism, but is should be agreed that feelings are highly variable, and techniques to measure these are imperative in order to establish a better understanding of the exercise response. As noted by Zajonc (1980), "If we consider just how much variance in the course of our lives is controlled by cognitive processes and how much by affect, and how much the one and the other influence the important outcomes in our lives, we cannot but agree that affective phenomena deserve far more attention than they have received" (p. 72).

Recommendations

The results of this study gave some indication to the benefit that music has on exercise. The following recommendations are made regarding future studies:

1. Much larger sample sizes are needed that would not bias the results.
2. Better methods of internalizing a persons strain need to be implemented. Even though the goggles and headphones were successful in depriving some of the light and sound respectively, all subjects reported being able to hear and see somewhat.
3. In this study, an old cycle ergometer was used. This only allowed the workloads to fluctuate by 35 watts. The use of a more precise instrument would be better for gearing each workload to their prescribed percentage of their maximal oxygen consumption.
4. Stricter control of outside variables such as light, students passing by, etc. are needed.
5. Perhaps introducing visual stimuli as well as audio would show collective benefits exceeding the incorporation of audio or visual alone.
6. Before actual data is collected, more practice with Borg's scale and the FS is probably needed.

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APPENDIX A

Statement of Informed Consent

The purpose of this study is to examine the effects that music and sensory deprivation have on rating of perceived exertion and exercise affect. The results of this study will work to both lend credibility to the induction of music in an exercise program, and to validate the use of the feeling scale in exercise testing.

Procedures

Maximal Oxygen Test

The first test performed will be a maximal cycle test to determine VO_{2max} and maximal heart rate. This test will be conducted in the human performance laboratory in Lantz gymnasium. It will involve exercising on a stationary cycle until exhaustion. You will be required to breathe through a mouthpiece and wear a heart rate monitor around your chest throughout the entire test.

The test will be ended at the time when you can no longer continue cycling. You will be cycling for approximately 10-20 minutes (depending on your fitness level and motivation). As this is a maximal test to exhaustion, there is the risk, in extreme cases of stroke or heart attack. All precautions will be taken however, and an experienced experimenter will monitor the test and ensure your well-being at all times.

Experimental testing

The second, third and fourth testing sessions will consist of three 6- minute stages of exercise on a stationary cycle with a 10-minute rest between each session. Everything you will need will be provided.

Your individual results will be available to you on completion of the experiment. Feel free to ask questions at any time. Thank you for your participation.

I, the undersigned, understand the procedures described above, and am aware of the risks involved. I also realize that I am free to withdraw from the study at any time, for whatever reason.

Signed:____ **Date:**______
Witness: ____ **Date:**______

APPENDIX B

CYCLE VO_{2max} TEST

PROTOCOL

STAGE	WATTS	DURATION
1	70	2 MIN
2	105	2 MIN
3	140	2 MIN
4	175	2 MIN
5	210	2 MIN
6	245	2 MIN
7	280	2 MIN
8	315	2 MIN
9	350	2 MIN
10	385	2 MIN

APPENDIX C

11-Point Bipolar Scale For Exercise Affect

-5 Very Bad

-4

-3 Bad

-2

-1 Fairly Bad

0 Neutral

+1 Fairly Good

+2

+3 Good

+4

+5 Very Good

APPENDIX D

Student-Newman-Keuls post-hoc for RPE vs. all conditions

Student-Newman-Keuls
Dependent: RPE-Light
Significance level: .05

	Vs.	Diff.	Crit. diff.
Music	Control	.364	1.108
	Sensory Dep.	.818	1.339
Control	Sensory Dep.	.455	1.108

None were significantly different at this level.

Student-Newman-Keuls
Dependent: RPE-Moderate
Significance level: .05

	Vs.	Diff.	Crit. diff.
Music	Control	.909	1.418
	Sensory Dep.	1.182	1.712
Control	Sensory Dep.	.273	1.418

None were significantly different at this level.

Student-Newman-Keuls
Dependent: RPE-Heavy
Significance level: .05

	Vs.	Diff.	Crit. diff.
Music	Control	1.364	1.265-**s**
	Sensory Dep.	1.727	1.528-**s**
Control	Sensory Dep.	.364	1.265

s = Significantly different at this level

APPENDIX D (cont.)

Student-Newman-Keuls Post-hoc for Affect vs. all conditions

Student-Newman-Keuls
Dependent: Affect-light
Significance level: .05

	Vs.	Diff.	Crit. diff
Sensory Dep.	Control	.364	1.217
	Music	1.000	1.470
Control	Music	.636	1.217

None were significantly different at this level.

Student-Newman-Keuls
Dependent: Affect-moderate
Significance level: .05

	Vs.	Diff.	Crit. diff.
Control	Sensory Dep.	.364	1.526
	Music	1.000	1.843
Sensory Dep.	Music	.636	1.526

None were significantly different at this level.

Student-Newman-Keuls
Dependent: Affect-heavy
Significance level: .05

	Vs.	Diff.	Crit. diff.
Sensory Dep.	Control	.182	1.395
	Music	1.455	1.685
Control	Music	1.273	1.395

None were significantly different at this level.

APPENDIX D (cont.)

Student-Newman-Keuls Post-hoc for HR vs. all conditions

Student-Newman-Keuls
Dependent: HR-Light
Significance level: .05

	Vs.	Diff.	Crit. diff.
Music	Control	1.636	14.915
	Sensory Dep.	7.545	18.012
Control	Sensory Dep.	5.909	14.915
None were significantly different at this level.			

Student-Newman-Keuls
Dependent: HR-Moderate
Significance level: .05

	Vs.	Diff.	Crit. diff.
Music	Control	.273	12.310
	Sensory Dep.	2.636	14.866
Control	Sensory Dep.	2.364	12.310
None were significantly different at this level.			

Student-Newman-Keuls
Dependent: HR-Heavy
Significance level: .05

	Vs.	Diff.	Crit. diff.
Control	Sensory Dep.	.727	7.677
	Music	2.636	9.271
Sensory Dep.	Music	1.909	7.677
None were significantly different at this level.			

APPENDIX E

Biometric and Maximal Oxygen Consumption data for all subjects

Age (yrs)	Weight(kg)	Height(cm)	VO_{2max} (ml/kg/min)	Max HR
23	72.00	177.80	51.16	200
27	63.00	147.40	40.16	200
22	83.00	183.00	47.81	195
22	81.00	190.50	42.16	186
23	81.00	183.90	39.86	190
22	68.00	177.80	37.00	184
33	77.20	170.18	46.63	179
22	83.50	182.88	49.04	201
23	64.00	147.40	46.40	201
22	84.00	154.00	35.47	180
22	86.00	182.88	41.44	182