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Does Music Tempo Influence Maximal Force Output?

DOES MUSIC TEMPO INFLUENCE MAXIMAL FORCE OUTPUT?

A Research Paper

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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Abstract

This study aimed to determine the influence of music tempo on maximal force output. Furthermore, this study also examined participant's perception of listening to different tempo music during a maximal force task. Fifteen recreationally active male participants with a mean age of 25.1 years, mass of 89.14 kg, and height of 182.1 cm performed isometric mid-thigh pulls under three different conditions (no music, slow tempo music, and fast tempo music) in the University of Northern Iowa free-weight room. The peak pulling force was measured using a portable force plate to the nearest tenth of a Newton under the three conditions for each participant. Participants were given a questionnaire after completion of the experiment to examine their perception of listening to music while performing a maximal force task. A repeated measures ANOVA was used to analyze the data collected during the experiment. Statistical analysis showed no significant differences between any of the three conditions ($F = 2.271$, $df = 2$, $p = 0.122$). A second statistical analysis was done to see if the order of trials or fatigue factored into the results between the conditions. Those results also showed no significant differences ($F = 2.405$, $df = 2$, $p = 0.109$). The questionnaire revealed that every participant enjoyed listening to fast tempo music while performing this maximal force task and 11 participants reported that they felt stronger when listening to the fast tempo music while performing isometric mid-thigh pulls compared to any of the other conditions. In conclusion, while listening to music during a maximal force task had no significant difference on performance when compared to no music, participants' perceptions were influenced. Though listening to music did not produce stronger lifts, it did have perceived psychological effects in that participants found listening to fast tempo music more enjoyable while some also felt stronger.

This Study by: Aaron D. Suma

Entitled: DOES MUSIC TEMPO INFLUENCE MAXIMAL FORCE OUTPUT?

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5-25-11
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Introduction

Most athletes who have worked out in some way, shape, or form (such as running, lifting weights, speed and agility training, etc.) have put on a pair of headphones or turned on the stereo and listened to music while performing these physical activities. Perhaps they listen to music because they believe it blocks out thoughts of quitting or fatigue. Some may consider it normal behavior and think nothing of it. Others may think the music provides a "psyching up" effect, raising adrenaline levels to help motivate them before performing physically demanding lifts. In support of these beliefs, research has shown music to have an effect on arousal levels (Terry & Karageorghis, 2006), increase work output and reduce rate of perceived exertion (Elliot, Carr, & Savage, 2004), impact attentional focus by providing distractions from pain and fatigue (Terry & Karageorghis, 2006), and even affect mood and motivation (Sorenson, Czech, Klein, & Lachowetz, 2008).

Research has also shown that there is a positive correlation between music tempo and arousal levels (Brown, 1980; Hohler, 1989; Vogel, 1986). According to Yamamoto et al. (2003), "listening to slow rhythm music decreases the plasma norepinephrine level, and listening to fast rhythm music increases the plasma epinephrine level" (p. 211). This leads to increased arousal levels that can elicit a "fight or flight" type of response, which could transition into increased performance in certain activities.

Experiments involving sports performance and music have shown music can provide a beneficial effect on endurance and athletic performance (Terry & Karageorghis, 2006). A study by Elliot et al. (2004) reported that participants listening to music while pedaling a stationary bike had a significantly higher work output in terms of distance pedaled and also had lower ratings of perceived exertion compared to riding and listening to no music at all. Terry and

Karageorghis (2006) found that listening to music can have a significant impact on a person's attentional focus by providing a distraction from fatigue, pain, and perceived exertion. This suggests that music can provide a distracting factor by drawing attention away from the mind's perception that the body is physically fatigued (Hernandez-Peon, 1961). Another study examined the effect of different tempo music on rowing sprints. The results showed that listening to faster tempo music significantly increased rowing performance compared to listening to no music at all (Rendi, Szabo, & Szabo, 2008). These results were attributed to an increase in arousal when listening to fast tempo music.

Pujol and Langenfeld (1999) conducted a study in which participants performed three consecutive wingate anaerobic tests on two different occasions (one occasion with music, one occasion without music), measuring mean power output, maximum power output, minimum power output, and fatigue index. There were no significant differences found for any of the variables between the music and non-music conditions. They suggested these findings may be due to the fact that "any potentially diverting effects of music were not sufficient to overcome the physical stress cues of supramaximal exercise" (p. 295).

Like most of the previous research, Pujol and Langenfeld (1999) tested subjects until they were fatigued, but can music have a beneficial effect on tasks using a non-fatiguing maximal force output protocol? Since music tempo has been correlated with arousal levels, it was hypothesized that listening to fast tempo music would have a beneficial effect on an individual's maximal force output, while listening to slow tempo music would have a detrimental effect on maximal force output.

Purpose Statement

The purpose of this research was to examine the effect music tempo has on an individual's maximal isometric force output. The second purpose of this research was to examine participants' perceptions of listening to different tempos of music while performing a maximal force task.

Methods

Participants

Approval for this study was granted by the University of Northern Iowa's Institutional Review Board before beginning any experimentation or selection of participants. Fifteen recreationally active male participants were recruited for this study. The participants were peers and fellow graduate students of the author and were approached one on one and by email asking if they would be participants for an experiment. Participants had a mean age of 25.1 years (*SD* = 2.4 years), height of 182.1 cm (*SD* = 7.62 cm), and mass of 89.1 kg (*SD* = 13.7 kg). Participants were pre-screened by having them fill out a health screening questionnaire (See Appendix A) in which they had to answer "No" to each question to be cleared for participation. Participants also signed an informed consent form before beginning participation in the study and were informed they could choose to discontinue the study at any time.

Questionnaire

Upon completion of the maximal force task portion of the experiment, participants were asked to complete a short questionnaire. The questionnaire was designed to assess participant's perceptions of listening to music while performing the output task (See Appendix B).

Procedures

An emergency action plan (EAP) was written (see Appendix C) and posted in plain sight.

Everyone in the room during experimentation was notified of the EAP's location in case of an accident or emergency. Participants were told the purpose of the study was to examine if listening to music while performing a maximal force task was distracting. Participants were mislead so that they did not consciously or unconsciously give more effort under some conditions and less effort under others. Participants performed isometric mid-thigh pulls to measure their maximal pulling force in the University of Northern Iowa free-weight room. The isometric mid-thigh pull was chosen because it is an isometric movement and is not extremely technical or difficult to learn.

Force generated by each participant was measured to the nearest tenth of a Newton using an AMTI Accupower portable force plate. The isometric mid-thigh pulls were performed by having the participants stand on a force plate inside a weightlifting power rack with safety catch bars around their mid thigh area. The participants stood inside the power rack where an Olympic Weightlifting weight bar was underneath the safety catch bars and participants isometrically pulled the weight bar against the bottom of the safety bars. Participants were provided with a pair of weightlifting straps to ensure maximal pulling force and prevent grip slippage. The participants then pulled with maximum exertion on the bar for three seconds. As participants isometrically pulled up into the safety bars, their force pushed down into the force plate. The participant's pulling force was measured on the force plate and the maximum force during each trial was recorded.

Participants warmed-up by doing a series of dynamic stretches to prevent any occurrence of injury. Participants then became familiar with doing an isometric mid-thigh pull by performing three isometric mid-thigh pulls prior to the actual experiment to counteract any type of learning curve which might be experienced by novice lifters who are unfamiliar with a mid-

thigh pull. Each warm-up mid-thigh pull was approximately three seconds long. The first warm-up mid-thigh pull was performed at approximately 30% of their maximum intensity. The second was performed at approximately 70% of their maximum intensity. The third and final warm-up mid-thigh pull was performed at each participant's maximum intensity. This gradual increase in intensity allowed participants to become accustomed to what they would do in the actual experiment.

Participants performed one isometric mid-thigh pull for each of the three different conditions (no music, slow tempo music, and fast tempo music) for a total of three pulls during the experiment. The order of conditions for each participant was randomly determined by having participants roll a six-sided die in which each number corresponded with a specific order of conditions. The participants heard the music for each condition for 30 seconds before the administrator instructed them to perform a mid-thigh pull at their maximum intensity for three seconds. After three seconds, the administrator told the participant to "Stop" and the participant had a two minute rest until the next condition. A two minute rest between conditions was deemed adequate rest time to ensure full recovery due to the fact that full ATP repletion in dynamic muscle actions occurs in 3-5 minutes (Harris et al., 1976; Hultman & Sjoholm, 1986), while isometric actions require considerably less time to full repletion (Bridges, Clark III, Hammond, & Stephenson, 1991). A pilot study with four participants was also done to ensure that two minutes was adequate recovery time. During the two minute rest, there was no music playing for the first 90 seconds, followed by 30 seconds of listening to the music of the next condition before being instructed by the administrator to start.

Music Selection and Administration

To reduce any cultural bias or offensiveness, non-lyrical music was chosen for the

experiment. In a study by Yamamoto et al. (2003) the administrators chose to play classical Chopin for the slow tempo music and music from the Rocky soundtrack for the fast tempo music. For this study, the song "River" by Chopin was administered for the slow tempo music and "Going the Distance" by Bill Conti was administered for the fast tempo music. The music was administered through an Ipod with external speakers, approximately 5 feet away from participants and at a medium auditory level.

Results

The mean maximum force output in Newtons for each of the three conditions was: Fast Tempo, $M = 3066.5$ ($SD = 596.1$); Slow Tempo, $M = 3045.5$ ($SD = 733.0$); No music, $M = 2940.8$ ($SD = 582.3$). A repeated measures analysis of variance (ANOVA) was used to analyze differences between the conditions using .05 as the alpha level. There were no statistically significant differences between the three conditions ($F = 2.271$, $df = 2$, $p = 0.122$). The mean maximum force outputs by order of trials were also calculated and were: first trial, $M = 3033.1$ ($SD = 625.9$); second trial, $M = 2942.1$ ($SD = 571.0$); third trial, $M = 3077.5$ ($SD = 716.5$). A repeated measures ANOVA was also used to analyze this data and there were no significant differences between trials ($F = 2.405$, $df = 2$, $p = 0.109$).

The post experiment questionnaire results revealed that none of the participants perceived the music as distracting. In addition, all fifteen of the participants indicated that the fast tempo music was most enjoyable. For the question asking participants to select the condition in which they felt the most relaxed, 47% (n = 7) chose slow music, 20% (n = 3) chose no music, 20% (n = 3) chose fast music, and 13% (n = 2) selected the "none" option. Finally, 73% (n = 11) indicated that the fast tempo music condition made them feel stronger while the remaining participants (27%, n = 4) did not feel stronger in any particular condition.

Discussion

The aim of this study was to see if the participants could produce more force when listening to faster tempo music and how they perceived the music while performing a maximal force task. The results showed there were no significant differences between the three conditions, which indicates that music tempo cannot be classified from this study as having a beneficial effect on maximal force output when performing an isometric mid-thigh pull. The analysis of the order of trials was to ensure there was no type of order effect or that muscular fatigue might be playing a role and corrupting the data. There were no significant differences between any of the trials by order, so fatigue and order did not factor into the results between the conditions.

There may be multiple reasons why the results of this study showed no significant effect. First, perhaps music does not affect performance on tasks requiring maximal force output, which is similar to the findings of Pujol and Langenfeld (1999). Second, only fifteen participants were selected for this study. Increasing the number of participants may increase the tendency and reveal significant results. Third, auditory level might be a factor in determining the effect of music on maximal force output. The auditory volume was set at mid-level. Increasing the decibel level may provide a higher level of arousal and increase maximal force output. Another reason may be due to an insufficient number of trials for each condition. By increasing the number of trials for each condition, there might be a greater chance that music tempo can influence maximal force output.

Another possible explanation for the non-significant findings might be that the music selected for this study was universal in the fact that every participant heard the same music for each condition. This may have been problematic if some participants did not respond to a certain

song that others may have. Perhaps letting each participant select their own songs may show better responses to the music and transition into higher force outputs. Additionally, the length of time listening to the music of each condition may not have provided an adequate amount of time to raise arousal levels. It may take longer than thirty seconds to changes arousal levels, so future studies may benefit from allowing participants to listen to the music of each condition for longer periods of time before performing the maximal force task. Testing different types of populations may also provide different results since this study involved younger males who tend to listen to music when working out, which could be part of the cultural norm for them.

Finally, the task itself may have been part of the reason there were no significant differences between trials. When performing an isometric force task, participants do not receive any feedback into how hard they are pulling because the weight bar does not move like it would during a deadlift or any other dynamic weight lifting. This may have minimized the response each participant had when listening to the music. If the task was dynamic and the participants saw the bar moving easier than normal when listening to fast tempo music, it may have provided a beneficial "psyching up" effect to help them lift the weight easier.

As might be expected, the questionnaire revealed that the music did influence participant's perceptions while performing an isometric mid-thigh pull. When asked if the music was distracting during the experiment, every participant answered "No", indicating that music was not a distracting factor during this maximal force task for the participants. The second question asked each participant if there was a condition which they enjoyed most. Every participant responded that the fast tempo condition was the most enjoyable suggesting that listening to music with a faster rhythm was preferable during this maximal force task. The third question asked if any of the conditions made the participants feel more relaxed. Responses to this

question varied; however, the slow tempo condition made more participants (n = 7) feel relaxed than any other condition. The final question asked participants if any of the conditions made them feel stronger. Eleven of the fifteen participants felt stronger during the fast tempo condition, while the remaining four participants did not think any of the conditions made them feel stronger.

The results of the questionnaire show that while the experiment revealed no statistically significant differences in maximal force output, the participants did enjoy listening to the fast tempo music while performing the experiment. The questionnaire also shows that while listening to fast tempo music did not translate into significantly higher force outputs, most of the participants (n = 11) felt stronger while listening to the fast tempo music condition.

In conclusion, while the physical results of this study were not statistically significant, the psychological perceptions might be. Participants' perception was that the music was not distracting and that the fast tempo music was enjoyable. The fast tempo music made most participants feel stronger even if it did not make them physically stronger. Thus, when making a decision whether to play music during maximal force tasks, the perception of the lifter should be taken into account. Since research has found that music can have an effect on mood and motivation (Sorenson et al., 2008), athletes may find it enjoyable and motivating whether or not listening to music produces stronger lifts.

Appendix A: Health Screening Questionnaire

(Circle yes or no)

1. Do you or have you had and cardiovascular problems that would prevent you from participating in this experiment?

Yes No

2. Do you or have you had and cardiorespiratory problems that would prevent you from participating in this experiment?

Yes No

3. Have you suffered any injuries in the past or have any current injuries that could affect your ability to participate in this experiment? (If yes, please list)

Yes No

4. Do you have any neuromuscular conditions which would prevent you from being able to participate in this experiment?

Yes No

5. Do you currently have any cold or flu-like symptoms that could affect your ability to participate in this experiment?

Yes No

Appendix B: Post Experiment Questionnaire

1. Was the music at all distracting? (circle one)

   A. yes B. no

2. Which music did you enjoy most? (circle one)

   A. no music B. slow music C. fast music

3. Did any condition make you feel more relaxed? (circle one)

   A. no music B. slow music C. fast music D. none

4. Did any condition make you feel stronger? (circle one)

   A. no music B. slow music C. fast music D. none

Appendix C: Emergency Action Plan

(Follow these steps in case of an emergency)

1. Check the scene and the victim

   A) check for heart beat

   B) check to see if victim is breathing

   C) check to see if victim is conscious

   D) check to see if victim is bleeding

   E) check victim for any obvious injuries

2. Call 9-1-1 from Investigator's Phone

   A) provide details to emergency operators

   B) provide directions to emergency operators

   C) send someone to meet Ambulance

3. Provide care for the victim

   A) send someone for AED

   B) perform CPR/first aid while other person is getting AED

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