Original Research

The Effect of Music as a Motivational Tool on Isokinetic Concentric Performance in College Aged Students

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ABSTRACT

International Journal of Exercise Science 7(1) : 54-61, 2014. Music has been identified as a motivational tool in physical activity and associated with improved performance in aerobic and anaerobic exercise. However, the effects of music on isokinetic strength testing have not been examined. The purpose of this study was to measure the difference in lower limb isokinetic force output in males and females when exposed to a motivational environment (arousing music) and non-motivational environment (silence). A 2 x 2 analysis of variance (group x gender) was used with participants (n = 19; 12 male, 7 female) serving as their own control. Participants performed 5 isokinetic concentric repetitions of knee extension and knee flexion at a set velocity of 60°/sec in both a non-music trial and music trial. Testing order was randomized to control for learning effect. No significant interactions were found for both the flexion and extension conditions (p > .05); however, there was a main effect for gender on the extension variable (p < .05). The authors concluded that music had no effect on lower limb force output in either males or females. The study may have been limited by a number of confounding effects, warranting a repeated yet enhanced research design of the study. Strength coaches, athletic trainers, and injury rehabilitation specialists (e.g., physical therapists) can use knowledge of this topic when working with clients and patients who are unmotivated to continue treatment. Music may not serve as an enhancer of patient or athlete performance in isokinetic testing or maximal isokinetic performance, but it may serve to increase enjoyment of otherwise monotonous activity.

KEY WORDS: anaerobic testing, motivation, force, knee, muscle

INTRODUCTION

The motivational aspects of music on athletic and sport performance have garnered much attention in recent literature due to its presence at sporting events and fitness facilities, as well as the emergence of personal music players that are popular among recreational exercisers (3,4,13). In fact, motivational music has almost become requisite in group fitness settings and competitive sport gatherings.

Music has been associated with improved aerobic and anaerobic performance due to its ability to influence the listener's mood, disposition, as well as distract the listener from other sensations stemming from their body (e.g., tiredness) and the environment (17). During aerobic exercise, music can be used to increase the excitement and motivation of a participant who may otherwise perceive the activity as dull or monotonous (28). In anaerobic exercise, music has been theorized to distract the exerciser from the physiological processes occurring during the activity, diverting their attention away from their perceived exertion (18,22,28). Perceived exertion (PE) has been defined as the subjective intensity of effort and/or fatigue that is experienced by an individual during exercise (17). During anaerobic activity, music has been associated with a decreased PE since the exerciser is not concentrating as hard on the difficulty of the activity. Theoretically, because of the motivational aspect of music, more intense anaerobic exercise can be performed (1,27,28).

Although upbeat or fast-paced music is common among recreational exercisers and athletes alike, slow-paced music has been found to be an aid to exercisers as well, particularly endurance runners (23). Different styles of music have been found to regulate mood and emotion at different phases of physical activity or sport. Soft, slow-paced music can be used to calm nerves before a race or match, while songs with moderate tempo can be played at the beginning of a race to remind a runner to pace themselves and not start too quickly (15). Research has indicated that music of any tempo can be beneficial to physical activity and performance when compared to white noise or silence (2,11).

During many competitive sports (e.g., basketball, volleyball) the athlete does not have the ability to select a personalized song to listen to during actual performance. Therefore, many athletes resort to using music in pre-competition rituals and warm-ups (13). It was found that adolescent volleyball players who listened to arousing, fast-paced music during an anaerobic warm-up (Wingate Anaerobic Test) achieved a significantly higher peak anaerobic output and mean heart rate than those who did not listen to music during the test (9). Similarly, Haluk et al. (11) found that maximum power output, mean power output, and minimum power output were significantly higher on the Wingate Anaerobic Test when physically fit college-aged students listened to fast-paced or slow-paced music than when in silence. Similar results have been found in other studies as well (12). These studies, while not conclusive, have strong implications on how music can be used as an ergogenic aid to impact performance.

While the literature is replete with studies on the impact of music on aerobic and anaerobic sport performance, the effect of music on isokinetic testing has been examined much less in comparison. Isokinetic testing is a reliable and valid way to assess muscle function among healthy and injured populations (8). In rehabilitation settings, motivational tools can be beneficial to individuals looking to improve performance and decrease recovery time. Two such methods of motivation that have been recently examined are visual feedback and verbal encouragement (6,7,21). Studies have shown that combined visual feedback (a computer screen displaying isokinetic torque curve graphs) and verbal encouragement (the researcher directing the exerciser to “push” or “pull” in a constant tone of voice) can lead to significantly higher isokinetic quadriceps and hamstring performance outcomes at slow velocities (30°/second and 60°/second) and high velocities

(300°/second and 450°/second) (6,21,25). However, to the authors' knowledge, music as a motivational stimulus has not been examined in its effect on isokinetic testing. Considering the acknowledged impact music has on other types of performance, the lack of research regarding music's effects on isokinetic performance warrants further investigation.

The purpose of this study was to investigate the effect of a motivational environment using music on isokinetic quadriceps and hamstring force output in college-aged males and females. It was hypothesized that participants would achieve higher force output while testing with music than when testing without music in both the quadriceps (knee extension) and hamstrings (knee flexion).

METHODS

Participants

Nineteen college-aged male (n = 12) and female (n = 7) students (mean age 22.85 ± 3.63) were recruited from two physical education courses at Austin Peay State University. Demographic data of participants are included in Table 1. Students who reported current or previous lower body injury, certain auditory limitations, implanted devices, and cardiovascular, metabolic or pulmonary diseases were excluded. All participants completed an informed consent form after being briefed on the procedures, the risks involved, and their right to voluntarily terminate participation at any time. The Austin Peay State University Institutional Review Board approved this research (Reference #12-006).

Protocol

Table 1. Participant characteristics.

	Male (n = 12) Mean±SD	Female (n = 7) Mean±SD
Age (y)	23.17±4.25	22.86±2.91
Weight (kg)	93.59±16.35	67.65±3.63*
Height (cm)	182.99±8.17	163.65±9.32*

*p < .05

Testing for maximal effort leg flexion and extension occurred across two weeks. During these two weeks, from 9:00 AM to 3:00 PM, participants scheduled a 20-minute block to perform their trials. Participants were advised that they would be scheduled for the same time block for both week one and week two. They were also encouraged to maintain the same dietary and sleeping patterns during the two weeks of testing. Baseline activity levels of these participants were not assessed for this experiment. Prior to implementation of the study, all principal investigators were educated on the entire experimental protocol and practiced using the Biodex® Quick Set Isokinetic Dynamometer (Model No. 840-000; Shirey, NY) at least six times to increase inter-rater reliability. The Biodex® Isokinetic Dynamometer has been established to be a reliable instrument to measure isokinetic force (r = .91). All testing was performed in the Exercise Physiology Laboratory at Austin Peay State University.

Participants signed an informed consent form prior to any exercise testing. External motivation was randomized during the trial. As each participant arrived investigators flipped a coin. If the coin landed on *heads*, participants had music on their first trial. If the coin landed on *tails*, they completed their first trial without music. Prior to beginning the trial participants' shoes were removed and their weight (kg) was recorded using a Detecto® Platform Scale (Brooklyn, NY). Next, their height (cm) was recorded using a Tanita™ Stadiometer. Participants then performed a sub-maximal warm up on a Monark® 828E ergomedic cycle (Halmstad, Sweden) with 1 kg of resistance at 50 RPMs for five minutes.

During the warm up, the principal investigator entered demographic data in the computer necessary to perform the test. Participants were then seated and secured in the chair of the dynamometer by four straps. Using their right leg, the lower leg attachment arm was measured so that the dynamometer was approximately at the lateral epicondyle of the femur. The pad at the end of the apparatus was strapped just below the body of the gastrocnemius. The principal investigator used the computer to calculate the degrees of freedom for total flexion and extension, the approximate 90-degree position, and total limb weight. Participants were instructed to perform five sub-maximal repetitions to familiarize themselves with the machine and the 60°/s velocity. Upon familiarization, the participant acknowledged readiness to perform the maximal effort trial. Subsequently, the maximal effort test was performed for five repetitions at 60°/s. The peak torques (in ft·lbs) were recorded on their data sheet and a results sheet was printed for future use.

The dependent variables in the design were maximal effort leg flexion and extension measured at 60°/second, and the independent variables were gender and motivation. One of the trials consisted of music as an external source of motivation, while the other had no source of external motivation. Trials were seven days apart and randomized to minimize residual training effect or learned effect (7,21). Week two testing followed the same protocol as in week one with the exception of participants' exposure or non-exposure to music during the trial. For example, if a participant was tested without music during week one, they were tested with music during week two, and vice versa. The music used was an instrumental version of "Eye of the Tiger" by Survivor, played on an iHome (Rahway, NJ) mp3 device set at five notches down from the max volume. In the external motivation (music) condition, participants acknowledged when they were ready to begin the maximal effort repetitions. There was no standardized time across participants for just listening to the music before beginning the repetitions.

Statistical Analysis

Data were analyzed using JMP 9.0.1 statistical software (SAS Institute Inc., Cary, NC). A 2 x 2 analysis of variance (group x gender) was used to determine whether main effects existed on both group and gender, as well as see if any interaction effects existed. Post hoc analyses were performed if a significant interaction existed using Tukey's HSD test. Significance was set at $p < .05$, and data were reported as mean ± SD.

RESULTS

The results from the 2 x 2 ANOVA indicate that there were no significant interactions or main effects when leg flexion was used as the dependent variable ($p > .05$). When leg extension was used as the dependent variable, there were also no significant interactions ($p > .05$); however, this analysis did indicate that a significant gender effect existed, $F(1, 34) = 15.21$, $p < .05$.

Age, weight, and height were reported for all 19 participants (see Table 1). Peak torques for all conditions are listed in Table 2.

Table 2. Participant peak torque values.

	Male (n = 12) Mean±SD	Female (n = 7) Mean±SD
Leg flexion with music (ft·lbs)	59.98±23.66	48.37±6.55
Leg flexion without music (ft·lbs)	67.10±32.38	49.67±9.79
Leg extension with music (ft·lbs)	158.05±53.11	95.67±27.05
Leg extension without music (ft·lbs)	157.33±59.21	92.87±30.29

There was a significant gender effect for leg extension independent of music ($p < .05$).

DISCUSSION

The literature suggests that individuals can use music to help improve aerobic and anaerobic performance, yet research is limited on the motivational aspects of music on isokinetic strength testing. The aim of the present study was to investigate the effects of music as a motivational tool on lower limb isokinetic force output in college-aged students. Contrary to the researchers' initial hypotheses, the results of this study indicate that the introduction of music had no significant effect on maximal isokinetic force output of lower limbs in either college-aged males or females.

The researchers hypothesized that participants would perform better on the isokinetic test during the music condition when compared to silence or no motivational environment. While other studies have identified significant increases in performance during aerobic performance and anaerobic testing with the addition of music (4,9,11,27), the results of this study suggest that music did not impact a healthy individual's maximal output of isokinetic strength. A possible explanation for this discrepancy is that an individual's performance on an isokinetic test is limited to a constant velocity, inherently inhibiting supramaximal testing and performance. The natures of most other anaerobic tests (such as the Wingate Test) allow for supramaximal performance capabilities (2,9).

There are a number of possible limitations to this study. First, O'Sullivan and O'Sullivan identified that using only 5 maximal contractions on an isokinetic strength test for force output may not be sufficient to demonstrate a significant difference with motivation (21). Since most of the participants expressed their unfamiliarity with isokinetic testing using a Biodex dynamometer (or similar machine), it is indeterminate whether the participants were giving maximal effort even after receiving and interpreting instructions. Participants may have benefited from a "familiarization period" in which they performed the exercise at a different (presumably higher) velocity a week or so prior to testing in order to gain more familiarity with the device. Future studies may also test isokinetic strength at different velocities and with increased repetitions to more accurately assess peak force output (21).

The researchers' assessment of the music used in this study was neutral, familiar, and motivational. Specifically, the researchers assessed the "Eye of the Tiger" instrumental as neutral because there were no lyrics, limiting the desire of participants to sing along—which could have distracted them from giving maximal effort. However, participants were not afforded the opportunity to choose their own music to listen to during testing and as a result, may not have been as motivated to an influential level. A future study could incorporate the use of a survey, such as the Brunel Music Rating Inventory (14), to measure the degree to which the music motivated the participant and how familiar the participant was with the musical selection (if it was not self-selected). It may also prove beneficial to investigate the effect of self-selected music on isokinetic strength testing and the effect of self-selected music on PE during isokinetic strength testing.

Also, there was no standardized time for participants to listen to the music before beginning the maximal effort repetitions. Participants began performing the repetitions when they acknowledged readiness, but this moment in relation to the start of the music varied across participants. A "queue" period (e.g., 30 seconds for just listening to the music before beginning repetitions) would have increased protocol consistency.

As with any research endeavor, it is ideal to maintain consistency in testing procedures. The more researchers that are involved with the study, the higher the possibility of procedure inconsistency. With multiple testers involved in the implementation of this study, it is possible that differences in investigator directives to the participants may have influenced results. For this reason, future studies should employ a script to be used by all researchers with participants, or reduce the number of researchers to decrease chances of inconsistency in procedure. Also, judgment of where the arm attachment pad should be placed on the participants' legs could have varied by researcher. Future studies should ensure that the pad is placed just superior to the participant's malleolus for consistency.

Previous research has indicated that music can have a more profound effect on untrained exercisers than on trained exercisers, and the effect of music on performance is reduced with increased fitness level (5). Neither fitness level nor training experience was controlled for in this study, and some participants (being college athletes) presumably had more exercise experience than others. This may have factored into the results as well. Future studies should either control for fitness level or exercise experience, or measure the difference in the effect of music on trained and untrained individuals.

The nature of the dynamometer has applications for use in the field. Injury rehabilitation or modification through the interaction with a physical therapist or certified athletic trainer often uses similar equipment to concentrate and stabilize rehabilitation efforts. Allowing a patient to select their music during the rehabilitation process may not impact recovery time or increase motivation directly but it may make him or her more comfortable with the environment and increase enjoyment of the activity.

In conclusion, this study suggests that lower limb isokinetic force output is not affected by the presence of music as a motivational environment in neither males nor females. However, due to the limitations described above, an enhanced research design of this study could more convincingly indicate the effect of music as a motivational environment on isokinetic testing.

ACKNOWLEDGEMENTS

The authors would like to thank the Austin Peay State University Health and Human Performance Department for the use of their facility and equipment to complete this study. The authors express their appreciation to Jamion Botch, CSCS, and all students for their participation in this study. The results of the present study do not constitute endorsement of the Biodex Isokinetic Dynamometer by the authors. This research project received no external financial assistance.

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