

ORIGINAL ARTICLE

Effects of tempo of self-selected music on isokinetic strength performance and psychological outcomes

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Abstract

Substantial research has supported using musical stimuli as an ergogenic aid before and during various forms of exercise. Researchers have demonstrated that music shifts attention from associative to dissociative, decreases perceived effort and discomfort, and increases arousal and pleasantness in longer-duration, low-to-moderate-intensity exercises. Strength training is shorter in duration and higher in intensity than aerobic or muscular endurance training. Limited research has examined the effects of music on strength performance and psychological outcomes. Therefore, the purpose of this study was to investigate the effects of the tempo of self-selected music on isokinetic knee extension and flexion performance, effort, discomfort, attention, arousal, and pleasantness in resistance-trained young adults. Thirty resistance-trained college-aged adults completed three exercise testing sessions. In a randomized, counterbalanced order, a repeated measures design was used to expose the participants to three conditions (fast music, slow music, and no music). The Biodex isokinetic dynamometer and standardized psychological Likert-style scales were used to measure concentric maximum effort knee extension and flexion torque at 60°/s and psychological variables, respectively. This study found that music improves knee extension torque but not knee flexion in resistance-trained young adults. In addition, music or the tempo of music did not influence any psychological outcomes during isokinetic strength testing. Therefore, listening to music is not detrimental to performance or psychological outcomes, but this study provides minimal support for music's use as an ergogenic aid during strengthening exercise.

KEYWORDS

affect, attention, dissociation, exercise, resistance training, RPE

The performance of many sport activities and activities of daily living are dependent on muscular strength. Muscle strength is the highest amount of force that can be exerted on objects.¹ High-force efforts associated with strength training have been found to be associated with high perceived exertion, local muscle discomfort, and negatively

valenced affective responses. Despite the established benefits of strength training, adherence rates remain low partly because of the discomfort, and high perceived exertion associated with this type of exercise.² Researchers continue to examine the most effective ergogenic aids for enhancing performance and promoting adherence to strength training.

Substantial research has supported the use of musical stimuli as an ergogenic aid prior to and during various forms of exercise, including aerobic exercise,³ isometric exercise^{4–7} dynamic muscular endurance exercise,^{8–16} and dynamic muscular strength exercise.⁶ Research on music has found several influential variables modify the relationship between music and performance, including tempo, lyrics, melody, personal associations (e.g., motivational interpretation), self-selected music versus researcher-selected music, music genre, and timing and duration of music application.³ In particular, self-selected and high-tempo music (≥ 120 bpm) have been efficacious in improving physical performance during exercise.^{3,6} Furthermore, high-tempo music has been shown to increase arousal and heart rate.¹⁷ The effects of high-tempo music on pleasantness during, immediately after, and after several minutes of exercise are less clear, with several studies indicating more pleasant affective responses to high-tempo music during exercise,^{18,19} but other studies reporting null findings while listening to high-tempo music.^{20,21}

It is postulated that music's ability to enhance performance, reduce RPE, and improve affective valence is a result of limitations in attentional capacity, which constrain the amount of sensory information perceived during physical activity. Musical stimuli downregulate afferent signals from internal sensations of exercise (e.g., muscle soreness).^{22,23} This dissociation results in lower perceived exertion at the same work intensity, higher work output, and more positive affect.³ However, much of the research on music's effects on exercise has focused on aerobic tasks.³ At higher physical activity levels, the inhibitory capabilities of music may be reduced as physiological feedback increases in potency.²⁴ Despite this theoretical reduction, several studies have found positive effects of music at high exercise intensities. Therefore, further research testing these theoretical assumptions is needed.⁶ In addition to testing the effects of music on high-intensity exercise, the impact of high-tempo music during exercise also requires further study. While there are no theoretical reasons to suspect differences in RPE or attention between high-tempo and slow-tempo music,³ the hypothesized presence of a centralized pattern generator supports changes in affect and performance. This centralized pattern generator favors high-tempo music during exercise and results in increased affective valence, remembered pleasantness, and aerobic exercise performance when exposed to high-tempo music.²⁵ However, this has not been studied in asynchronous anaerobically demanding tasks.

To test this, researchers have examined the effects of music on more anaerobically demanding tasks. Researchers studying the impact of music on Wingate tests of anaerobic cycling have found mixed results, with a recent meta-analysis concluding that relative peak power and relative mean power were improved, but absolute peak power

was not improved by music.²⁶ Similarly, listening to music during isometric muscular endurance exercises has resulted in both performance improvements⁴ and null results.²⁷ As task intensity increases toward maximal efforts, several studies have found positive effects of music on isometric strength, particularly on handgrip dynamometer tasks.^{5,6} However, music failed to induce a positive ergogenic effect during maximum isometric knee extension testing.⁴

When strength was assessed more dynamically, individuals exposed to their preferred music genre demonstrated improved muscle strength (performed more lat-pulldown repetitions at 85% of one repetition maximum; 1-RM) and reported lower RPE than individuals exposed to a nonpreferred music genre or no music.⁶ However, the beneficial effects of music during dynamic muscular strength were not supported in two 1-RM bench press studies.^{11,13} Lastly, researchers examined the effects of music versus no music on isokinetic leg flexion and extension peak torque using the Biodex Quick Set Isokinetic Dynamometer. They concluded that music did not affect maximal isokinetic force output. However, they suggested several design flaws, such as a lack of familiarization and not using self-selected music, in their methodology.²⁸ Despite these non-significant findings, the use of an isokinetic dynamometer is advantageous for future research on potential ergogenic aids (e.g., music) because it provides a highly accurate measure of force production while providing minimal performance feedback allowing for separation of effort and preconceived notions of potential performance.²⁹

To further investigate the effects of music on dynamic muscular strength performance, this study examined the effects of tempo of self-selected music on knee extension and flexion peak torque, as well as participant's effort, discomfort, attention, arousal, pleasantness, and remembered pleasantness in resistance-trained young adults. It was hypothesized that participants would perform better on strength variables during the fast-tempo music condition compared to the slow-tempo and no-music conditions. It was also predicted that individuals would display lower perceived effort, less discomfort, more dissociative attention, increased pleasantness, and increased arousal during the music condition compared to the no-music condition. The methodology, hypotheses, and data analysis plan were preregistered with Open Science Framework before the initiation of the experiment.

1 | METHODS

1.1 | Participants and design

A repeated measures design using a randomized, counterbalanced order assigned participants to three

conditions (fast music, slow music, and no music). An a priori power analysis using G*Power indicated that based on a small to medium effect size of $f=0.165$ (using average effect sizes of attention, RPE, and strength performance in the presence of music),^{6,8,27} an alpha level of 0.05, and a power $(1-\beta)=0.80$, a sample size of 30 participants was required.

To ensure participants could safely complete the exercise protocol, only individuals aged 18–35 years old ($M=23.30$, $SD=3.04$) with at least 3 months of current and consecutive lower extremity resistance training experience ($M=4.94$ years, $SD=3.93$) were eligible to participate in the study. Over half of the participants reported listening to music always during training sessions (53.8%). The Physical Activity Readiness Questionnaire (PARQ+) was used to determine that each participant was safe to participate in exercise testing. Exclusion criteria included any current orthopedic injuries to the lower extremities, health conditions that would preclude an individual from participating in a high-intensity exercise test, hearing impairments, and cognitive impairments that would impede the participant's ability to follow directions. Participants were instructed to (1) not participate in lower body resistance training for 48 h, (2) not to consume alcohol for 12 h, (3) refrain from caffeine consumption beyond their normal daily amount, (4) not ingest pre-workout supplements or other stimulants for 4 h, (5) refrain from smoking or vaping for 4 h, and (6) not to consume food for 90-min before testing. The study was approved by the Florida International University institutional review board (#110366) and preregistered with data available at <https://doi.org/10.17605/OSF.IO/2TWSU>.

1.2 | Independent variable: Music selection

All participants completed a music preference worksheet during the familiarization day. The worksheet consisted of four questions: (1) What genre(s) of music motivates you to work hard during resistance training exercise? (2) What are some artists/bands that motivate you to work hard during resistance training exercise? (3) What are some of your favorite motivational songs for resistance training exercise? (4) Alternatively to answering questions 1–3, please share a Spotify or Apple Music playlist you would enjoy listening to during resistance training with the research team. Researchers compiled two playlists using the Spotify application based on participants' shared personal resistance exercise playlists or their answers to the music preferences worksheet. Researchers parsed the provided playlist into two playlists: songs between 80 and 90 beats

per minute (slow) and songs between 120 and 130 beats per minute (fast). Before starting the daily warm-up, each participant selected a song from the approved fast or slow playlist respective to their assigned condition. The participants were blinded to the beats per minute of each playlist. The music started 2 min before the exercise test and continued until after the fifth repetition on the Biodex. The music was played from the Spotify application on an iPad and heard through JBL LIVE500BT on-ear headphones, and the volume was kept standard at 78 decibels as measured by the Decibel X application (SkyPaw Co. Ltd).

1.3 | Outcome measures

1.3.1 | Isokinetic dynamometry

The Biodex System 4 Pro isokinetic dynamometer was used to measure concentric knee extension and knee flexion peak torque. The Biodex has demonstrated an intraclass correlation coefficient for knee extension at peak torque at 60°/s of 0.95.³⁰

1.3.2 | Rate of perceived exertion: Effort and discomfort

The rating of perceived exertion-effort and rating of perceived exertion-discomfort scales were used to measure perceived effort and discomfort. Participants were asked, “How hard do you think you are working?” and “How much discomfort do you feel?” These Likert scales ranged from 0 to 10 points and were explained to the participants by reading scripts published in the previous literature.³¹ The anchors of 0 (no exertion/no discomfort) to 10 (maximal effort/maximal discomfort) were used. Steele and associates demonstrated that these two scales are effective in differentiating between the “dose-response nature of perceived effort” and the “perceived discomfort associated with effort” and had acceptable levels of intra-rater reliability.³¹

1.3.3 | Attention

Tammen's 10-point Likert scale was used to assess attention during the exercise test. The anchors of 0 (external thoughts) to 10 (internal thoughts) were used.³² This one-question scale, and others like it, have been supported as effective and ecologically valid measures of attention during and immediately after physical activity.^{24,33} This scale has been widely used in exercise psychology literature to measure state association/dissociation.^{27,34,35}

1.3.4 | Affect grid (pleasantness and arousal)

The Affect Grid measured overall pleasantness and arousal before and after the exercise. The affect grid contains two items ranging from 1 to 9 using the anchors unpleasant/pleasant and sleepiness/high arousal, respectively.³⁶ The affect grid has demonstrated strong convergent and discriminant validity and test–retest reliability for assessing pleasantness and arousal.^{36,37}

1.3.5 | Commitment check

To assess commitment to the exercise task, participants were asked three questions after the exercise test, “How much effort did you invest in the exercise task? How hard did you try when completing the task? How well do you believe you handled any physical discomfort during the task?” The scales ranged from 1 to 10 and have been used and supported in previous exercise research.^{27,35,38}

1.3.6 | Enjoyment of music

Participants were asked, “How much did you enjoy the music?” The scale is anchored by 0 (I did not like it at all) and 10 (I liked it very much). Versions of this scale have been used in numerous music³⁹ and exercise research studies).^{27,40} Although the psychometric properties of this scale have not been studied, it has been found to be highly convergent with other measures of music enjoyment.³⁹

1.3.7 | Remembered pleasantness

Participants were asked, “How did the exercise make you feel?” 5 min after completing the exercise test to assess remembered pleasantness. The question was answered using a visual analog scale (VAS) ranging from unpleasant (−100) to pleasant (+100).⁴¹ The VAS has been validated extensively in pain research, showing excellent test–retest reliability coefficients⁴² and as a measure of core affect demonstrating strong convergent validity and test–retest reliability.^{43,44} The VAS has been used extensively in exercise psychology research to measure remembered pleasantness.^{27,40,45}

1.4 | Procedure

Participants completed a PARQ+ and informed consent document before being familiarized with the testing protocol and psychological outcome measures. The participant

also electronically shared a music playlist they enjoyed listening to during resistance training with the researcher. The participant was then familiarized with isokinetic dynamometry testing. The right leg was used for testing. The knee was permitted 90° of flexion to lacking 10° of an extension for a total arc of motion of 80°. Seat settings were recorded for both the bicycle and Biodex to ensure standardization throughout each testing day. Participants completed three exercise testing sessions separated by approximately 7 days, starting the week after their familiarization day. Participants were stratified by biological sex, and a random number generator was used to select the order of exposure to the independent variable for each participant.

Participants completed a warm-up on a stationary bicycle (Schwinn Airdyne) for 8 min at 40–50 revolutions per minute to prepare their bodies for exercise testing. After the cycling warm-up, participants completed a task-specific warm-up on the isokinetic dynamometer for knee flexion and extension. The warm-up consisted of two sets of five repetitions at 60°/s with a 3-min rest period between sets. Participants were directed to perform the first three warm-up repetitions at a submaximal effort (50% of perceived maximal effort) to orient to the movement pattern. Participants were instructed to complete the final two repetitions of each set at a maximal effort.

After the warm-up, the following things happened in succession: a 3-min rest period began, pretest psychological questions were asked, and the headphones were placed on the participants' ears (with fast, slow, or no music playing). The exercise test consisted of five repetitions of maximal effort knee extension and knee flexion on the Biodex at 60°/s. Immediately following the fifth repetition, the participants were asked the subjective scores for perceived exertion (effort and discomfort), attention, affect (arousal and pleasantness), commitment, and music enjoyment (when applicable). Remembered pleasantness was assessed 5 min after the completion of the test. All psychological data were obtained by the participant manually answering the questions on an iPad using the Qualtrics software.

1.5 | Statistical analyses

The data was exported from Qualtrics and the Biodex software to IBM SPSS 27 for analysis. Descriptive statistics were used to describe the participants and outcome variables. Strength performance variables were examined using two repeated measures analysis of variance (RM-ANOVA) across the within-participants' factor of music condition (i.e., fast tempo, slow tempo, no music). The two RM-ANOVAs analyzed the strength performance

variable isokinetic concentric peak force for knee extension and flexion. Two RM-multivariate analyses of variances (MANOVAs) were used to compare perceived exertion (effort and discomfort) and affect (arousal and pleasantness) across music conditions. A RM-ANOVA was used to compare attention across music conditions. A RM-MANOVA was used to compare the three commitment check variables across music conditions. A RM-ANOVA was used to compare remembered pleasantness across music conditions. Finally, a paired samples *t*-test was used to compare music enjoyment between the two music conditions. Šidák corrections were used for pairwise comparisons. Cohen's *d* and η_p^2 were used as measures of effect size.

2 | RESULTS

2.1 | Inferential statistics assumptions

Assumptions of normality and multivariate normality were met for all univariate (skewness and kurtosis $z < 1.96$) and multivariate tests (visual inspection of P-P and Q-Q plots and tests for multivariate outliers using Mahalanobis distances). For multivariate analyses, there was strong multicollinearity ($r=0.88$) between the two strength outcome variables; therefore, the peak knee extension and flexion torque were analyzed in separate ANOVAs. For all other multivariate tests, the dependent variables were approximately linearly related (visual inspection of scatterplot matrices), and there were no multicollinear relationships greater than $r=0.9$. The Greenhouse–Geisser correction was used when the assumption of sphericity was violated.

2.2 | Strength outcomes

A RM-ANOVA on the effects of condition indicated a significant difference in peak knee extension torque, $F(2, 58)=3.589$, $p=0.034$, $\eta_p^2=0.110$. Planned comparisons between conditions did not reveal any significant differences among conditions. However, there was a descriptively larger difference between the slow tempo and the control conditions ($p=0.092$, $d=0.412$) and the fast tempo and control conditions ($p=0.200$, $d=0.341$) than the two music conditions ($p=0.796$, $d=0.152$; see Table 1). A second RM-ANOVA did not find a significant difference among conditions for peak torque of knee flexion, $F(1.422, 41.243)=0.397$, $p=0.604$, $\eta_p^2=0.014$.

2.3 | Psychological outcomes

There was not a significant difference for perceived exertion across the three conditions, Pillai's Trace=0.022, $F(4, 116)=0.325$, $p=0.860$, $\eta_p^2=0.011$ as indicated by RM-MANOVA. Neither perceived effort, $F(2, 58)=0.422$, $p=0.657$, $\eta_p^2=0.014$, nor perceived discomfort were significantly different across conditions, $F(2, 58)=0.182$, $p=0.834$, $\eta_p^2=0.006$.

A RM-MANOVA did not find any significant differences in affect across the three conditions, Pillai's Trace=0.035, $F(4, 116)=0.511$, $p=0.728$, $\eta_p^2=0.017$. This multivariate result was supported by the univariate results for arousal, $F(2, 58)=0.807$, $p=0.451$, $\eta_p^2=0.027$, and pleasantness, $F(2, 58)=0.110$, $p=0.896$, $\eta_p^2=0.004$.

A RM-ANOVA did not find a significant difference in attention among the three conditions, $F(2, 58)=1.593$, $p=0.212$, $\eta_p^2=0.052$.

TABLE 1 Mean and standard deviation for dependent variables by music condition.

	Fast	Slow	Control
Peak extension (Nm)*	127.03 (64.4)	129.88 (70.36)	118.89 (66.11)
Peak flexion (Nm)	94.55 (35.2)	97.64 (34.67)	95.67 (36.00)
RPE: Effort	7.10 (2.70)	7.23 (2.81)	7.30 (2.76)
RPE: Discomfort	2.80 (2.16)	2.60 (2.11)	2.77 (2.31)
Attention	6.23 (2.70)	6.30 (2.18)	6.90 (2.62)
Affect: Arousal	6.47 (2.16)	6.43 (1.99)	6.13 (2.19)
Affect: Pleasantness	6.83 (1.68)	6.70 (1.68)	6.77 (1.65)
Remembered Pleasantness	85.80 (17.82)	84.17 (16.65)	83.07 (16.61)
Commitment check: Try	8.30 (2.14)	8.23 (2.14)	8.33 (2.02)
Commitment check: Effort	8.63 (1.96)	8.30 (1.62)	8.10 (1.92)
Commitment check: Handled	9.13 (1.94)	9.37 (1.03)	9.47 (0.94)
Music enjoyment	8.87 (1.76)	9.13 (1.48)	

* $p < 0.05$.

A RM-ANOVA did not indicate any significant difference in remembered pleasantness across conditions, $F(2, 58) = 0.445$, $p = 0.643$, $\eta_p^2 = 0.015$.

2.4 | Commitment and music enjoyment

A RM-MANOVA found no significant difference between the three commitment check variables across the three music conditions, Pillai's Trace = 0.142, $F(6, 114) = 1.448$, $p = 0.203$, $\eta_p^2 = 0.071$. Similarly, a two-tailed, paired samples t -test did not indicate a significant difference for music enjoyment between fast and slow music, $t(29) = -0.772$, $p = 0.446$, $d = -0.141$.

3 | DISCUSSION

It was hypothesized that participants would demonstrate superior performance for strength variables during the fast-tempo music condition compared to the slow-tempo or no-music conditions. This hypothesis was partially accepted; there was a significant difference between conditions for extension peak torque but not flexion peak torque. Planned comparisons of peak extension between conditions did not result in significant differences. However, descriptively, the two music conditions performed similarly to each other, and both performed better than the control group. Speculatively, seated knee extension may have benefited more from music than knee flexion due to greater familiarity with quadriceps dominant movements during exercise than hamstrings dominant movements. In the only other study examining torque production during isokinetic strength exercise, Godwin et al.²⁸ found no significant difference between music and no music conditions; rather, there was a descriptive decline in peak flexion while listening to music, specifically, "Eye of the Tiger" by Survivor. "Eye of the Tiger" is often rated as highly motivational by participants using the Brunel Music Rating Inventory⁴⁶; however, this song was chosen by the research team and not self-selected by participants in Godwin et al.²⁸ This contrasts with the improvement in peak extension in the presence of self-selected music observed in this study. Similar to the current study's findings, Silva et al.⁶ found that individuals performed more lat-pulldown repetitions at 85% of 1-RM when listening to preferred fast music than nonpreferred fast music or no music. However, researchers did not find an effect of music on strength performance in studies examining maximum bench press strength.^{11,13}

According to the National Strength and Conditioning Association,¹ training for muscle strength consists

of lifting loads at or greater than 85% of 1-RM. On the other hand, training for muscular hypertrophy or endurance consists of lifting loads between 67%–85% of 1-RM and less than 67% of 1-RM, respectively. Much of the literature looking at the effectiveness of music as an ergogenic aid in resistance training used protocols that assessed muscle hypertrophy and endurance. In those studies, there is a more compelling case that music enhances muscle endurance and hypertrophy performance; however, these studies should be interpreted with caution as their sample sizes are small.^{8–14,16} On the other hand, two studies examining muscle hypertrophy and endurance found that music did not enhance performance.^{47,48} Moss et al.¹⁵ also found that music did not improve the performance of the bench press and back squat exercises at higher percentages of 1-RM, but that self-selected music did provide an ergogenic effect at lower intensities. Combined with the results of the present study, it appears that any potential central pattern generator requires a combination of synchronous movement and low-intensity exercise to improve performance.

It was hypothesized that individuals would display lower perceived effort, less discomfort, more dissociative attention, increased pleasantness, and increased arousal during the music conditions compared to the no-music condition. These hypotheses were rejected as no significant difference existed between music conditions for any of the psychological variables. Overall, participants reported high perceived effort and low perceived discomfort across all conditions. Our rating of perceived exertion (RPE) results are similar to Greco et al.,⁴ who also found that music did not affect perceived exertion during isometric knee extension strength testing. However, our RPE results differ from Silva et al.,⁶ who found that preferred fast music lowered RPE more than nonpreferred fast music or no music. A possible explanation is that due to the self-selected nature of the music in the present study, variability in the complexities and confounds found in the complex musical variables, such as lyrics and rhythm beyond tempo, may alter the potential inspirational and energetic effects at both tempos.^{20,21}

The lack of inspirational or energetic effects were also seen in affective responses to exercise, both during and 5 min after were not significantly influenced by listening to music. These findings support previous research on the effects of music during muscular endurance exercise, which did not indicate a significant effect of music^{27,48} but contrast with other research which has found positive effects of music on arousal^{4,5} and pleasantness.⁴

An essential explanation of these null results can be found in the lack of attentional differences between

both music conditions and the control condition. Thus, the primary proposed mechanism of music's effect on exercise experience (i.e., attentional shifting) was not supported. This is likely due to the maximal nature and high RPE, likely causing high levels of associative attention during all conditions. Although this differed from our hypothesis, it supports the general assumptions of Tenenbaum's²⁴ exercise intensity-attention linkage model and Ekkekakis's²² dual-mode model, which suggests that it is challenging to dissociate attention during high-intensity exercise.^{3,24} This lack of attentional effects makes changes in RPE, affective response, and performance unlikely. In this context, it is unsurprising that the present study did not support the hypothesized impact of music on performance, RPE, and affective response.

3.1 | Strengths and limitations

This study used an isokinetic dynamometer to measure torque output. The benefits of the isokinetic dynamometer include valid and reliable data collection, the researcher does not need to make a judgment call about technique, it allows for testing of dynamic movements, and it provides the participants with minimal external feedback. Other research groups have used dynamic strength exercises such as bench press, lat-pulldown, and leg press to study muscular strength and endurance. Unfortunately, completing these exercises with suboptimal form is possible, which forced the researcher to determine when to discontinue the test due to poor form; this was not necessary on the dynamometer. Other studies used handgrip dynamometry and load cells to measure maximum isometric muscle strength, which only reflects an individual's strength at a specific range of motion. Preconceived notions of strength were also minimized in this study by using a dynamometer compared to a bench press or lat-pulldown test. Finally, participants were permitted to select their music which has been demonstrated to be more efficacious than playing a standard track for each person. Self-selection allowed each participant to consider their personal extramusical associations.⁴⁹ This was seen in our study by individuals reporting high music enjoyment for both slow and fast music. Notably, the music enjoyment scale has not been empirically validated despite widespread use. Future research may wish to create or modify a brief music enjoyment scale. Finally, individuals reported high values for all three commitment check questions across all conditions demonstrating validity in our results.

This study's external validity is limited because we conducted a laboratory-based experiment and controlled for

many confounds that individuals would experience in a fitness center. For example, the participants were not influenced by other auditory stimuli, visual stimuli, or other individuals in the controlled environment. Additionally, the use of an isokinetic dynamometer allowed for precise measurements of peak torque while blinding participants to performance feedback. However, the isokinetic movement did not allow for any movement synchronization with music, which has been shown to positively affect exercise experience.⁵⁰ It is possible that music synchronization, independently or in combination with attentional manipulation, may result in more facilitative effects on exercise experience. Next, this study examined healthy young adults who participate in lower extremity resistance training, which will limit generalizing our findings to other populations. Finally, this study modified tempo, which is only one of many essential properties of using music as an ergogenic aid for exercise. Participants were permitted to select their music based on their preferences for artists, genres, and songs, but further instructions for selecting motivational music were not provided.

4 | PERSPECTIVE

This study suggests that music or the tempo of self-selected music influences isokinetic knee extension strength but not knee flexion strength in resistance-trained young adults. These positive findings align with previous research that found an ergogenic effect of music on dynamic strength⁶ but differs from other studies that did not find a positive impact of music on dynamic strength.^{11,13,28} In addition, this study found that music or the pace of music does not influence perceived effort, discomfort, attention, arousal, pleasantness, or remembered pleasantness during strength performance. Some studies found similar psychological outcomes,^{4,27,48} while other studies differed from the present study.⁴⁻⁶ Listening to fast or slow-tempo music is not detrimental to performance or psychological outcomes in high-intensity resistance exercise. Personal preference may allow coaches and athletes to continue to use self-selected high-tempo music during high-intensity resistance exercise. Still, it should not be purported as an ergogenic aid that will influence performance during strengthening exercises.

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CONFLICT OF INTEREST STATEMENT

We have no known conflicts of interest or competing interests to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Open Science Framework at <https://osf.io/8sh6b/files/osfstorage/649c64326c09810cce7d23e2> via @OSFramework.

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