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Lyrical Music Improves 5 km Time Trial Performance Compared to Non-Lyrical Music

Denise J. Myers MS
Georgia State University

J. Andrew Doyle PhD
Georgia State University

Jeffrey Scott Otis
Georgia State University

Christopher P. Ingalls PhD
Georgia State University

ACCEPTANCE

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The Thesis Advisory Committee and the student's Department Chairperson, as representatives of the faculty, certify that this thesis has met all standards of excellence and scholarship as determined by the faculty.

_____
J. Andrew Doyle, PhD, FACSM
Committee Chair

_____
Jeffrey S. Otis, PhD
Committee Member

_____
Christopher P. Ingalls, PhD
Committee Member

_____
Date

_____
Mark Geil, PhD
Chairperson, Department of Kinesiology & Health

_____
Paul A. Alberto, Ph.D.
Dean
College of Education
and Human Development

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Denise Jane Myers
Department of Kinesiology and Health
College of Education and Human Development
Georgia State University

The director of this thesis is:

Dr. Andrew Doyle
Department of Kinesiology and Health
College of Education and Human Development
Georgia State University
Atlanta, GA 30303

CURRICULUM VITAE

Denise Myers

ADDRESS: PO Box 147
Perry, MO 63462

EDUCATION:

Masters Degree	2016	Georgia State University Kinesiology and Health
Bachelors Degree	2012	University of Louisiana-Monroe Exercise Science

PROFESSIONAL EXPERIENCE:

2013-2016	Exercise Physiology TA Georgia State University
2011-2012	Trainer Athletic Republic

PROFESSIONAL SOCIETIES AND ORGANIZATIONS

2012	American College of Sports Medicine
2012	USA Track & Field

LYRICAL MUSIC IMPROVES 5 KM TIME TRIAL PERFORMANCE COMPARED TO NON-LYRICAL MUSIC.

by

DENISE MYERS

Under the Direction of Dr. Andrew Doyle

ABSTRACT

This study examined the effects of lyrical music compared to non-lyrical music on 5 km running performance. Thirteen subjects with an average age of 33.5 ± 8.3 years of age ran three separate 5 km time trials. The first trial acted as a familiarization trial where no music was present, followed by either a lyrical or non-lyrical music trial in a random counterbalanced order. Trial times, RPE, HR, and questionnaire information was analyzed using paired samples t-tests, ANOVA, and multivariate regression analyses. Lyrical music showed a significant improvement over non-lyrical music improving performance time compared to non-lyrical music, on average by 36 ± 41s (p=.000). While not statistically significant, a trend showing lyrical music was faster than no music, followed by the slowest trial of non-lyrical music. No change was detected in HR, or RPE at the 3.05 km mark suggesting that at the end although subjects were working harder (indicated by the faster completion times) they do not perceive themselves to be working harder. A correlation between increased mileage and the decreased effects of music as an ergogenic aid was seen (p=.044 r=.638) which supports previous research. This study suggests that lyrical music may improve 5 km running performance compared to no lyrical music.

INDEX WORDS: Running, Music, Lyrics, Performance, 5 km, Ergogenic aid

LYRICAL MUSIC IMPROVES 5 KM TIME TRIAL PERFORMANCE COMPARED TO NON-LYRICAL MUSIC.

by

DENISE MYERS

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DEDICATION

In dedication to my grandparents Buzz & Jane Myers and Doc & Rosemary Graham who instilled the importance of education and learning into my family life.

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1 [1]MUSIC AND EXERCISE LITERATURE REVIEW MANUSCRIPT

Guiding Questions

It is commonplace to see athletes listening to music while training (Copeland & Franks, 1991; Matesic & Cromartie, 2008; Simpson & Karageorghis, 2006). Music is incorporated as a part of sports routine in many settings, including practices and competitions held in both indoor and outdoor settings (Mohammadzadeh, Tartibiyan, & Ahmadi, 2008). Athletes are constantly striving to get ahead of their competition by any means possible. Music as an ergogenic aid during exercise has been studied since the 1970s, and its benefit to exercise performance has been a compelling topic of research. A broad array of studies have examined different aspects of music in training, ranging from physiological to psychological effects. Current research studies compare many different aspects of music and exercise performance including: the training status of subjects, mode of exercise, metabolic pathways, and selection of music, as well as descriptive aspects of the music being tested.

The majority of research on music and its effect on exercise performance has been geared toward running, followed by a sizable amount on cycling, and a limited amount on lifting, circuit training, and other modes of exercise. Aspects of music that have specifically been investigated include; genre, tempo, and volume and their effects on exercise performance.

Review

Training Status

Training status of the athletes is an important factor to consider when testing music's effect on exercise performance. The majority of evidence suggests music is of a greater benefit to untrained athletes than to trained athletes. Highly trained athletes tend to see less of an effect due to music because they are already highly motivated, with respect to untrained athletes which reap larger benefits of the effects that music has on improving rating of perceived exertion (RPE) due to their lack of motivation, the dullness, or repetitiveness (Mohammadzadeh et al., 2008). Even though it is suggested that untrained athletes receive greater performance improvements while listening to music than trained athletes do, in both Mohammadzadeh et al. (2008) and Matesic and Cromartie (2008) there is still a statistically significant improvement for the trained athletes time performance and time to exhaustion (TTE) .

Mohammadzadeh et al. (2008) has also shown a decrease in RPE of .97 in untrained subjects and an improvement of .34 in trained subjects' in addition to performance improvements of an increase in TTE of 17.45s in untrained athletes and 9s in trained athletes. Notably trained athletes still benefited, less than untrained athletes, but trained athletes were still receiving significant benefit from listening to music. However research by Matesic and Cromartie (2008) also suggests that trained nor untrained subjects RPE were significantly lowered by listening to music while exercising. Brownley, McMurray, and Hackney (1995), also suggest trained nor untrained athletes received aid from listening to music during exercise in TTE. Young, Sands, and Jung (2009) and, suggest as well that there is no significant benefit in RPE from listening to music, nor any performance benefits to listening to music while running for a trained athlete population, however this study was not testing against and untrained population. Past research comparing

trained athletes an untrained athletes has been done on treadmills (Brownley et al., 1995; Matesic & Cromartie, 2008; Mohammadzadeh et al., 2008; Young et al., 2009) and seems to suggest that performance (time and TTE) benefits are occurring more in the untrained populations (Matesic & Cromartie, 2008; Mohammadzadeh et al., 2008) yet the RPE does not seem to be a difference between the trained and untrained populations (Matesic & Cromartie, 2008; Young et al., 2009).

Type of Exercise

Mode of exercise is also an important factor to look at when considering music's effect on exercise performance. Only minimal research has been done on weight lifting and music as an ergogenic aid, however, music has been shown to be of at least some aid. A study done by Biagini et al. (2012) found that music can be of benefit during jump squats and, Crust (2004a) showed music benefited endurance resistive training. On the other hand, Biagini et al. (2012) discovered no increase in repetitions to failure, or RPE benefits from listening to music during bench press. Crust (2004b) soon did a second experiment to determine if the Biagini et al. (2012) study did not see improvements due to it being an upper body only exercise rather than a full body exercise. Crust (2004b) had subjects hold a weight at a ninety degree angle for as long as possible, this exercise was an upper body test that did not include the lower limbs. In this case the athletes were able to sustain holding the weights at 90° longer with the help of listening to music. The benefits of music seen in the Crust (2004b) suggests that the upper body muscle performances may still receive benefits in performance with the use of music.

Much more research has been done on music and its effect on endurance exercise such as cycling. The majority of cycling studies reported listening music as a performance benefit. A synthesis of studies by Nakamura, Pereira, Papini, Nakamura, and Kokubun (2010), Potteiger, Schroeder, and Goff (2000), Cohen, Paradis, and LeMura (2007), and Elliott, Carr, and Orme

(2005) all coincide to show music's benefit during cycling. Research by Yamashita, Iwai, Akimoto, Sugawara, and Kono (2006) agrees with music being a benefit, but only for sub-maximal intensity exercise not for maximal exercise. T J Pujol and Langenfeld (1999) study also showed no benefit to cyclists listening to music during 30-sec maximal wingate test. There is minimal controversy when it comes to music's benefit on cycling. The majority of research suggests music has been an aid to sub-maximal cycling (Cohen et al., 2007; Elliott et al., 2005; Nakamura et al., 2010; Potteiger et al., 2000; Yamashita et al., 2006). Listening to music was shown to decrease RPE by 1-3.1 , (Nakamura et al., 2010; Potteiger et al., 2000) increase of revolutions per minute by 2.7, (Cohen et al., 2007) as well as increase distance traveled by .55 and .53 km in a time trial depending on the type of music the subject listened to (Elliott et al., 2005).

The bulk of research examines music as an ergogenic aid has been done on running and suggests that listening to music is a benefit to running performance (Bharani, Sahu, & Mathew, 2004; Crust, 2004a, 2004b; Dyrlund & Wininger, 2008; Edworthy & Waring, 2006; Mohammadzadeh et al., 2008; Simpson & Karageorghis, 2006). These benefits range from TTE, exercise enjoyment, and tempo. An increase in TTE was measured during Bruce Protocol tests ranging from 9 to 115 s longer (Bharani et al., 2004; Mohammadzadeh et al., 2008) and 1055.9 and 1035.4 s longer during a Balke Walking Test (Crust, 2004a), an increase in enjoyment of exercise was found in Dyrlund and Wininger (2008), and an increased tempo was shown in ; Edworthy and Waring (2006) and Simpson and Karageorghis (2006) study where a 400 m time trial was 31s and 68s faster when music was present.

When considering maximal intensity exercise, a study with runners on a track, showed an increasing lap pace of 3-5s per lap (during a 20 min time trial) as a benefit to listening to music, yet the same study also showed an increase in RPE, which was not a benefit (Matesic &

Cromartie, 2008). Other maximal intensity research studies by Brownley et al. (1995); Tenenbaum et al. (2004); Young et al. (2009) also show evidence contradicting music's benefit on running. However, one cannot assume that maximal intensity testing protocol was the sole reason why these subjects did not receive positive benefits from music because a convincing amount of the research reports that music did act as an ergogenic aid for maximal intensity exercise testing procedures (Bharani et al., 2004; Crust, 2004b; Dyrlund & Wininger, 2008; Edworthy & Waring, 2006; Matesic & Cromartie, 2008; Mohammadzadeh et al., 2008; Simpson & Karageorghis, 2006).

Research about music's effect on exercise has mainly been aimed at aerobic exercise, however, mixed results have been observed for anaerobic exercise. In a 400 m sprint, music decreased the time necessary to complete a 400 meter lap by 31 and 68 s (Simpson & Karageorghis, 2006), and jump squat take off velocity has also been shown to increase while listening to music (Biagini et al., 2012). However, during a thirty second Wingate test different results were observed. T J Pujol and Langenfeld (1999) found no benefit to listening to music to be observed for mean power output, maximum power output, or time to exhaustion, contrary to that Brooks & Brooks (2010) found an increase in both peak power output (a 225 W increase) and mean power output (a 285 W increase). One main difference in these two studies was that T J Pujol and Langenfeld (1999) allowed their subjects to choose from a preset selection of music including new wave, hard rock, and pop music, while Brooks and Brooks (2010) allowed their subjects to completely select their own music according to the Brunel music inventory rating.

Music Selection

A multitude of studies have all looked at self-selection and music preference as an important factor in music's effect on exercise (Biagini et al., 2012; Dyrlund & Wininger, 2008;

Nakamura et al., 2010). These studies all suggested that there is a benefit to allowing subjects to select their own music. Although the purpose of Bharani et al. (2004) study was not to identify if self-selected music as an ergogenic aid, they did allow their subjects to choose their own music, and yet their study still agreed that subjects benefited while listening to self-selected music.

Similarly, Crust (2004b) looked at familiarity of music, where familiarity was described as how well subjects knew the music that was played during their performance. However, this study found that the familiarity of music provided no benefit to subjects during treadmill endurance walking. One possible reasoning behind this finding could be that there is a possible optimal level of familiarity, and familiarity beyond that optimum point has no further benefits and may even possibly have adverse effects (Crust, 2004b). There has yet to be further research to better clarify on familiarity of music and its effect on exercise performance. This allows for the suggestion of letting participants choose their own music to listen to while testing is of more benefit than standardizing the song selections for their exercise bout would be.

Genre

Music alone is far too broad of a term to describe these studies; there is a wide variety of different types of music, and potentially each type of music could have a different effect on exercise performance, due to the many characteristics that converge to create music. The five main components of music; rhythm, melody, harmony, timbre, and texture, converge to create music (Schmidt-Jones, 2013). Genre is the shared characteristics of music, however one song may be classified into multiple genres due to overlapping of characteristics (Correa, Saito, & da F. Costa, 2010).

Comparisons have been executed on different genres of music such as, techno and electronic dance music, where a decrease in lap pace time in a 20 min run was shown (Matesic &

Cromartie, 2008) in other instances dance, inspirational, and rock music were studied and showed a large variance in discomfort levels during each (Tenenbaum et al., 2004). Jazz, classical, and self-selected music were also compared and has also shown an improvement in RPE during moderate intensity cycling (Potteiger et al., 2000). This is rather interesting because jazz and classical music have quite different tempos, with jazz being fast tempo while classical is typically a much slower tempo of music.

Tempo

Merriam-Webster dictionary defines tempo as "the speed at which a a musical piece is played or sung" or "the rate of something moves or happens". Tempo is measured in beats per minute (bpm). Brownley et al. (1995) published a study comparing sedative and fast music, sedative being defined as marketed stress management music and fast music being referenced to 154-162 bpm. This study showed no benefit on TTE for either music tempos. However Edworthy and Waring (2006) looked at not only music tempo, but also volume of music, with fast music in this study being defined as 200 bpm and slow music being defined as 70 bpm. In this study fast tempo music aided runners to increase their running pace by .54 km/h (.33 mph). In this case, loud fast music was of most benefit, while quiet fast music was still a benefit to the athletes it was not as of much as the loud fast music but still showed a definite benefit.

Volume

The volume used in different musical studies varies a considerable amount as some studies control the volume while other studies allow participants to choose their desired volume prior to testing, and yet others allow participants to change the volume as they wish throughout the exercise bout. However the only study that actually compared the volume of music was the Edworthy and Waring (2006) study that defined loud music as 80 decibels (dB) and quiet music

as 60 dB. Here the loud volume was seen as an aid to increasing pace while running, although it was not as much of an aid as the tempo of the music, it was still statistically significant as an aid. Although studies have been done on genre of music, tempo of music, and even volumes of music, to my knowledge there has yet to be any research done on lyrical music and its effect on exercise performance.

Emotional Response

Not only is it important to look at physiologically how music can affect performance but also it is necessary to consider the psychological role that music plays. Scherer and Zentner (2001) have identified routes of emotion that results from listening to music: memory, empathy, and appraisal. The memory's route of emotional response would include a trigger of recollection or an event. While the empathy route relates to the ability of the listener to recognize or identify with the emotions that the performer is expressing, or possibly with the music itself and what it is expressing. The last route of appraisal where the listener evaluates the personal significance of the music being communicated in association with their own. Regardless of which route of emotional response the listener takes music's affective qualities impact on the psychological state has been shown effective in aiding participants especially when the participants are permitted to select their own music as well as exercise intensity (Karageorghis & Priest, 2012).

A substantial amount of research has been conducted on music and its effect on running, not every study is in agreeance with music being a benefit, yet a significant amount of evidence appears to indicate that listening to music benefits running performance (Bharani et al., 2004; Brownley et al., 1995; Crust, 2004b; Dyrlund & Wininger, 2008; Edworthy & Waring, 2006; Mohammadzadeh et al., 2008; Simpson & Karageorghis, 2006) The type of music in which the runner listens to has the potential to affect individuals differently and has to some degree been

studied. Genre of music has been studied comparing techno, dance, inspirational, classical, jazz, and rock music. While techno and dance improved performance, dance inspirational, classical, jazz, and rock all improved perception of difficulty of the exercise task at hand (Matesic & Cromartie, 2008; Potteiger et al., 2000; Tenenbaum et al., 2004). Letting the subjects choose the music in which they want to listen to has been shown to benefit subjects even more than just listening to music chosen by testers (Biagini et al., 2012; Dyrlund & Wininger, 2008; Nakamura et al., 2010). The majority of research has allowed subjects to choose the volume in which they would like to listen to music but when specifically looking at volume alone the louder music was found to slightly benefit runners (Edworthy & Waring, 2006).

Although many aspects of music have been taken into consideration, the effect of lyrics within music, to my knowledge, have yet to be studied in published literature. The purpose of this study was to determine if lyrical music compared to non-lyrical music will have an ergogenic effect on 5km timed trial running performance through 5km timed trial completion time, RPE, and heart rate (HR). Therefore, the hypothesis was determined to be that there will be no difference in 5km time trial times, RPE, or HR between lyrical and non-lyrical time trial performances.

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2 LYRICAL MUSIC IMPROVES 5 KM TIME TRIAL PERFORMANCE COMPARED TO NON-LYRICAL MUSIC RESEARCH MANUSCRIPT

Music is an integral part of our everyday lives, evolving from live performances, record players, boom boxes, cassette players, walk-mans, and now mp3 players that are smaller than the palm of our hands, and even built into our cell phones. Not only is music a part of our day-to-day lives, it is also part of our experience at many sporting events. Professional baseball players each have a walk-up song that plays when it is their turn at bat, and basketball and hockey franchises have their starting lineup jingles played before each game. In addition, music is played throughout sporting events, during timeouts, commercials, and half times.

Sporting events are not the only thing that music has become a part of, almost every group exercise class has music playing, and many classes are designed to fit specific song selections. In fact, a survey of college students showed that running was the most common exercise that students "always listened to a music player" (Barney, Gust, & Liguori, 2012).

The bulk of previous research has shown that music acts as an ergogenic aid that improves running performance by increasing time to exhaustion (TTE) as well as decreasing rating of perceived exertion (RPE). In research by Matesic and Cromartie (2008) and Mohammadzadeh, Tartibiyan, and Ahmadi (2008) a significant difference in performance improvements was seen between untrained athletes and trained athletes. The untrained runners received a greater benefit than trained athletes, but both still did see performance improvements while listening to music. In the study by Matesic and Cromartie (2008) trained subjects improved by 3 s and untrained subjects improved by 5 s per lap while listening to music in a 20 min timed

trial. In the study by Mohammadzadeh et al. (2008) trained subjects improved their graded exercise test (Bruce Protocol) time by 9s and untrained subjects improved their time by 17.4 seconds while listening to music. Improvements in TTE running performance have been seen ranging from 9 to 1056 s faster while listening to music during a maximal effort graded exercise test (Bruce Protocol & Balke Protocol) and a 1.5 mile run (Bharani, Sahu, & Mathew, 2004; Bonette, Smith, & Spaniol, 2012; Copeland & Franks, 1991). Some other exercise performance studies have also shown music to have no effect on TTE (Brownley, McMurray, & Hackney, 1995; Young, Sands, & Jung, 2009). It is important to note that the Young et al. (2009) experiment was made up of college soccer players, indicating that the subject group was composed of trained athletes, which has previously been shown to receive less benefit in running performance when listening to music.

Self-selected running pace while listening to music was studied by Dyrlund and Wininger (2008) who reported that music did not help subjects perform better during a 20 min timed trial. However, Simpson and Karageorghis (2006) and Matesic and Cromartie (2008) suggested that during time trials the subjects who were listening to music showed a significant improvement in running pace by .31 s per lap in a 400 m run and 5 s per lap in a 20 minute run respectively. Matesic and Cromartie (2008) also saw a significant decrease in RPE during the 20 min time trial. Similar to the Matesic and Cromartie (2008) study, Potteiger, Schroeder, and Goff (2000) published a study composed of a 20 min time trial, on cyclists providing evidence that music of several different types can significantly decrease the subjects RPE by 1 or 4.

The specifics of how music impacts exercise performance remain controversial. For example, research has suggested that the beat of the music is the ergogenic aid (Copeland & Franks, 1991; Potteiger et al., 2000); other research proposes that it is the genre of music

(Tenenbaum et al., 2004), while yet other research suggests it is the volume (Edworthy & Waring, 2006). However, one aspect of music that has had little research attention thus far and has therefore left open a gap in scientific research is lyrics of music and its effects on running performance. Therefore, the purpose of this study was to determine if there is a difference in 5km time trial running performance between lyrical and non-lyrical music.

Methodology

This study was a quasi-experimental design experiment, with a crossover design, where subjects acted as their own control by completing three timed trials to determine the effect of lyrical music on 5km running performance. The first visit included a familiarization trial with no auditory stimulation, and the next two trials were in a random counterbalanced order, listening to either lyrical or non-lyrical music. This study was approved by the Georgia State University Institutional Review Board.

Participants

Male and female subjects between the ages of twenty-one and forty-eight years with prior running experience were recruited for this study. Running experience was defined for this study as running on a consistent basis (running at least 3 miles on at least 3 days per week for the past year) and have competed in at least 2 races 5 km or greater within the past 2 years (1 race per year). This ensured that subjects were able to not only complete the 5 km timed trial, but they had some prior knowledge and experience of how to run a 5 km timed trial. Potential subjects were excluded if they typically ran faster than 18 minutes for males and 21 minutes for females

for a 5km race. This exclusion was to eliminate having highly trained athletes in the study because previous research suggests that trained athletes see significantly smaller effects on performance due to listening to music.

Procedures

Subjects were asked to come to the lab on three separate occasions. On the first visit three forms were completed prior to running their first timed trial: a consent form, health history questionnaire, and a short questionnaire with an area to list 15 songs that they would like to listen to during their future performances. Subjects were asked to suggest the order in which they would like the songs they had chosen to be played to more closely simulate a regular running experience. Music was obtained from YouTube by creating YouTube playlists; both a lyrical and a non-lyrical version of each song was found and a playlist was created for each subject. Both playlists of each subject contained the same songs in the same order to control for the effect of tempo upon performance.

Subjects also completed an activity log for two days prior to testing for all three trials. Subjects were asked to do no more than 45 minutes of running two days before, and no more than 30 minutes of running the day before their timed trial and no running higher than moderate intensity. Also subjects filled out a nutrition/hydration log one day prior to testing. The logs were collected and given back to the subjects after their timed trial was complete. Subjects were asked to follow the same routine as closely as possible leading up to each performance test to control for the effect diet and prior exercise on performance.

Subjects' physical characteristics were measured: age, height, weight, heart rate, resting blood pressure and body fat percentage (3-site skinfold method). The health history was evalu-

ated to ensure that all subjects were Low Risk according to American College of Sports Medicine (*ACSM's Guidelines for Exercise Testing and Prescription*, 2013) guidelines. Subjects who were not Low Risk were excluded from testing due the maximal or near maximal exercise testing intensity. Subjects were allowed access to a water bottle and able to drink water *ad libitum* throughout the exercise testing if they chose to, although most chose not to drink during their time trials.

Subjects completed a 5-minute warm up by running or jogging at the speeds of their choice that they found necessary for warm-up prior to a timed trial. This speed was noted, and subjects were asked to warm up at the same speeds for all subsequent trials. Subjects then completed a familiarization 5 km timed trial in the Georgia State University Sports Medicine Lab where temperature and humidity were controlled for the entire building; no large variances were noted. Placed on the wall in front of the subjects was a Borg RPE scale (6-20) as well as a conversion indicating that 5km = 3.1 miles. Subjects ran on a treadmill (Star Trac Class SA 9-3561-MUSAPO, Irvine CA) with access to speed control, so that subjects could increase or decrease speed throughout their run, depending upon how they felt. Subjects were able to see the accumulated distance run but not their time or speed. They were encouraged to complete the 5km as rapidly as possible. This was followed by a cool down of five minutes at the pace of their choice. This initial test acted as a baseline performance for the subjects as well as a familiarization trial.

Subjects were then asked to return between 10 to 20 days after each trial to perform their next trial. This allowed for enough time for ample recovery, without training or detraining effects occurring. During the next two visits to the lab subjects again performed the same 5km time trial on the treadmill while either listening to their playlist of either lyrical music or non-lyrical music.

The order (lyrical or non-lyrical) was assigned in a random, counterbalanced order, using a random numbers generator. This resulted in two different trial orders; no music, lyrical, non-lyrical or no music, lyrical, non-lyrical. Throughout the 5 minute warm up, the speeds from the familiarization trial were given to subjects as necessary. When the trial started subjects again chose their running speed, and were able to adjust the speed throughout the entire test depending upon how they felt. However, subjects were still not allowed to see the speed at which they were running at nor their time to prevent subjects from trying to "beat" prior trial performances. However, subjects were able to see the distance run throughout the trial so that they could adjust their speed according to how they felt and how much distance is left in the trial to ensure that they performed to the best of their ability. They were verbally encouraged to complete the 5 km as rapidly as possible. At the end of each song distance traveled, HR, and RPE were recorded. Following the non-lyrical trial two questions were asked: 1) Could you tell what each song was? 2) Did you mentally sing along to the songs, and if so, how many of the songs did you mentally sing along to?

Subject playlists were stored on a YouTube account and played through an external speaker (UE Boom, Irvine Ca) in the identical order for both trials to ensure that the beat of the music didn't influence the performance of the subjects. The subject chose a volume during their first music trial, the volume was noted and the same volume was used during both music trials to ensure volume was controlled and did not have an effect on the subject's performance.

A One-way ANOVA was used to compare completion times for trial 1, trial 2, and trial 3 (regardless of treatment) to analyze for an order effect. A paired samples two-tailed t-test was used to compare completion times for the lyrical and non-lyrical music time trials to determine if there was an effect of lyrics on performance. A paired samples, two-tailed t-test was also used to

compare the subjects RPE and HR at the 3.05km mark to determine if there was a difference in the subjects' RPE and HR between the lyrical and non-lyrical trials. For each subject an average change in RPE (ΔRPE) per song was calculated, by taking the difference of RPE between each trial (lyrical-non-lyrical) and then creating an average of the differences. The same procedure was performed with HR to determine change in HR per song (ΔHR) and change in distance per song (Δd). A t-test was used to compare the ΔRPE, ΔHR, and the Δd. A step-wise multiple regression analysis was used to look for correlations between the difference in time it took for the subject to complete the 5km timed trial and both physical characteristics and questionnaire. The statistical software used to analyze this data was SPSS 18.0. P value of less than .05 was designated as significant. All data is presented as means ± standard deviation.

Results

A total of 16 subjects were recruited, however, only 13 were able to complete all 3 trials of the study and therefore only 13 were analyzed. Subject Characteristics are outlined in *table 1*. Testing for an order effect on time to complete the 5 km time trial was done using a one-way ANOVA to test between groups based on the order in which the trials were conducted. There was no significance found therefore the order in which the trials were run was not a reason for any difference in the trial times (p=.816).

Table 1: Subject Characteristics

Subject Characteristic[s]

		Sub-ject	Gender	Race	Age	Height (in)	Height (cm)	Weight (lbs)	Weight (kg)	Body Fat % (3-site skin-fold method)
1		1	Male	African American	21	70	178	206	93	6.67
2		3	Male	White/Caucasian	26	71	180	175	79	16.22
3		4	Male	White/Caucasian	28	74	188	195	88	9.46
4		5	Female	White/Caucasian	28	62	157	125	57	21.69
5		6	Female	White/Caucasian	35	65	165	123	56	25.02
6		7	Female	African American	43	66	168	142	64	28.08
7		8	Female	African American	48	63	160	125	57	26.48
8		9	Male	White/Caucasian	28	68	173	140	63	11.75
9		10	Male	White/Caucasian	39	75	191	220	100	23.87
10		11	Female	African American	46	61	155	125	57	32.59
11		12	Male	White/Caucasian	34	64	163	115	52	9.50
12		14	Female	African American	31	67	170	169	77	23.21
13		15	Male	White/Caucasian	28	71	180	150	68	11.29
Total	Mean				33.46	67.46	171.38	154.62	70.08	18.9100
	Minimum				21	61	155	115	52	6.67
	Maximum				48	75	191	220	100	32.59
	Std. Deviation				8.313	4.502	11.493	35.075	15.809	8.47016

A significant difference was found between the lyrical and non-lyrical music trials, with the mean of the respective groups being 1684 ± 369s and 1720 ± 361s (28:04 ± 6:08 min & 28:40 ± 6:00 min). The lyrical trial was on average 36.15 s faster than the non-lyrical trial (p=.009) (*Figure 1*). It is unclear if there is a significant difference in average lyrical music time

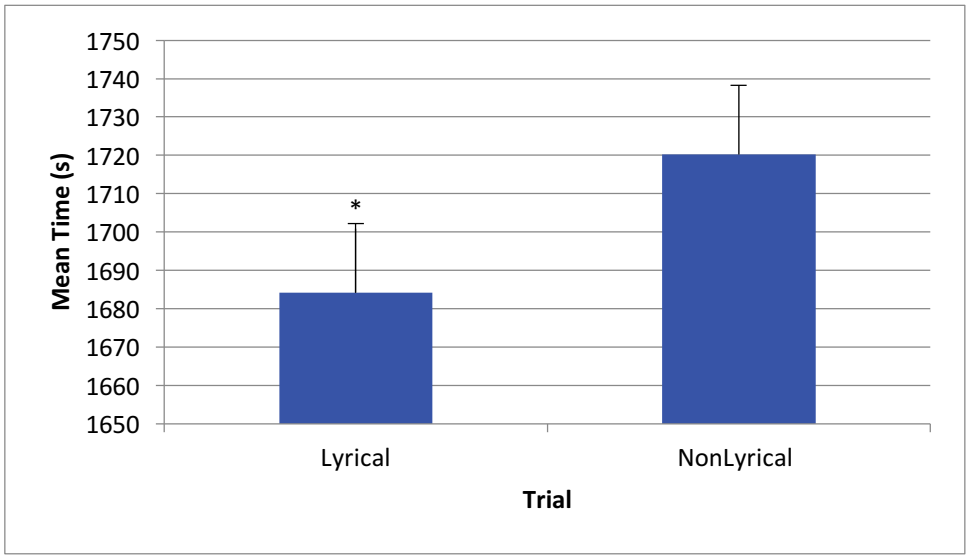


Figure 1: Completion time for lyrical and non-lyrical time trials
Values are reported as means ± standard deviation. *A significant difference was found 1684 ± 369s and 1720 ± 361s respectively (p=.009)

trial performance and no music (familiarization) time trial performance. There was an average improvement of 12.31 seconds (*Figure 2)* seen between the lyrical and familiarization trial. However, a repeated measures ANOVA shows that there is no statistical significance between the familiarization trail and either lyrical or non-lyrical time trial performances (p=.733 and p=.515 respectively) this may be due to the small sample size. There was no statistical significance detected when comparing change in trial time between lyrical to non-lyrical music trials by gender (males p=.476 & females p=.469).

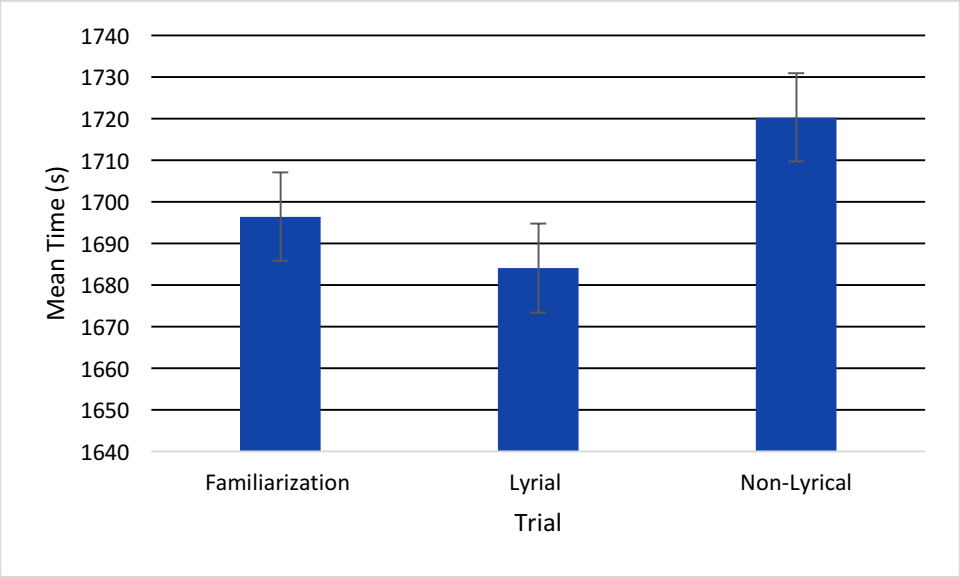


Figure 2: Mean Completion Time Between Familiarization, lyrical, and Non-Lyrical Trials. Average times are 1696.39 ± 85.16s, 1684 ± 369s and 1720 ± 361s respectively.

No statistical significance was found for either RPE or HR at the 3.05 km mark, using a paired samples t-test (p=.457 and p=.993 respectively). A one-sample t-test was completed to determine if there was a statistical significance in the average ΔRPE, ΔHR, and Δd per song between the lyrical music trial and the non-lyrical music trial. No statistical significance was found for ΔRPE/song or ΔHR/song (p=.677 and p=.099 respectively). Statistical significance was found for Δd/song (p=.023), with an average difference in distance completed per song of .023 ± .031 km (.014 ± .019 mi) greater for the lyrical versus non-lyrical trial (*Figure 3)*. It is important to note that not all of the trials had the same number of RPE's, HR's, or distance measurements recorded due to the different lengths of time to complete the 5 km timed trials, as well as the differing lengths of songs due to subjects picking their own songs. Any non-paired RPE's, HR's, or distances were excluded in the mean change per song analysis. Subjects listened to on average seven songs (± 1.58) during their trials, ranging from four to ten songs. The mean change per song was calculated by finding the change in RPE (or HR or d) for each song by a single subject

and then calculating the average of each subject's average and finally averaging all of the subject's averages together.

Table 2: Average Changes in RPE, HR and Distance per song and at the 3.05 km mark. Standard deviations, errors of the mean and significance. *A significant difference is indicated for ΔRPE/song. $^{+}$ Nearing significance is ΔHR/song.

Lyrical-NonLyrical	Mean Difference	Std. Deviation	Std. Error Mean	2-tailed significance
RPE @ 3.05 km	0.192	0.902	0.25	0.457
HR @ 3.05 km	0.308	13.002	3.606	0.933
ΔRPE/song	0.161	1.356	0.377	0.677
ΔHR/song	3.337	6.721	1.864	0.099^{+}
Δd/song	0.014	0.019	0.005	0.023*

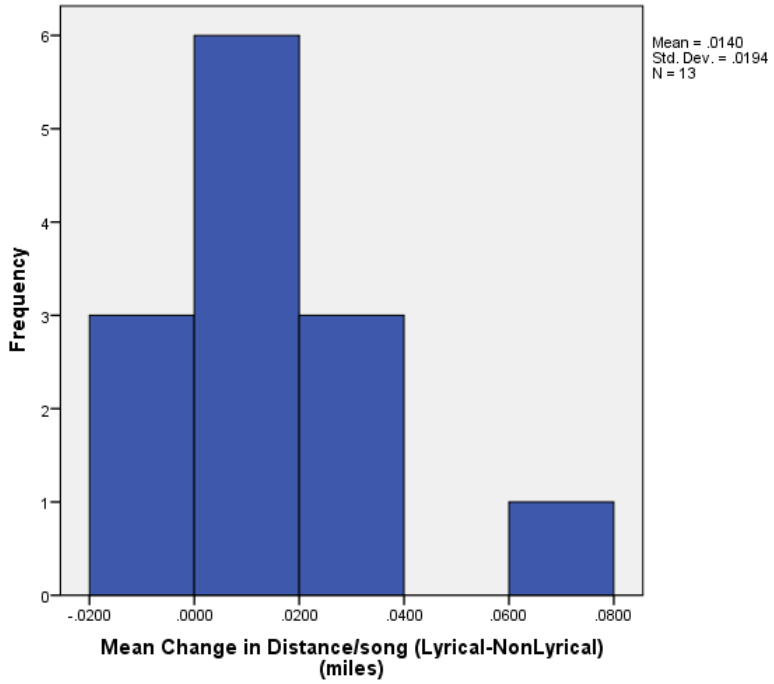


Figure 3: Average Change in distance/song of subjects comparing lyrical and non-lyrical trial. A positive digit indicates more distance (km) covered during each song during the lyrical music trial.

The survey revealed that during the non-lyrical trial 80% of subjects could identify each song, even without the lyrics present. No subjects reported mentally singing along to all of the songs neither did any subjects report not singing to any of the songs either. Four mentally sang

along to less than half of the songs, two mentally sang along to half of the songs, three mentally sang along to more than half of the songs, and five subjects were not asked (*Figure 4)*. The first 5 subjects to complete the trials were not asked because this question was not part of the original procedure design, but was added due to observations and conversations with subjects.

Step-wise multiple regressions were used to determine correlations between the differ-

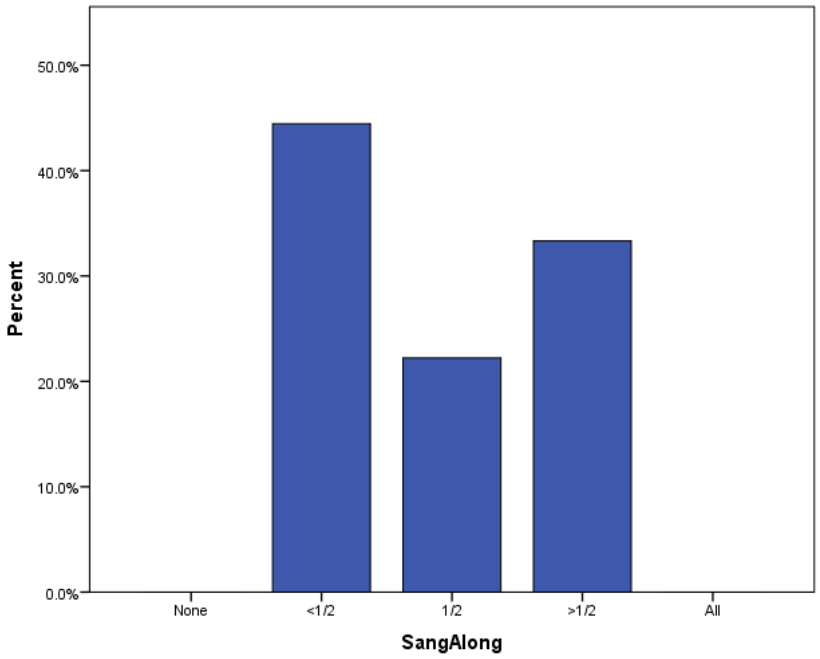


Figure 4: Percentages of subjects that mentally sang along to less than half, half, or more than half of the songs on their playlist.

ence in time it took for the subject to complete the 5 km timed trial and the questionnaire, survey questions, subject characteristics, and volume of music. This included age, race, gender, body fat percentage, volume of music chosen, did the subject mentally sing along with the music, how many miles per week the subject runs, how much time per day the subject spends listening to music, what media does the subject currently run with, does the subject play any instruments, and has the subject written any of their own music.

Table 3: Step-wise multiple regression analysis to detect correlations and predictors of change in 5 km time trial performance via subjects physical characteristics.

	r [Difference Lyrical-Non Lyrical (s)]	p
Difference Lyrical-Non Lyrical (s)	1.000	-
Gender	-0.217	0.238
Age	0.318	0.145
Weight (kg)	0.079	0.399
Body Fat (3-site skin fold)	-0.019	0.475
BMI	0.072	0.408

The strength of relationship between all of the physical characteristics was determined to be less than .30 except for age. The correlation coefficient showed a weak correlation between age and improved 5 km time trial performance with lyrics (R=.318). (*Table 3).*

Another multiple regression was completed to detect correlations and predictors using the subject's questionnaire. A correlation of .638 showed that as the subjects weekly mileage increased the amount of change between the lyrical and non-lyrical trial decreased. A weak correlation of .423 also presented where subjects who play instruments on average have less improvement of time between their lyrical and non-lyrical music trials than those who do not (28.5s & 37.55s respectively). It is noteworthy that only two of the subjects play an instrument, and both of those subjects did complete faster lyrical 5km trials, and only one subject had written their own music and that subject did not see an improvement between the lyrical and non-lyrical 5 km trials. There were no significant predictors to determine the change in performance time between non-lyrical and lyrical music trials.

Table 4: Step-wise multiple regression analysis to detect correlations and predictors of change in 5 km time trial performance via subjects questionnaire. *Significance was detected for how many miles per week do subjects currently run and a decrease in change between their 5 km time trial performances.

	r [Difference Lyrical-Non Lyrical (s)]	p
Difference Lyrical-Non Lyrical (s)	1.000	-
Did you know each song?	0.197	0.320
Sang along	0.029	0.473
How many miles per week do you run*	0.638	0.044
What do you currently run with	0.264	0.264
How much time a day do you spend listening to music	0.304	0.232
Do you play any instruments	0.423	0.148
Have you written your own music	-	0
Volume	0.029	0.473

Discussion

The major finding of this study was that when runners listen to music with lyrics they complete a 5 km time trials significantly faster than when listening to music without lyrics. The results show that the subjects were able to run a faster 5 km time (on average 36 seconds faster) while listening to lyrical music rather than non-lyrical music. Subjects completed the 5 km lyrical and non-lyrical trials in 1684 ± 369s and 1720 ± 361s (28:04 ± 6:08 min & 28:40 ± 6:00 min) respectively (p=.009) (*Figure 1).* This refuted the hypothesis that lyrics would have no effect on 5 km timed trial performance for moderately trained runners ages 21-46. However, it is unclear if lyrical music has a benefit over no music at all (familiarization) due to the small sample size. The results show that the lyrical time trials were on average the fastest trial 1684 ± 369s

on average 12.31 ± 35.27s faster than the no music trial 1696.39 ± 85.16s despite not being statistically significant (p=.733). Interestingly, the non-lyrical trials were on average the slowest trials at 1720 ± 361s which on average was 23.85 ± 35.53s slower than the average no music time trials, but was still not statistically significant (p=.515). This indicates that while lyrical music is beneficial compared to non-lyrical music, a possible but un-proven trend may suggest that non-lyrical music compared to no music may be detrimental to 5 km running performance. This may be due to the subjects spending more effort trying to mentally sing along to music (80% of subjects sang along to the music in their minds while running their non-lyrical trial) rather than focusing on the task at hand, or even a possible diversion of blood flow from the large muscle groups to the brain for memory recall of lyrics.

The center for disease control and prevention (CDC) reported in the *2014 State Indicator Report on Physical Activity* only 51.6% of American adults exercise and 25.4% of adults participate in no leisure-time physical activity at all. In 2011, the CDC and the National Center for

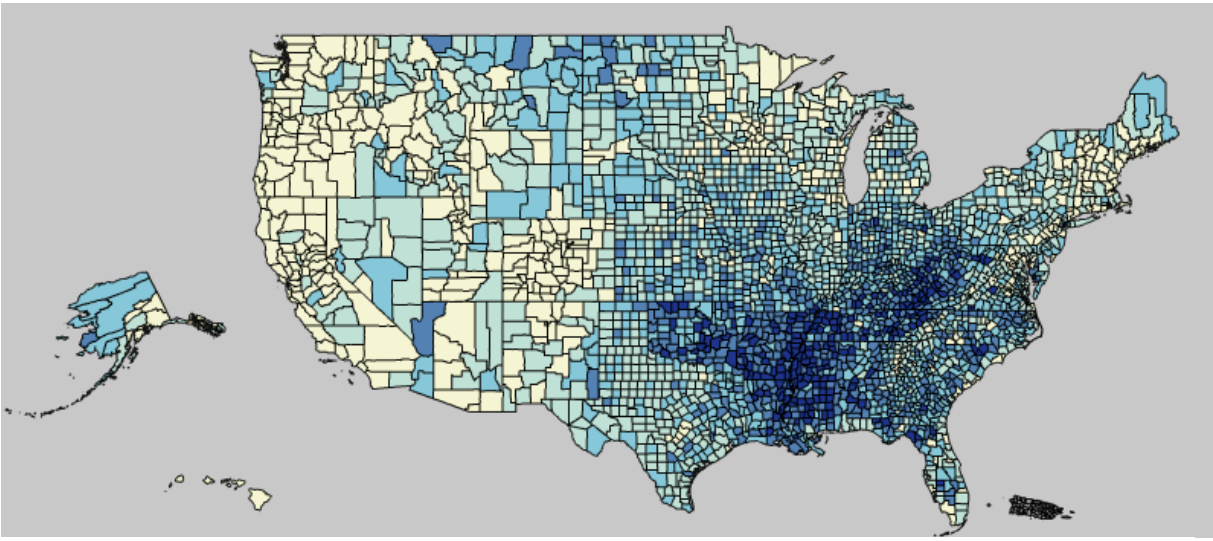
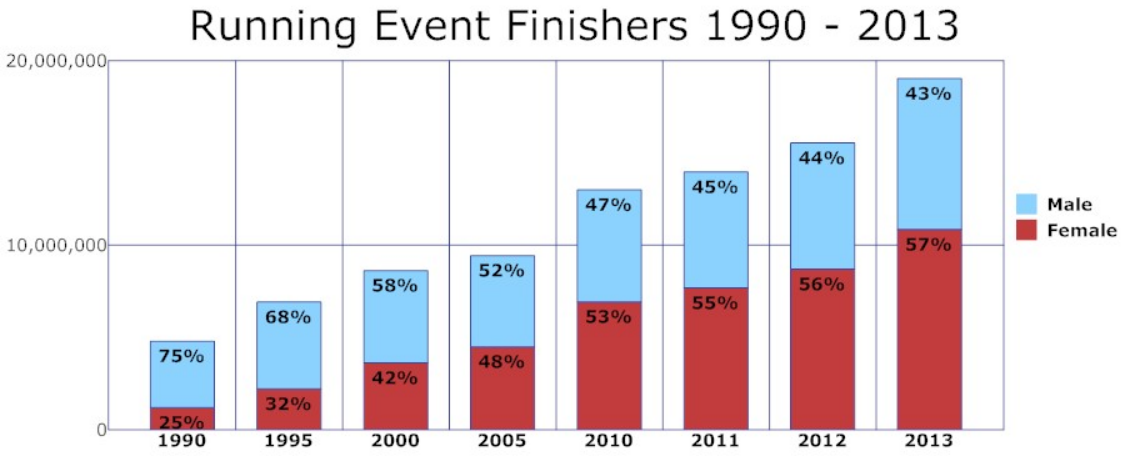


Figure 5: 2013 Age-Adjusted Estimates of the Percentage of Adults Who are Physically Inactive Retrieved from http://www.cdc.gov/diabetes/atlas/countydata/atlas.html

Health Statistics collaborated and released a report showing that only 20.6% of adults reached daily physical activity goals for both aerobic and muscular strength. Interestingly the CDC is

asking that adults participate in 150 minutes of moderate intensity aerobic activity or 75 minutes of vigorous aerobic activity (running is considered vigorous activity) per week and 2 days a week of strength training major muscle groups (“Adult Participation in Aerobic and Muscle-Strengthening Physical Activities — United States, 2011,” n.d.).

While the number of Americans reaching daily physical activity goals remains fairly low, participation in running and running-related events has hit an all-time high in the United States with many different types of races to participate in from 5k’s to ultra-marathons and adventure/obstacle runs to colorful runs ("Statistics | Running USA,"). As seen in *Figure 6* running event finishes have increased by 25% from 1990 to 2013.



	1990	1995	2000	2005	2010	2011	2012	2013
Female	1,199,200	2,215,500	3,619,600	4,494,400	6,929,000	7,685,700	8,699,000	10,844,200
Male	3,597,800	4,708,000	4,998,400	4,947,600	6,071,000	6,288,300	6,835,000	8,180,800

Figure 6: U.S. Race Finishers 1990-2013 Retrieved from http://www.runningusa.org/2014-state-of-sport?returnTo=annual-reports

When surveyed college students reported running was the most common exercise in which they “always listened to music” (Barney et al., 2012). Music has coalesced itself with exercise from sport to group exercise classes and personal devices during individual work-outs.

Genre, tempo, and volume of music have all previously been shown to improve either performance or perception of difficulty of exercise (Edworthy & Waring, 2006; Matesic &

Cromartie, 2008; Tenenbaum et al., 2004) The results of this study suggest that lyrics are also an important aspect of music as an ergogenic aid in 5 km running performance.

The ΔHR/song was not shown to be statistically significant (p=.099) but was nearing significance with a difference of 3.34 bpm in the lyrical trials compared to non-lyrical trials. A p<.05 may have increased the possibility of a type II error (where the null hypothesis is to be rejected, but is not). One subject did not receive HR measurements due to a malfunction in HR monitor equipment during the trial, and therefore was not used in any of the HR statistical analysis. A change in HR was to be expected with the decreased performance time, indicating that the subject is running faster therefore will have an increased heart rate to meet the demands of the higher workload. However, this was not indicated as statistically significant but does have implications of being significant with the smaller p value. The ΔHR at the 3.05 km revealed no significance (p=.933). This indicates that during both the lyrical and non-lyrical trials, subjects at the very end (only .05 km or .03 miles, to go) were both performing at their max or near max level and that the difference in decreased performance time was more spread throughout the entire timed trial rather than just a sprint at the very end. This can also be seen in the Δd/song, where during lyrical trials the Δd/song was .023 km more per song than in non-lyrical trials.

Some suggest that music benefits exercise performance because it allows subjects to focus on something other than their effort; subjects "disassociate" themselves from the task at hand (Dyrlund & Wininger, 2008). Subjects did not show a decrease in RPE which did support part of the hypothesis. No ΔRPE/song was seen between lyrical and non-lyrical performances (p=.677) even though subjects were running at significantly faster speeds during lyrical trials (indicated by the decreased 5 km completion times) the implication of a significant increase in ΔHR/song (p=.099) would indicate that while the subjects performed at a higher level, they did not perceive

themselves to be working at a higher level. Some research suggests that an external focus (something other than the body itself) can help decrease RPE especially in low to moderate exercises; this is considered top-down processing where the subject is disassociating from task. When the task at hand begins to increase in difficulty and physiological factors such as HR, blood pressure, respiratory rate, lactate level, creatine level begin to increase, the focus shifts toward an internal or bottom-up processing (Lohse & Sherwood, 2011). However, this was not seen in this study. It is worth noting is that subjects were asked about their RPE between songs, which could possibly hinder the constant disassociation from discomfort received by listening to music. However ordinarily when listening to music via mp3 player there is a short pause between songs, which may act as an instance in which the individual does associate with the exercise at hand, much like what was done in this study.

Several subjects mentioned that they had never listened to music without lyrics before their 5 km timed trial. There may be a possibility that subjects did not run well with the non-lyrical music because they were not used to running under these conditions. The closest to this scenario would be not listening to music at all while running, interestingly only one person in this study exclusively ran without music at all, this person fascinatingly experienced a forty-seven second improvement between their non-lyrical and lyrical trial. However, four people reported that depending upon their particular run they typically ran with a combination of Medias which included nothing. These four also experienced a positive influence from lyrics running an average of 37.50 seconds faster on their lyrical trial compared to their non-lyrical trial. Statistically however, a linear regression analysis shows that only 17% (R=.170) of what subjects currently run with correlates to the difference seen between the two musical trials (lyrical - non-lyrical = difference between trials).Therefore future research may be directed toward comparing the effect

of music on subjects who already typically run with music, subjects who typically run without music, and subjects who typically run with other people, to see if this may have an effect on how music aids performance (*Figure 8)*.

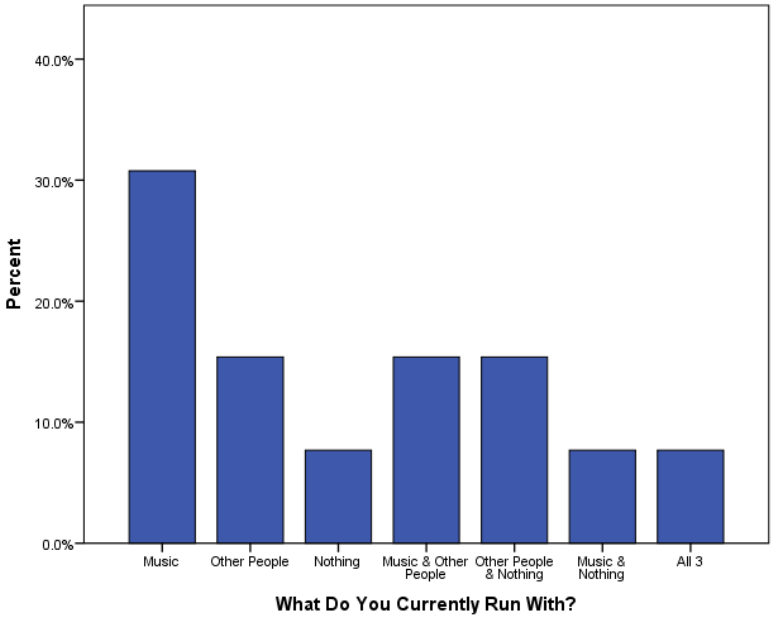


Figure 7: Percentages of the type of media subjects are currently running with. Data collected from pre-trial questionnaire.

Mentally singing along to music is another practice in which some subjects partake in while running, and others do not. As seen in *Figure 4* all subjects, who answered the question, responded that they did mentally sing to some yet, no subjects reported that they mentally sang along to every song. However when a Pearson correlation was performed on the subjects' data there was minimal correlation between mentally singing along to music and performance improvements (R=.133). Worth noting is that all subjects were not asked about how many songs they sang along to in their minds, this was a question added due to comments made by subjects during the data collection process. Rather compelling was that some subjects mentioned after their non-lyrical trial that they were surprised by not remembering all of the words to the songs

on their playlist. This may constitute as why no subjects reported singing along to all of the songs. Therefore, future research may include the tendency of subjects to mentally sing along to music or whether or not singing along in one's head to the music has an effect on subject performance comparing the difference between songs rather than trials. Another direction for future research may be, to determine if there is a difference in the amount mentally singing along to music, whether there are, or are not lyrics playing, as well as possibly where the lyrics are provided in text form (much like karaoke) and what effect this may have on performance.

The only significant correlation determined from the questionnaire and physical characteristics of subjects was the average weekly mileage of the subjects of subjects ($p=.044$ $r=.638$) (*Table 4)*. As the weekly mileage of subjects increased their difference in performance times between trials significantly decreased (*Figure 8)*. Increased mileage per week would indicate that the subjects are more highly trained. This supports previous research suggesting that more highly trained athletes will see less performance benefit from listening to music than untrained subjects (Matesic & Cromartie, 2008; Mohammadzadeh et al., 2008).

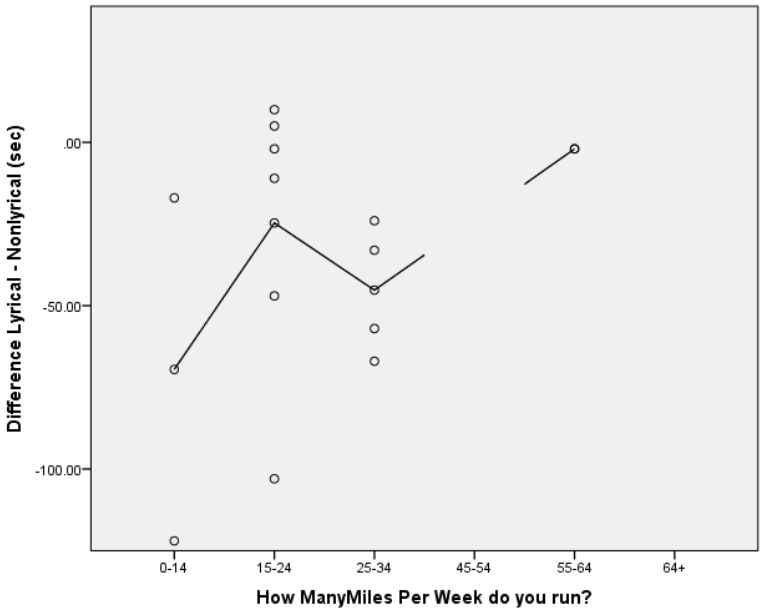


Figure 8: Correlation between number of miles/wk subjects run and their improvement between lyrical and non-lyrical music trials (p=.044)

There was a weak correlation relating the younger age of the subject may be more benefited by music as an ergogenic aid (*Table 3)*. This supports previous research by Priest, Karageorghis, and Sharp (2004) showing that younger individuals rated the importance of music while exercising as 89% more important than older individuals. Also there was a weak correlation between less improvement between lyrical and non-lyrical time trials if the subject plays an instrument (*Table 4)*. However, there were only two subjects which play their own instruments and thus this may need a larger sample size to make any true conclusions about.

Subjects were required to complete both activity and nutrition logs which were used as a template to follow for the ensuing trials. No large variations in subject activity or nutrition was noted, this helped to ensure that activity and nutrition were not factors affecting the performance of subjects. Since this was all self-reported there is no way to ensure that subjects were fully truthful, due to the data being seen by the investigators, which may induce the Hawthorne effect.

Running 5 km on a treadmill is not the same as a typical 5 km run on a track, road, or trail, however it does provide a controlled environment including; temperature, humidity, incline, surface, and wind. One limitation of this research is that subjects had to manually change the speed of the treadmill via speed control buttons which does not have exactly the same effect as increasing or decreasing running speed on the ground. Newer treadmill designs incorporate features such as motion control, where a wave of the hand can increase or decrease speed, or even newer technology (not yet commercially available) that can automatically change the treadmill speed via sonar range finders to detect the location and adjust speeds accordingly (Scheadler & Devor, 2015). These could all potentially improve the experimental protocol used to test 5 km running performance. Another factor worthy of future research may be at what point subjects increase the speed of the treadmill, not only looking at what point, but also how much and then determining how this may affect subject performance. No data was collected, but after watching subjects perform trials the questions of, at what point during songs do subjects change speed arose. This could be an important factor, if subjects tend to increase speed at the end of songs, then would an increased number of songs (shorter lengths of songs) have an impact on subject performance? Also worthwhile may be looking at if subjects ever decrease their speed throughout trials or not, if subjects do not decrease their speed throughout, than would a higher starting speed be of benefit to performance?

The subject population was chosen in order to limit the population to subjects that were low risk by ACSM standards. Subjects were required to be actively running and have some previous racing experience, to ensure that subjects had some idea of how to pace themselves to successfully complete a 5 km race. Subjects, however, were excluded for being too fast, if they ran faster than 18 minutes for males and 21 minutes for females. This was to prevent missing any

significance, because the highly trained have been shown by a number of studies to be less affected by music as an ergogenic aid (Brownley et al., 1995; Matesic & Cromartie, 2008; Mohammadzadeh et al., 2008; Young et al., 2009). Also the intention of this research was geared toward the general population, rather than directly toward elite athletes, so that it could have an impact on a larger amount of people.

Finding no significant increase RPE between lyrical and non-lyrical trials indicates that listening to lyrical music while running may help improve adherence to exercise. This conceivable decrease in the perceived difficulty of the run may lead to an increase in the number of people who reach their daily physical activity goal set by the CDC.

This research may also be applicable in improving training rather than actual competition, since most running competitions do not permit the use of personal music players. Nonetheless while not statistically significant this study may imply that listening to lyrical music while training can increase the maximal training pace without increasing RPE and therefore allow for improved training which theoretically should lead to increased competitive performance levels.

Conclusions

The main finding of the study was that listening to lyrical music does have a significant beneficial effect on 5 km running performance over non-lyrical music in healthy individuals aged eighteen to forty-five. Subjects on average completed their 5 km trial thirty-six seconds faster than their corresponding non-lyrical trial. It is important to note is that subjects did not just run faster at the very end of the trial, but ran faster throughout the entire trial. This was shown in the Δd/song of .023km and the possible implication of ΔHR/song of 3.34 bpm in conjunction

with no significant different between RPE and HR at the 3.05 km mark, which are both correlated to the amount of effort being exerted. RPE was not determined to be statistically significant by the different lyrical and non-lyrical music trials.

Only one primary correlation was determined to be statistically significant; as subject's weekly mileage increased the improvement in their lyrical compared to non-lyrical music trial decreased ($p=.044$ $r=.638$) this supports previous research that music as an ergogenic is less beneficial to highly trained subjects. As subject age decreased the improvement between lyrical and non-lyrical trials also increased, though not statistically significantly ($p=.145$ $r=.318$). Similarly, while not statistically significant it seems that if subjects play their own instrument they may receive less performance benefit from listening to lyrical music compared to non-lyrical music ($p=.148$ $r=.423$).

This research is valuable in addition to our previous knowledge of exactly how music aids in running performance, however it does not complete the analysis of music and 5 km running. Rather it merely helps direct future inquiry of the effect of music to 5 km running. Things such as, being presented with lyrics which can be read rather than heard, if/where during songs subjects increase speed, determining if different modes of increasing speed are relevant, a larger subject population that includes more subjects which do not typically run with music may be areas of future research.

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APPENDICES

Appendix A Procedure Checklist

1. Take down clock
2. Informed Consent
3. Questionnaire (look up song lengths immediately)
4. PA & Nutrition Log
5. Health History Questionnaire
6. Physical Measurements
7. Explain Treadmill & Test procedure
8. 5 min warm-up
    a. Subject Selects pace
    b. Write down pace
    c. Make sure Shuffle is OFF
    d. Make sure sleep is OFF
9. STOP TREADMILL –clear out to start the 5k
10. Start Stop Watch
11. START 5K
12. Record @ end of each Song
    a. HR
    b. RPE
    c. Distance
13. Stop Stop watch
14. Go into 5 min cool (choice to stop & cool down or go straight into cool-down)
15. Put clock back up

Appendix B Informed Consent

Georgia State University
Department of Kinesiology
Informed Consent

Title: Self-selected Lyrical Music vs. Non-Lyrical Music and its Effect on Running Performance

Principal Investigator: Dr. Andrew Doyle
Student Principal Investigator: Denise Myers

I. Purpose:

You are invited to participate in a research study. The purpose of the study is to investigate the effect of music with lyrics compared to music without lyrics on running performance. You are invited to participate because you are a male or female between the ages of eighteen and forty-five. You are a consistent runner. You have run at least 3 miles on at least 3 days per week. You have competed in at least 2 races of 5km or greater within the past 2 years. You have not run a 5 km race faster than 18 minutes (males) or 21 minutes (females). A total of 20 participants will be recruited for this study. Participation will require about 3 to 4 hours of your time over a nine to twenty-one day time frame.

II. Procedures:

If you decide to participate, you will make 3 separate trips to the GSU Applied Physiology Lab. The first trip will include filling out a health and running history questionnaire. Based on your answers to the questionnaire, if you are classified as low risk you may participate in the study. Your height, weight, resting heart rate, resting blood pressure and body fat percentage will be measured and recorded. You will then complete a warm up of 5 minutes. This warm up will be at a self-selected pace on a treadmill. You will then run a 5 kilometer time trial as fast as you can on the treadmill. During this time trial you will be able to adjust the speed of the treadmill depending upon how you feel. Your rating of perceived exertion, distance traveled, and heart rate will be recorded. During the next 2 visits to lab you will perform the same 5 kilometer time trial. You will either listen to music with lyrics or music without lyrics. The order in which the music trials will take place will be in random order.

Each time trial will take about 45 minutes. The first day will take longer due to surveys and forms. It should take around an hour. You will need to complete each test no less than 10 days and no more than 14 days from the last test. This will prevent results from being affected due to training, but allow for recovery time.

III. Risks:

There is the possibility that participation in this study may cause you shortness of breath, leg cramps, muscle soreness, fatigue, light-headedness, confusion, or nausea. To try and prevent these you will only perform the exercise trials when you have prepared properly to run. If you experience any of these symptoms the exercise test will be stopped and you will no longer need to participate in the study.

IV. Benefits:

Participation in this study may not benefit you personally. You may benefit by being able to run a new 5km personal record and learn about your running performance. Overall, we hope to gain information about music and exercise. More directly we hope to learn if lyrical music affects running performance compared to music with no lyrics.

V. Voluntary Participation and Withdrawal:

Participation in research is voluntary. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:

We will keep your records private to the extent allowed by law. Denise Myers and Dr. Andrew Doyle will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (GSU Institutional Review Board, the Office for Human Research Protection (OHRP). We will use an assigned number for participants. The code sheet that identifies your subject number will be destroyed after the study is complete. The information you provide will be stored on a computer that is protected with a password and a firewall. Your name and other facts that might point to you will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. You will not be identified personally.

VII. Georgia State University Disclaimer:

If you have any question about this study, or believe you have suffered any injury because of participation in the study, you may contact Dr. Andrew Doyle at (404) 413-8050. If you are injured you will be referred to the Georgia State University Student Health Center or to your personal physician for treatement. Georgia State University, however, has not set aside funds to pay for this care or to compensate you if something should occur.

VIII. Contact Persons:

Contact Denise Myers or Dr. Andrew Doyle at (573) 231-2988 / (478) 213-6810 or dmyers7@student.gsu.edu / adoyle@gsu.edu if you have questions, concerns, or complaints about this study. You can also call if you think you have been harmed by the study. Call Susan Vogtner in the Georgia State University Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu if you want to talk to someone who is not part of the study team. You can talk about questions, concerns, offer input, obtain information, or suggestions about the study. You can also call Susan Vogtner if you have questions or concerns about your rights in this study.

IX. Copy of Consent Form to Subject:

We will give you a copy of this consent form to keep.

If you are willing to volunteer for this research, please sign below.

_____	_____
Participant	Date
_____	_____
Principal Investigator or Researcher Obtaining Consent	Date

Appendix C Questionnaire

How many miles per week do you typically run?

a. 0-14
b. 15-24
c. 25-34
d. 45-54
e. 55-64
f. 64+

What do you currently run with? Circle all that apply

a. music
b. other people
c. nothing

How much time a day do you typically spend per day listening to music?

a. 0-15 min
b. 15-30 min
c. 30 min- 1 hr
d. 1-2 hrs
e. 2+ hrs

Do you play any instruments?

a. Yes
b. No

Have you ever written your own music?

a. Yes
b. No

Please list songs that you would like to listen to during a 5k timed-trial run

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

Appendix D Physical Activity/ Nutrition Log

	Date:	**Date:**
Type of Physical Activity:		
Length of Physi-cal Activity:		
Intensity of Physical Activity		
Food Intake		
Breakfast		
Lunch		
Dinner		
snacks		
Hydration		

Appendix E Health History Questionnaire

Applied Physiology Laboratory

Department of Kinesiology and Health
Georgia State University

Health History

All information given is personal and confidential. The information will enable us to better understand you and your health and fitness habits.

Subject Number: _____

Birth Date_____Gender_____Height_____Weight_____Ethnicity_____

****

i. Signs and Symptoms

****

Have you ever experienced any of the following?:
(please circle yes or no)

yes no 1. Pain, discomfort, tightness or numbness in the chest, neck, jaw or arms.

yes no 2. Shortness of breath at rest or with mild exertion.

yes no 3. Dizziness or fainting.

yes no 4. Difficult, labored or painful breathing during the day or at night.

yes no 5. Ankle swelling.

yes no 6. Rapid pulse or heart rate.

yes no 7. Intermittent cramping.

yes no 8. Known heart murmur.

yes no 9. Unusual shortness of breath or fatigue with usual activities.

If you answered yes to any of the above—

How often do you experience the symptom?_____

Have you ever discussed the symptom with a doctor?_____

Explain the symptom in more detail:_____
_____

****

ii. Major Risk Factors

****

yes no 1. Do you have a body mass index ≥ 30 or a waist girth >100 cm?

yes no 2. Have you had a fasting glucose of ≥ 110 mg/dl confirmed by measurements on at least 2 separate occasions.

yes no 3. Has your father or brother experienced a heart attack before the age of 55? Or has your mother or sister experienced a heart attack before the age of 65?

yes no 4. Do you currently smoke or quit within the past 6 months?

yes no 5. Has your doctor ever told you that you have high blood pressure?

yes no 6. Do you have high cholesterol?
Total cholesterol:_____HDL:_____Date tested:_____

yes no 7. Do you have a sedentary lifestyle? (sitting most of the day in your job with no regular physical activity)

****

iii. Medical Diagnoses

****

Have you ever had any of the following? Circle all that apply:

heart attack	angioplasty	heart surgery	coronary artery disease
angina	hypertension	heart murmur	heart clicks
asthma	emphysema	bronchitis	stroke
anemia	phlebitis	emboli	cancer
osteoporosis	emotional disorders	eating disorders	

Any special problems not listed above:_____

If any of the above are circled, please give details and explain:_____

_____

_____

_____

_____

****

iv. General

****

yes no 1. Are you pregnant?

yes no 2. Do you have arthritis or any bone or joint problem?
If yes, please explain:_____

_____

yes no 3. Do you currently exercise?
If yes, how long have you been exercising?_____

What do you do and how often?_____

yes no 4. Are you taking any medication, vitamins or supplements?
Name them and their dosage (list both prescribed and over-the-counter medications)

Drug name and dosage / purpose of drug / prescribed or over-the-counter

_____

_____

****

My signature certifies that all of the above is true, to the best of my knowledge.

Signature:_____Date:_____

****

1. **STAFF USE ONLY**

****

Comments:_____

2.

3. Stratification (circle one):Low Risk Moderate Risk High Risk

4.

Resting blood pressure:_____Resting heart rate:_____

yes no Do meds affect BP or HR?

3-site Skinfold Measurements: Body fat %:

_____ _____ _____ _____

Date:_____Initials:_____

Appendix F IRB APPROVAL

INSTITUTIONAL REVIEW BOARD

Mail: P.O. Box 3999
Atlanta, Georgia 30302-3999
Phone: 404/413-3500
Fax: 404/413-3504

In Person: Dahlberg Hall
30 Courtland St, Suite 217

June 30, 2014

Principal Investigator: James Doyle

Key Personnel: Doyle, James; Lund, Jackie; Myers, Denise; Otis, Jeffrey

Study Department: GSU - Kinesiology & Health

Study Title: Self-selected Lyrical Music vs Non-Lyrical Music and itâ??s Effect on Running Performance.

Review Type: Expedited 4, 7

IRB Number: H14535

Reference Number: 327699

Approval Date: 06/30/2014

Expiration Date: 06/29/2015

The Georgia State University Institutional Review Board (IRB) reviewed and approved the above referenced study in accordance with 45 CFR 46.111. The IRB has reviewed and approved the study and any informed consent forms, recruitment materials, and other research materials that are marked as approved in the application. The approval period is listed above. Research that has been approved by the IRB may be subject to further appropriate review and approval or disapproval by officials of the Institution.

Federal regulations require researchers to follow specific procedures in a timely manner. For the protection of all concerned, the IRB calls your attention to the following obligations that you have as Principal Investigator of this study.

1. For any changes to the study (except to protect the safety of participants), an Amendment Application must be submitted to the IRB. The Amendment Application must be reviewed and approved before any changes can take place

2. Any unanticipated/adverse events or problems occurring as a result of participation in this study must be reported immediately to the IRB using the Unanticipated/Adverse Event Form.

3. Principal investigators are responsible for ensuring that informed consent is properly documented in accordance with 45 CFR 46.116.

    - The Informed Consent Form (ICF) used must be the one reviewed and approved by the IRB with the approval dates stamped on each page.

4. For any research that is conducted beyond the approval period, a Renewal Application must be submitted at least 30 days prior to the expiration date. The Renewal Application must be approved by the IRB before the expiration date else automatic termination of this study will occur. If the study expires, all research activities associated with the study must cease and a new application must be approved before any work can continue.

5. When the study is completed, a Study Closure Report must be submitted to the IRB.

All of the above referenced forms are available online at http://protocol.gsu.edu. Please do not hesitate to contact the Office of Research Integrity (404-413-3500) if you have any questions or concerns.

Sincerely,

Andrew I. Cohen, IRB Vice-Chair

Appendix G Recruitment Flyer

Participate in a Research Study

5k Timed Trial

Georgia State University

Subject Requirements
- Age 18-45
- Female or Male

Minimal Running Experience
- Run 3 days/wk
  - @ least 3 miles
- Run 2 5km races
  - w/ in past 2 years

Purpose

To determine if lyrical music compared to non-lyrical music will have an ergogenic effect of 5k timed trial running

When & Where:

Subjects will be asked to come to Applied Physiology lab in the Sports Arena

Subject will make 3 visits to the lab to complete 3 5k timed trials

Contact for more Information

Denise Myers Dmyers7@student.gsu.edu
Denise Myers Dmyers7@student.gsu.
Denise Myers Dmyers7@student.gsu.edu
Denise Myers Dmyers7@student.gsu.edu
Denise Myers Dmyers7@student.gsu.edu
Denise Myers Dmyers7@student.gsu.edu
Denise Myers Dmyers7@student.gsu.edu
Denise Myers Dmyers7@student.gsu.edu
Denise Myers Dmyers7@student.gsu.edu

Appendix H Data Collection Form

Subject #:
Test :
#:

Song	Song length	Acc. Time	Distance @ start	Distance @ end	RPE	HR
		0				
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
		0:00:00	0			
				3.05	RPE	HR
STOP TIME						
Warm-Up Speed						
Music Volume						

Could You Tell What Each Song Was?
Were you singing the words?

NO
< 1/2
1/2
> 1/2
ALL

Appendix I Statistical Analysis

Appendix I.1

Subject Characteristic[s]

		Sub-ject	Gender	Race	Age	Height (in)	Height (cm)	Weight (lbs)	Weight (kg)	Body Fat % (3-site skin-fold method)
1		1	Male	African American	21	70	178	206	93	6.67
2		3	Male	White/Caucasian	26	71	180	175	79	16.22
3		4	Male	White/Caucasian	28	74	188	195	88	9.46
4		5	Female	White/Caucasian	28	62	157	125	57	21.69
5		6	Female	White/Caucasian	35	65	165	123	56	25.02
6		7	Female	African American	43	66	168	142	64	28.08
7		8	Female	African American	48	63	160	125	57	26.48
8		9	Male	White/Caucasian	28	68	173	140	63	11.75
9		10	Male	White/Caucasian	39	75	191	220	100	23.87
10		11	Female	African American	46	61	155	125	57	32.59
11		12	Male	White/Caucasian	34	64	163	115	52	9.50
12		14	Female	African American	31	67	170	169	77	23.21
13		15	Male	White/Caucasian	28	71	180	150	68	11.29
Total	Mean				33.46	67.46	171.38	154.62	70.08	18.9100
	Minimum				21	61	155	115	52	6.67
	Maximum				48	75	191	220	100	32.59
	Std. Deviation				8.313	4.502	11.493	35.075	15.809	8.47016

Appendix I.2

ANOVA (Oneway-Order as Factor)

		Sum of Squares	df	Mean Square	F	Sig.
Trial1	Between Groups	192347.077	1	192347.077	2.253	.161
	Within Groups	939012.000	11	85364.727		
	Total	1131359.077	12			
Trial2	Between Groups	263165.145	1	263165.145	2.202	.166
	Within Groups	1314624.548	11	119511.323		
	Total	1577789.692	12			
Trial3	Between Groups	147693.040	1	147693.040	1.101	.317
	Within Groups	1476090.190	11	134190.017		
	Total	1623783.231	12			

Appendix I.3

Paired Samples Statistics (T-Test)

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Lyrical Trial (s)	1684.0769	13	368.61463	102.23530
	Non-Lyrical (s)	1720.2308	13	360.89129	100.09324

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Lyrical Trial (s) & Non-Lyrical (s)	13	.994	.000

Paired Samples Test

		Paired Differences			
					95% Confidence Interval of the Difference
		Mean	Std. Deviation	Std. Error Mean	Lower
Pair 1	Lyrical Trial (s) - Non-Lyrical (s)	-36.15385	41.48865	11.50688	-61.22518

Paired Samples Test

		Paired Differences				
		95% Confidence Interval of the Difference				
		Upper	t	df	Sig. (2-tailed)
Pair 1	Lyrical Trial (s) - Non-Lyrical (s)	-11.08251	-3.142	12	.009

Appendix I.4

General Linear Model

Measure: MEASURE_1

TimeToCompletion	Dependent Variable
1	Familirzation
2	Lyrical
3	NonLyrical

Descriptive Statistics

	Mean	Std. Deviation	N
Familirzation	0:28:16	0:05:07	13
Lyrical	0:28:04	0:06:08	13
NonLyrical	0:28:40	0:06:00	13

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
TimeToCompletion	Pillai's Trace	.452	4.529[b]	2.000	11.000	.037
	Wilks' Lambda	.548	4.529[b]	2.000	11.000	.037
	Hotelling's Trace	.823	4.529[b]	2.000	11.000	.037
	Roy's Largest Root	.823	4.529[b]	2.000	11.000	.037

Multivariate Tests[a]

Effect		Partial Eta Squared	Noncent. Parameter	Observed Power[c]
TimeToCompletion	Pillai's Trace	.452	9.057	.645
	Wilks' Lambda	.452	9.057	.645
	Hotelling's Trace	.452	9.057	.645
	Roy's Largest Root	.452	9.057	.645

Time to Completion

Estimates

Measure: MEASURE_1

TimeToCompletion	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	1696.385	85.160	1510.836	1881.933
2	1684.077	102.235	1461.325	1906.829
3	1720.231	100.093	1502.146	1938.315

Pairwise Comparisons

Measure: MEASURE_1

(I) TimeToCompletion	(J) TimeToCompletion	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]
					Lower Bound
1	2	12.308	35.272	.733	-64.544
	3	-23.846	35.532	.515	-101.263
2	1	-12.308	35.272	.733	-89.159
	3	-36.154*	11.507	.009	-61.225
3	1	23.846	35.532	.515	-53.571
	2	36.154*	11.507	.009	11.083

Pairwise Comparisons

Measure: MEASURE_1

(I) TimeToCompletion	(J) TimeToCompletion	95% Confidence Interval for Difference
		Upper Bound
1	2	89.159
	3	53.571
2	1	64.544
	3	-11.083
3	1	101.263
	2	61.225

Appendix I.5

Group Statistics (T-Test)

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Difference Lyrical - Nonlyrical (sec)	Male	7	-28.1429	45.72173	17.28119
	Female	6	-45.5000	37.78756	15.42671

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means
		F	Sig.	t
Difference Lyrical - Nonlyrical (sec)	Equal variances assumed	.021	.887	.738
	Equal variances not assumed			.749

Independent Samples Test

		t-test for Equality of Means		
		df	Sig. (2-tailed)	Mean Difference
Difference Lyrical - Nonlyrical (sec)	Equal variances assumed	11	.476	17.35714
	Equal variances not assumed	10.995	.469	17.35714

Independent Samples Test

		t-test for Equality of Means		
		Std. Error Difference	95% Confidence Interval of the Difference	
			Lower	Upper
Difference Lyrical - Nonlyrical (sec)	Equal variances assumed	23.53365	-34.44007	69.15435
	Equal variances not assumed	23.16512	-33.63201	68.34630

Appendix I.6

One-Sample Statistics (T-Test)

	N	Mean	Std. Deviation
Mean Change in HR/song (Lyrical-NonLyrical)	13	3.3369	6.72099
Mean Change in RPE/song (Lyrical-NonLyrical)	13	.1608	1.35635
Mean Change in Distance/song (Lyrical-NonLyrical)(km)	13	.022568	.0312774
Mean Change in Distance/song (Lyrical-NonLyrical)(miles)	13	.014023	.0194349

One-Sample Statistics

	Std. Error Mean
Mean Change in HR/song (Lyrical-NonLyrical)	1.86407
Mean Change in RPE/song (Lyrical-NonLyrical)	.37618
Mean Change in Distance/song (Lyrical-NonLyrical)(km)	.0086748
Mean Change in Distance/song (Lyrical-NonLyrical)(miles)	.0053903

One-Sample Test

	Test Value = 0		
	t	df	Sig. (2-tailed)
Mean Change in HR/song (Lyrical-NonLyrical)	1.790	12	.099
Mean Change in RPE/song (Lyrical-NonLyrical)	.427	12	.677
Mean Change in Distance/song (Lyrical-NonLyrical)(km)	2.602	12	.023
Mean Change in Distance/song (Lyrical-NonLyrical)(miles)	2.602	12	.023

One-Sample Test

	Test Value = 0	
	Mean Difference	95% Confidence Interval of the Difference
		Lower
Mean Change in HR/song (Lyrical-NonLyrical)	3.33692	-.7245
Mean Change in RPE/song (Lyrical-NonLyrical)	.16077	-.6589
Mean Change in Distance/song (Lyrical-NonLyrical)(km)	.0225679	.003667
Mean Change in Distance/song (Lyrical-NonLyrical)(miles)	.0140231	.002279

One-Sample Test

	Test Value = 0
	95% Confidence Interval of the Difference
	Upper
Mean Change in HR/song (Lyrical-NonLyrical)	7.3984
Mean Change in RPE/song (Lyrical-NonLyrical)	.9804
Mean Change in Distance/song (Lyrical-NonLyrical)(km)	.041469
Mean Change in Distance/song (Lyrical-NonLyrical)(miles)	.025767

Appendix I.7

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Non-Lyrical RPE at 3.05 km	16.3077	13	2.68901	.74580
	Lyrical RPE at 3.05 km	16.5000	13	2.67706	.74248
Pair 2	Non-Lyrical HR at 3.05 km	176.4615	13	17.53385	4.86302
	Lyrical HR at 3.05 km	176.7692	13	19.21438	5.32911

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Non-Lyrical RPE at 3.05 km & Lyrical RPE at 3.05 km	13	.943	.000
Pair 2	Non-Lyrical HR at 3.05 km & Lyrical HR at 3.05 km	13	.753	.003

Paired Samples Test

		Paired Differences		
		Mean	Std. Deviation	Std. Error Mean
Pair 1	Non-Lyrical RPE at 3.05 km - Lyrical RPE at 3.05 km	-.19231	.90228	.25025
Pair 2	Non-Lyrical HR at 3.05 km - Lyrical HR at 3.05 km	-.30769	13.00247	3.60624

Paired Samples Test

		Paired Differences			
		95% Confidence Interval of the Difference			
		Lower	Upper		
Pair 1	Non-Lyrical RPE at 3.05 km - Lyrical RPE at 3.05 km	-.73755	.35293	-.768	12
Pair 2	Non-Lyrical HR at 3.05 km - Lyrical HR at 3.05 km	-8.16500	7.54962	-.085	12

Paired Samples Test

		Sig. (2-tailed)
Pair 1	Non-Lyrical RPE at 3.05 km - Lyrical RPE at 3.05 km	.457
Pair 2	Non-Lyrical HR at 3.05 km - Lyrical HR at 3.05 km	.933

Appendix I.8

Did You Know Each Song?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	61.5	80.0	80.0
	No	2	15.4	20.0	100.0
	Total	10	76.9	100.0	
Missing	System	3	23.1		
Total		13	100.0		

Appendix I.9

Sang Along

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<1/2	4	28.6	44.4	44.4
	1/2	2	14.3	22.2	66.7
	>1/2	3	21.4	33.3	100.0
	Total	9	64.3	100.0	
Missing	System	5	35.7		
Total		14	100.0		

Appendix I.10

Regression

Descriptive Statistics

	Mean	Std. Deviation	N
Difference Lyrical - Nonlyrical (sec)	-36.1538	41.48865	13
Gender	1.46	.519	13
Age	33.46	8.313	13
Weight (kg)	70.08	15.809	13
Body Fat % (3-site skinfold method)	18.9100	8.47016	13
BMI	23.6073	2.91526	13

Correlations

		Difference Lyrical - Nonlyrical (sec)	Gender	Age	Weight (kg)	Body Fat % (3-site skinfold method)	BMI
Pearson Correlation	Difference Lyrical - Nonlyrical (sec)	1.000	-.217	.318	.079	-.019	.072
	Gender	-.217	1.000	.584	-.533	.827	-.175
	Age	.318	.584	1.000	-.395	.805	-.264
	Weight (kg)	.079	-.533	-.395	1.000	-.321	.858
	Body Fat % (3-site skinfold method)	-.019	.827	.805	-.321	1.000	-.074
	BMI	.072	-.175	-.264	.858	-.074	1.000
Sig. (1-tailed)	Difference Lyrical - Nonlyrical (sec)	.	.238	.145	.399	.475	.408
	Gender	.238	.	.018	.030	.000	.284
	Age	.145	.018	.	.091	.000	.192
	Weight (kg)	.399	.030	.091	.	.143	.000
	Body Fat % (3-site skinfold method)	.475	.000	.000	.143	.	.405
	BMI	.408	.284	.192	.000	.405	.
N	Difference Lyrical - Nonlyrical (sec)	13	13	13	13	13	13
	Gender	13	13	13	13	13	13
	Age	13	13	13	13	13	13
	Weight (kg)	13	13	13	13	13	13
	Body Fat % (3-site skinfold method)	13	13	13	13	13	13
	BMI	13	13	13	13	13	13

Appendix I.11

Descriptive Statistics (Regression)

	Mean	Std. Deviation	N
Difference Lyrical - Nonlyrical (sec)	-54.1250	43.26146	8
Did You Know Each Song?	1.13	.354	8
SangAlong	2.75	.886	8
How ManyMiles Per Week do you run?	2.63	1.188	8
What Do You Currently Run With?	4.00	2.000	8
How Much Time a day do you spend listening to music?	3.75	1.165	8
Do You play any instruments?	1.75	.463	8
Have You written your own music?	2.00	.000	8
Volume	6.500	3.1623	8

Correlations

		Difference Lyrical - Nonlyrical (sec)	Did You Know Each Song?	SangAlong	How ManyMiles Per Week do you run?	What Do You Currently Run With?	How Much Time a day do you spend listening to music?
Pearson Correlation	Difference Lyrical - Nonlyrical (sec)	1.000	.197	.029	.638	.264	-.304
	Did You Know Each Song?	.197	1.000	-.342	.128	-.404	-.607
	SangAlong	.029	-.342	1.000	.170	.564	.208
	How ManyMiles Per Week do you run?	.638	.128	.170	1.000	.481	-.490
	What Do You Currently Run With?	.264	-.404	.564	.481	1.000	.061

	How Much Time a day do you spend listening to music?	-.304	-.607	.208	-.490	.061	1.000
	Do You play any instruments?	-.423	.218	-.174	-.455	-.154	.397
	Have You written your own music?	.	.	.	.	.	.
	Volume	.029	.703	.204	.399	-.023	-.737
Sig. (1-tailed)	Difference Lyrical - Nonlyrical (sec)	.	.320	.473	.044	.264	.232
	Did You Know Each Song?	.320	.	.204	.382	.160	.055
	SangAlong	.473	.204	.	.344	.073	.311
	How ManyMiles Per Week do you run?	.044	.382	.344	.	.114	.109
	What Do You Currently Run With?	.264	.160	.073	.114	.	.443
	How Much Time a day do you spend listening to music?	.232	.055	.311	.109	.443	.
	Do You play any instruments?	.148	.302	.340	.129	.358	.165
	Have You written your own music?	.000	.000	.000	.000	.000	.000
	Volume	.473	.026	.314	.163	.479	.019
N	Difference Lyrical - Nonlyrical (sec)	8	8	8	8	8	8
	Did You Know Each Song?	8	8	8	8	8	8
	SangAlong	8	8	8	8	8	8
	How ManyMiles Per Week do you run?	8	8	8	8	8	8
	What Do You Currently Run With?	8	8	8	8	8	8
	How Much Time a day do you spend listening to music?	8	8	8	8	8	8

	Do You play any insturments?	8	8	8	8	8	8
	Have You written your own music?	8	8	8	8	8	8
	Volume	8	8	8	8	8	8

Correlations

		Do You play any insturments?	Have You written your own music?	Volume
Pearson Correlation	Difference Lyrical - Nonlyrical (sec)	-.423	.	.029
	Did You Know Each Song?	.218	.	.703
	SangAlong	-.174	.	.204
	How ManyMiles Per Week do you run?	-.455	.	.399
	What Do You Currently Run With?	-.154	.	-.023
	How Much Time a day do you spend listening to music?	.397	.	-.737
	Do You play any instruments?	1.000	.	.000
	Have You written your own music?	.	1.000	.
	Volume	.000	.	1.000
Sig. (1-tailed)	Difference Lyrical - Nonlyrical (sec)	.148	.000	.473
	Did You Know Each Song?	.302	.000	.026
	SangAlong	.340	.000	.314
	How ManyMiles Per Week do you run?	.129	.000	.163
	What Do You Currently Run With?	.358	.000	.479
	How Much Time a day do you spend listening to music?	.165	.000	.019
	Do You play any instruments?	.	.000	.500
	Have You written your own music?	.000	.	.000
	Volume	.500	.000	.

N	Difference Lyrical - Nonlyrical (sec)	8	8	8
	Did You Know Each Song?	8	8	8
	SangAlong	8	8	8
	How ManyMiles Per Week do you run?	8	8	8
	What Do You Currently Run With?	8	8	8
	How Much Time a day do you spend listening to music?	8	8	8
	Do You play any instruments?	8	8	8
	Have You written your own music?	8	8	8
	Volume	8	8	8

Appendix J Subject Data

Appendix J. 1 Subject 1

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
Measurements at the end of each song	11	148	13	236	2	88	0	0.38	0	0.41	0.38	0.41	0.03	
	11	158	13	157	2	-1	0.38	0.85	0.41	0.91	0.47	0.5	0.03	
	12	167	13	164	1	-3	0.85	1.28	0.91	1.35	0.43	0.44	0.01	
	13	168	15	154	2	-14	1.28	1.95	1.35	2.02	0.67	0.67	0	
	15	174	18	167	3	-7	1.95	2.66	2.02	2.69	0.71	0.67	-0.04	
				MEAN	2	12.6	2.66		2.69					
3.05 miles	18	178	19	171	1	-7							**Miles**	**Km**
												Mean Δd	0.006	0.0097

Appendix J. 2 Subject 3

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
Measurements at the end of each song	11	134	11	128	0	-6	0	0.36	0	0.36	0.36	0.36	0	
	13	143	13	143	0	0	0.36	0.9	0.36	0.93	0.54	0.57	0.03	
	14	149	14	146	0	-3	0.9	1.33	0.93	1.34	0.43	0.41	-0.02	
	14	151	15	146	1	-5	1.33	1.73	1.34	1.76	0.4	0.42	0.02	
	14	154	16	151	2	-3	1.73	2.14	1.76	2.21	0.41	0.45	0.04	
	15	159	17	156	2	-3	2.14	2.53	2.21	2.62	0.39	0.41	0.02	
	17	159					2.53	2.98	2.62		0.45			
				MEAN	0.83333333	-3.3333333	2.98							
													miles	**km**
3.05 miles	18	168	18	165	0	-3						**Mean Δd**	0.015	0.0241401

Appendix J. 3 Subject 4

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	14	164	15	174	1	10	0	0.51	0	0.55	0.51	0.55	0.04	
	15	170	16	176	1	6	0.51	0.97	0.55	1.07	0.46	0.52	0.06	
	15	175	16	172	1	-3	0.97	1.56	1.07	1.67	0.59	0.6	0.01	
Measurements	16	177	16	173	0	-4	1.56	2.03	1.67	2.12	0.47	0.45	-0.02	
at the end of	17	182	16	176	-1	-6	2.03	2.58	2.12	2.65	0.55	0.53	-0.02	
each song	17	183	19	184	2	1	2.58	2.92	2.65	3.03	0.34	0.38	0.04	
				MEAN	0.66666667	0.66666667								
													miles	**km**
3.05 miles	19	187	19	184	0	-3						**Mean Δd**	0.01833333	0.02950457

Appendix J. 4 Subject 5

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	11	148	12	148	1	0	0	0.35	0	0.34	0.35	0.34	-0.01	
	13	155	13	160	0	5	0.35	0.79	0.34	0.8	0.44	0.46	0.02	
	15	163	14	166	-1	3	0.79	1.09	0.8	1.12	0.3	0.32	0.02	
	16	171	15	170	-1	-1	1.09	1.56	1.12	1.63	0.47	0.51	0.04	
Measurements	16	171	16	178	0	7	1.56	1.91	1.63	2	0.35	0.37	0.02	
at the end of	17	171	19	178	2	7	1.91	2.43	2	2.57	0.52	0.57	0.05	
each song	19	208					2.43	2.98			0.55			
				MEAN	0.16666667	3.5								
													miles	**km**
3.05 miles	19	208	19	178	0	-30						**Mean Δd**	0.0175	0.02816345

Appendix J. 5 Subject 6

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	11	165	12	176	1	11	0	0.3	0	0.3	0.3	0.3	0	
	12	171	12	170	0	-1	0.3	0.54	0.3	0.59	0.24	0.29	0.05	
	13	178	13	175	0	-3	0.54	0.89	0.59	0.9	0.35	0.31	-0.04	
	13	179	13	179	0	0	0.89	1.18	0.9	1.19	0.29	0.29	0	
Measurements	14	184	13	179	-1	-5	1.18	1.53	1.19	1.52	0.35	0.33	-0.02	
at the end of	14	183	14	202	0	19	1.53	1.88	1.52	1.88	0.35	0.36	0.01	
each song	15	185	15	231	0	46	1.88	2.12	1.88	2.1	0.24	0.22	-0.02	
	15	187	15	230	0	43	2.12	2.33	2.1	2.32	0.21	0.22	0.01	
	15	187	16	220	1	33	2.33	2.69	2.32	2.68	0.36	0.36	0	
	16	187	16	196	0	9	2.69	2.97	2.68	2.98	0.28	0.3	0.02	
				MEAN	0.1	15.2	2.97		2.98					
													miles	**km**
3.05 miles	17	189	17	212	0	23						**Mean Δd**	0.001	0.00160934

Appendix J. 6 Subject 7

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	12	156	13	153	1	-3	0	0.31	0	0.32	0.31	0.32	0.01	
	12	157	13	155	1	-2	0.31	0.6	0.32	0.62	0.29	0.3	0.01	
	12	162	14	161	2	-1	0.6	1.02	0.62	1.03	0.42	0.41	-0.01	
	13	161	13	166	0	5	1.02	1.36	1.03	1.38	0.34	0.35	0.01	
	12	165	14	165	2	0	1.36	1.76	1.38	1.78	0.4	0.4	0	
Measurements	13	169	14	163	1	-6	1.76	2.1	1.78	2.12	0.34	0.34	0	
at the end of	13	170	14	166	1	-4	2.1	2.44	2.12	2.46	0.34	0.34	0	
each song	13	173	14	169	1	-4	2.44	2.88	2.46	2.9	0.44	0.44	0	
				MEAN	1.125	-1.875	2.88		2.9					
													miles	**km**
3.05 miles	13	174	14	169	1	-5						**Mean Δd**	0.0025	0.00402335

Appendix J. 7 Subject 8

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	13	163	13	153	0	-10	0	0.44	0	0.4	0.44	0.4	-0.04	
	14	165	13	159	-1	-6	0.44	0.83	0.4	0.8	0.39	0.4	0.01	
	14	157	13	165	-1	8	0.83	1.28	0.8	1.21	0.45	0.41	-0.04	
	14	155	14	168	0	13	1.28	1.68	1.21	1.59	0.4	0.38	-0.02	
	15	164	15	167	0	3	1.68	2.05	1.59	1.95	0.37	0.36	-0.01	
Measurements	14	169	15	170	1	1	2.05	2.37	1.95	2.34	0.32	0.39	0.07	
at the end of	15	165	15	170	0	5	2.37	2.75	2.34	2.68	0.38	0.34	-0.04	
each song	15	165					2.75	3.08	2.68		0.33			
				MEAN	-0.1428571	2	3.08							
													miles	**km**
3.05 miles	15	165	17	178	2	13						**Mean Δd**	-0.0100	-0.0160934

Appendix J. 8 Subject 9

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	14	150	13	159	-1	9	0	0.42	0	0.45	0.42	0.45	0.03	
	15	165	13	176	-2	11	0.42	0.83	0.45	0.85	0.41	0.4	-0.01	
	15	168	13	177	-2	9	0.83	1.32	0.85	1.31	0.49	0.46	-0.03	
	15	169	13	185	-2	16	1.32	1.69	1.31	1.67	0.37	0.36	-0.01	
Measurements	15	172	13	185	-2	13	1.69	2.04	1.67	2.02	0.35	0.35	0	
at the end of	16	173	14	187	-2	14	2.04	2.63	2.02	2.61	0.59	0.59	0	
each song	17	185	14	193	-3	8	2.63	3.03	2.61	3.01	0.4	0.4	0	
				mean	-2	11.4285714	3.03		3.01					
													miles	**km**
3.05 miles	17	185	16	202	-1	17						**Mean Δd**	-0.0028571	-0.0045981

Appendix J. 9 Subject 10

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	9	122	11	106	2	-16	0	0.27	0	0.24	0.27	0.24	-0.03	
	11	122	11	116	0	-6	0.27	0.51	0.24	0.48	0.24	0.24	0	
	11	125	11	120	0	-5	0.51	0.75	0.48	0.73	0.24	0.25	0.01	
	12	125	12	121	0	-4	0.75	1.15	0.73	1.12	0.4	0.39	-0.01	
	12	129	13	118	1	-11	1.15	1.4	1.12	1.4	0.25	0.28	0.03	
	13	136	13	130	0	-6	1.4	1.65	1.4	1.65	0.25	0.25	0	
	13	130	13	128	0	-2	1.65	1.92	1.65	1.92	0.27	0.27	0	
	14	136	13	128	-1	-8	1.92	2.17	1.92	2.13	0.25	0.21	-0.04	
Measurements	14	136	13	136	-1	0	2.17	2.36	2.13	2.38	0.19	0.25	0.06	
at the end of	15	131	13	129	-2	-2	2.36	2.64	2.38	2.64	0.28	0.26	-0.02	
each song	14	137	13	132	-1	-5	2.64	3.03	2.64	3.02	0.39	0.38	-0.01	
				mean	-0.1818182	-5.9090909	3.03		3.02					
													miles	**km**
3.05 miles	14	137	13	134	-1	-3						**Mean Δd**	-0.0009091	-0.001463

Appendix J. 10 Subject 11

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	9	147	6	167	-3	20	0	0.27	0	0.29	0.27	0.29	0.02	
	12	154	7	171	-5	17	0.27	0.57	0.29	0.56	0.3	0.27	-0.03	
	11	153	7	162	-4	9	0.57	0.87	0.56	0.87	0.3	0.31	0.01	
	11	152	10	160	-1	8	0.87	1.27	0.87	1.27	0.4	0.4	0	
	12	195	10	149	-2	-46	1.27	1.61	1.27	1.61	0.34	0.34	0	
Measurements	13	157	12	125	-1	-32	1.61	1.99	1.61	2	0.38	0.39	0.01	
at the end of	13	154	12	160	-1	6	1.99	2.45	2	2.49	0.46	0.49	0.03	
each song	14	160	13	167	-1	7	2.45	2.87	2.49	2.94	0.42	0.45	0.03	
				mean	-2.25	-1.375	2.87		2.94					
													miles	**km**
3.05 miles	14	166	13	165	-1	-1						**Mean Δd**	0.00875	0.01408173

Appendix J. 11 Subject 12

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	16	180	10.5	179	-5.5	-1	0	0.74	0	0.76	0.74	0.76	0.02	
Measurements	17	184	17	184	0	0	0.74	1.44	0.76	1.45	0.7	0.69	-0.01	
at the end of	18	186	18	185	0	-1	1.44	2.08	1.45	2.12	0.64	0.67	0.03	
each song	19	189	19	191	0	2	2.08	2.82	2.12	2.96	0.74	0.84	0.1	
							2.82		2.96					
				Mean	-1.375	0								
													miles	**km**
3.05 miles	20	193	20	192	0	-1						**Mean Δd**	0.74	1.1909116

Appendix J. 12 Subject 14

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	11	146	13	149	2	3	0	0.3	0	0.34	0.3	0.34	0.04	
	13	148	14	181	1	33	0.3	0.8	0.34	0.85	0.5	0.51	0.01	
	13	150	15	160	2	10	0.8	1.24	0.85	1.32	0.44	0.47	0.03	
	14	157	16	164	2	7	1.24	1.71	1.32	1.82	0.47	0.5	0.03	
Measurements	15	157	15.5	160	0.5	3	1.71	2.09	1.82	2.2	0.38	0.38	0	
at the end of	15	156	16.5	165	1.5	9	2.09	2.45	2.2	2.61	0.36	0.41	0.05	
each song	16	165	17.5	169	1.5	4	2.45	2.89	2.61	3.05	0.44	0.44	0	
				MEAN	1.5	9.85714286	2.89		3.05					
													miles	**km**
3.05 miles	17	163	17.5	169	0.5	6						**Mean Δd**	0.02285714	0.03678491

Appendix J. 13 Subject 15

	NL		L				NL		L		NL	L	L-NL	
	RPE	**HR**	**RPE**	**HR**	**Δ RPE**	**Δ HR**	**Distance @ start**	**Distance @ end**	**Distance @ start**	**Distance @ end**	**Δd/song**	**Δd/song**	**Δd**	
	8	173	9	174	1	1	0	0.4	0	0.45	0.4	0.45	0.05	
	8	177	9.5	180	1.5	3	0.4	0.8	0.45	0.89	0.4	0.44	0.04	
	8	176	10	178	2	2	0.8	1.22	0.89	1.36	0.42	0.47	0.05	
	9	183	11	181	2	-2	1.22	1.62	1.36	1.79	0.4	0.43	0.03	
Measurements	9.5	179	11	179	1.5	0	1.62	1.98	1.79	2.17	0.36	0.38	0.02	
at the end of	9.5	179	12	181	2.5	2	1.98	2.34	2.17	2.72	0.36	0.55	0.19	
each song	11	181	12	179	1	-2	2.34	2.79	2.72		0.45			
				MEAN	1.64285714	0.57142857	2.79							
													miles	**km**
3.05 miles	11	181	12	179	1	-2						**Mean Δd**	0.06333333	0.10192487

Appendix K Composite Data

Subject	Familirza-tion	FamSec	Lyrical	LyrSec	NonLyrical	NonLyrSec	Order	Trial1	Trial2	Trial3	difference	KnowSong
1	00:26:22	1582.00	00:23:53	1433.00	00:24:10	1450.00	2	00:26:22	00:24:10	00:23:53	-17.00	
3	00:30:23	1823.00	00:27:42	1662.00	00:28:29	1709.00	2	00:30:23	00:28:29	00:27:42	-47.00	1
4	00:21:32	1292.00	00:23:49	1429.00	00:24:13	1453.00	1	00:21:32	00:23:49	00:24:13	-24.00	1
5	00:24:20	1460.00	00:23:17	1397.00	00:24:24	1464.00	2	00:24:20	00:24:24	00:23:17	-67.00	1
6	00:26:40	1600.00	00:27:32	1652.00	00:28:29	1709.00	1	00:26:40	00:27:32	00:28:29	-57.00	1
7	00:31:46	1906.00	00:32:14	1934.00	00:32:25	1945.00	1	00:31:46	00:32:14	00:32:25	-11.00	2
8	00:30:55	1855.00	00:32:24	1944.00	00:32:26	1946.00	2	00:30:55	00:32:26	00:32:24	-2.00	1
9	00:28:26	1706.00	00:25:25	1525.00	00:25:15	1515.00	1	00:28:26	00:25:25	00:25:15	10.00	
10	00:39:00	2340.00	00:43:26	2606.00	00:43:21	2601.00	2	00:39:00	00:43:21	00:43:26	5.00	
11	00:34:07	2047.00	00:33:06	1986.00	00:33:39	2019.00	2	00:34:07	00:33:39	00:33:06	-33.00	2
12	00:19:59	1199.00	00:18:54	1134.00	00:18:56	1136.00	1	00:19:59	00:18:54	00:18:56	-2.00	1
14	00:28:07	1687.00	00:27:19	1639.00	00:29:02	1742.00	1	00:28:07	00:27:19	00:29:02	-103.00	1
15	00:25:56	1556.00	00:25:52	1552.00	00:27:54	1674.00	2	00:25:56	00:27:54	00:25:52	-122.00	1

Subject	SangAlong	Mile-sAWeek	RunWith	TimeOf-Music	Instrumen-tal	Written	Gender	Race	Age	Height	HeightSCI	Weight
1		1	1	5	2	2	1	1	21	70	178	206
3	2	2	3	3	1	2	1	2	26	71	180	175
4	4	3	5	3	2	2	1	2	28	74	188	195
5	3	3	7	3	2	2	2	2	28	62	157	125
6	2	3	5	5	2	2	2	2	35	65	165	123
7		2	1	4	2	2	2	1	43	66	168	142
8	3	2	4	5	2	2	2	1	48	63	160	125
9		2	2	5	2	2	1	2	28	68	173	140
10		2	1	5	2	1	1	2	39	75	191	220
11	2	3	2	2	2	2	2	1	46	61	155	125
12	4	5	6	3	1	2	1	2	34	64	163	115
14	2	2	1	4	2	2	2	1	31	67	170	169
15	4	1	4	5	2	2	1	2	28	71	180	150

Subject	WeightSCI	BodyFat	BMI	Volume	RPE_F	HR_F	RPE_NL	HR_NL	RPE_L	HR_L	MeanDeltaRPE	MeanDel-taHR
1	93	6.67	29.55	16.0	17.00		18.00	178.00	19.00	171.00	2.00	12.60
3	79	16.22	24.40	4.0	18.00	160.00	18.00	168.00	18.00	165.00	.83	-3.33
4	88	9.46	25.03		20.00	191.00	19.00	187.00	19.00	184.00	.67	.67
5	57	21.69	22.86	8.0	19.00	181.00	19.00	208.00	19.00	178.00	.17	3.50
6	56	25.02	20.47	3.0	16.00	232.00	17.00	189.00	17.00	212.00	.10	15.20
7	64	28.08	22.92	4.0	14.00	166.00	13.00	174.00	14.00	169.00	1.13	-1.88
8	57	26.48	22.14	3.0	16.00	172.00	15.00	165.00	17.00	178.00	-.14	2.00
9	63	11.75	21.28	4.0	15.00	173.00	17.00	185.00	16.00	202.00	-2.00	11.43
10	100	23.87	27.50	9.0	17.00	143.00	14.00	137.00	13.00	134.00	-.18	-5.90
11	57	32.59	23.62	12.0	13.00	156.00	14.00	166.00	13.00	165.00	-2.25	-1.38
12	52	9.50	19.74	9.0	18.00	187.00	20.00	193.00	20.00	192.00	-1.38	.00

14	77	23.21	26.47	6.0	20.00	177.00	17.00	163.00	17.50	169.00	1.50	9.90
15	68	11.29	20.92	7.0	15.00	184.00	11.00	181.00	12.00	179.00	1.64	.57

Subject	Mean-DelltaD	MeanDel-taD2
1	.0060	.0097
3	.0150	.0241
4	.0183	.0295
5	.0233	.0375
6	.0010	.0016
7	.0025	.0040
8	-.0100	-.0161
9	-.0029	-.0047
10	-.0009	-.0014
11	.0088	.0142
12	.0350	.0563
14	.0229	.0369
15	.0633	.1019