



# International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

**Operating Publisher**  
**SciFormat Publishing Inc.**  
ISNI: 0000 0005 1449 8214

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Calgary, Alberta, T3E0A7,  
Canada  
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**ARTICLE TITLE** THE ERGOGENIC POTENTIAL OF RHYTHMIC AUDITORY STIMULATION ON EXERCISE KINETICS AND PSYCHOPHYSIOLOGICAL RESPONSES

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**DOI** [https://doi.org/10.31435/ijitss.1\(49\).2026.4968](https://doi.org/10.31435/ijitss.1(49).2026.4968)

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**RECEIVED** 19 December 2025

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**ACCEPTED** 15 February 2026

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**PUBLISHED** 20 February 2026

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# THE ERGOGENIC POTENTIAL OF RHYTHMIC AUDITORY STIMULATION ON EXERCISE KINETICS AND PSYCHOPHYSIOLOGICAL RESPONSES

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## ABSTRACT

**Background.** Music is a recognized ergogenic aid that enhances mood and reduces the Rating of Perceived Exertion (RPE). By modulating the brain's processing of somatic signals, it enables athletes to maintain their effort when they feel this subjectively fatigued.

**Aim.** This review evaluates the impact of music on aerobic and anaerobic performance and RPE, focusing on the roles of synchronization, attentional dissociation, and individual preference.

**Methods.** A comprehensive search of PubMed and Google Scholar databases was conducted for peer-reviewed studies published between 2012 and 2024. The selection included experimental trials and reviews focusing on the psychophysiological and kinetic effects of music in sport and exercise.

**Results.** Music operates through a mechanism of attentional dissociation, reward systems activation and rhythmic entrainment. It increases time to exhaustion during endurance tasks and decreases RPE. For anaerobic effort, it increases the power and alters the technical ability. Personal preference is a significant consideration; Self-Selected Music (SSM) produces greater power, motivation and total work than non-preferred music. Furthermore, music aids metabolic recovery and enhances enjoyment during High-Intensity Interval Training (HIIT).

**Conclusions.** Music optimizes work capacity and exercise tolerance by lowering RPE and stabilizing motor patterns. To maximize its ergogenic potential, practitioners should prioritize athlete-curated, preferred playlists tailored to specific training goals.

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## KEYWORDS

Music, Physical Performance, RPE, Ergogenic Aid, Music Preference

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## CITATION

Klaudia Brzoza, Filip Matusiak. (2026) The Ergogenic Potential of Rhythmic Auditory Stimulation on Exercise Kinetics and Psychophysiological Responses. *International Journal of Innovative Technologies in Social Science*. 1(49). doi: 10.31435/ijitss.1(49).2026.4968

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## 1. Introduction

Physical exercise and sports are areas where the quest for means to optimize performance and control psychophysiological conditions has extensively utilized music. Scientific literature acknowledges that music is a legal form of ergogenic aid, with multidimensional effects on the practitioner. Listening to music prior to and/or during exercise is associated with a wide variety of psychological benefits (e.g. improving mood and creating a positive affective state) along with psychophysiological advantages, including lowering the Rating of Perceived Exertion (RPE). This permits athletes to exercise despite subjective feelings of tiredness (Terry et al., 2020). A crucial factor determining the magnitude of these effects is individual music preference. Research indicates that preferred music modulates physiological and behavioral responses much more strongly than non-preferred or neutral music, directly impacting motivation and overall performance (Ballmann, 2021). The neurophysiological mechanism underlying these phenomena is associated with variations in the brain's electrical activity. Auditory inputs modulate somatic signal processing in the cerebral cortex that might reduce the perception of physical strain from doing work using muscles (Bigliassi et al., 2017). In addition to that an application of music can be structured in synchronous or asynchronous mode. Whereas asynchronous music (uncorrelated with movements) has been used as a “background” stimulant in all of these studies, synchronous music – where the tempo is synchronised with the rhythmically induced movement – can promote affective valence and possibly also influence movement efficiency by regulating cadence which potentially provides a more selective tool for performance optimisation (Lim et al., 2014).

## 2. Materials and Methods

The present narrative review was conducted through a comprehensive search of electronic databases, including PubMed and Google Scholar, covering the period from 2012 to 2024. The search strategy employed combinations of the following keywords: music, physical performance, RPE, ergogenic aid, music preference, and rhythmic entrainment.

The inclusion criteria focused on peer-reviewed experimental studies, meta-analyses, and systematic reviews published in English that investigated the psychophysiological and kinetic effects of music on both aerobic and anaerobic exercise. Studies were selected based on their relevance to three primary thematic areas: attentional dissociation, physiological arousal, and motor synchronization. Articles focusing solely on clinical populations or non-exercise-related auditory stimuli were excluded to maintain the focus on athletic performance and exercise science.

## 3. Mechanisms of action: Psychobiological perspective

Music and exercise influence one another via psychobiological mechanisms that combine to affect both emotional and autonomic responses. By modulating the brain's interpretation of somatic signals and activating reward centers, music effectively regulates arousal, stabilizes motor patterns, and delays the onset of physical fatigue.

**3.1. Attentional processing and dissociation:** The theoretical foundation for the distracting effect of music lies in the limited information-processing capacity of the human nervous system. As synthesized by Karageorghis and Priest (2012), external stimuli (music) compete with internal sensory signals related to fatigue for access to consciousness. Music acts as a powerful distractor during low-to-moderate intensity workloads and narrow the focus of attention diminished RPE. However, results of a study by Jones et al. (2024) show that as exercise intensity increases and reaches critical thresholds (such as the respiratory compensation point RCP), internal physiological cues naturally dominate the attentional field, which prevents music from distracting the person from the sensation of exertion.

**3.2. Neurochemical response and arousal regulation:** Music has a direct impact on the brain's reward and emotional regulation systems. Ferreri et al. (2019) provided evidence that dopamine is directly involved in the modulation of reward experiences induced by music, suggesting that striatal dopaminergic activity is responsible for the pleasure of auditory stimuli. Music is also a means of arousal regulation; music with fast tempo triggers activation of the sympathetic nervous system, which creates a physiological priming before or during exercise (Karageorghis and Priest, 2012).

**3.3. Rhythmic entrainment and performance stabilization:** The third mechanism involves auditory-motor synchronization, where movement patterns are coordinated with a musical beat. Bood et al. (2013) found that music can work as an external "acoustic pacer" to steady movement and decreases cadence variability, increasing time of running task until exhaustion. The utility of this rhythmic entrainment is demonstrated in elite athletes; Terry et al. (2012) showed that synchronized motivational music resulted in 18.1-19.7% greater

time to exhaustion in elite triathletes versus a no-music control. Finally, music is an important psychological intervention; Lam et al. (2021) observed that hearing self-selected music reduces the impairment effect in endurance performance mediated by mental fatigue, this would enable to active individuals the possession of higher work capacity despite being cognitively exhausted.

#### 4. Impact on Physical Performance

The impact of music on performance varies depending on the intensity of the effort and the characteristics of the selected tracks. Aerobic endurance, anaerobic power and modulation of fatigue perception during and post-exercise are among the effects that are included in current literature.

**4.1. Aerobic and Endurance Performance:** It seems that endurance tasks can be very influenced by auditory stimuli. A study by Thakare et al. (2017) among untrained young people showed that listening to fast and loud music of one's own choice substantially extended the duration of submaximal exercise. In the present study, they found that participants exercising while listening to music attained a longer total duration ( $37.12 \pm 16.26$  min) compared with exercising without music ( $22.48 \pm 10.26$  min).

**4.2. Anaerobic and Resistance Performance:** The impact of music appears to be inconsistent during high-intensity and supramaximal exercise. Research by Spahiu et al. (2023) in a 6-minute Astrand cycling test showed that listening to music did not have a significant effect on performance or perceived level of exertion. Their response pattern is in line with the contention that at higher exercise intensities (e.g.,  $> 75\%$   $VO_{2max}$ ) during which internal physiological feedback prevails over external auditory cues; so, the effectiveness of using music as a distractive task declines. But in precision requirement sports such as tennis, motivational music  $>120$  bpm is relevant, it improved ITN test score in recreational players (Cengiz et al., 2024). Specifically, motivational music significantly improved groundstroke depth, volley depth, groundstroke accuracy, and serve scores, likely due to improved starting speed, reaction time, and motor coordination.

Regarding supramaximal performance, Jarraya et al. (2012) found that listening to high-tempo music (120–140 bpm) specifically during the warm-up phase led to a significant improvement in both peak and mean power output during a subsequent 30-s Wingate test in highly trained male athletes. Notably, this warm-up intervention did not significantly affect heart rate, Rating of Perceived Exertion (RPE), or the fatigue index during the actual sprint. Furthermore, Biagini et al. (2012) proved that self-selected music (SSM) may improve acute power performance. Although SSM did not alter bench press repetitions to failure or squat jump height, peak takeoff velocity and the rate of force development during jump squats were significantly higher than with no music. So, music makes the muscles more responsive and able to generate power in a quicker manner in explosive-type movements.

**4.3. Modulation of RPE and Recovery:** Perceived effort is also influenced by music tempo. Patania et al. (2020) examined the effect of music tempo on RPE and reported a significant reduction in RPE scores with fast-tempo music as opposed to no music. This effect was greater for endurance exercise (11% reduction) compared with high-intensity exercise (6.5% reduction), indicating that music may be particularly successful in stimulating individuals during steady state activity.

Moreover, the impact of auditory stimuli extends to the post-exercise recovery window. Eliakim et al. (2013) demonstrated that listening to motivational music during the recovery phase after intense exercise led to significantly lower blood lactate levels and a greater decrease in RPE compared to a no-music control. This metabolic recovery was associated with an increase in spontaneous physical activity (number of steps) during the recovery break, suggesting that music-driven pacing facilitates a faster return to homeostasis.

#### 5. Practical Applications

There is empirical evidence for the use of music as a convenient means to promote motivation and physical performance in different exercise conditions. To maximize the advantages of music use, coaches need to move beyond generic background noise and towards structured, athlete-focused application of aural stimuli according to identified training objectives.

**5.1. Application in High-Intensity Interval Training (HIIT):** Sprint Interval Training (SIT) is a time-efficient alternative to traditional endurance training, but its "all-out" nature is often perceived as aversive. Research indicates that listening to self-selected music during acute sessions of SIT significantly increases both peak and mean power output (Stork et al., 2015). While music may not necessarily alter task motivation or the Rating of Perceived Exertion (RPE) during such high-intensity efforts, it consistently enhances perceived enjoyment. For coaches, this suggests that music is a strategic intervention to buffer the perceived aversiveness

of intense fatigue, potentially facilitating long-term participation and adherence to demanding training protocols.

**5.2. Importance of Music Preference:** The alignment of music with an athlete's personal taste is a critical determinant of performance outcomes. In a study involving Division I NCAA female athletes, listening to preferred warm-up music led to significantly higher mean power and total work during subsequent repeated 15-second Wingate Anaerobic Tests compared to non-preferred music (Meglic et al., 2021). Furthermore, while RPE remained unchanged regardless of the music condition, preferred warm-up music resulted in sustainably elevated motivation throughout the entire exercise session.

**5.3. Psychological Empowerment and Self-Esteem:** Outside of the psychological practice of pacing, music is traditionally used to assist in enhancing and priming motivation in sport. Listening to motivational music puts individuals in the mood for risk tasking, during motor coordination tasks – an effect that may be explained by a psychobiological approach. This phenomenon is much stronger in males compared to females. In addition, the research demonstrates a "congruency effect", or that motivational music – specifically when it matches an athlete's successful performance in competition – also increases an individual's state self-esteem. While the experimental phase utilized researcher – selected motivational tracks, the authors suggest that these psychological benefits could be even more substantial when athletes use self-selected playlists (Elvers and Steffens, 2017). Ultimately, "empowering" music helps athletes adopt a confident mindset and reach the thresholds of their competency by identifying with the positive attitudes expressed in the music.

## 6. Discussion

These results highlight the complex nature of music as a strong ergogenic intervention. The findings imply that music influences performance by way of an intricate balance of attentional dissociation, neurochemical reward, and rhythmic entrainment. An important remark is that the strategy for dissociation is intensity dependent. Although music successfully reduces RPE during steady-state exercise, its ability to distract attention is decreased when physiological strain becomes too high at approximately 75% VO<sub>2</sub>max or respiratory compensation point. On the contrary, at such a level internal signal coming from the body take naturally over in driving attentional focus.

Notably, during high-intensity exercise, music facilitates a decoupling of physiological output from perceived exertion. Athletes can achieve significantly higher power outputs while maintaining a stable RPE. Although music may not reduce the absolute sensation of strain at supramaximal intensities, it buffers the aversiveness of fatigue by increasing enjoyment and enhancing motor efficiency. This allows individuals to reach higher physiological thresholds without an equivalent increase in perceived effort.

Moreover, the continual significant improvement of self-selected music during anaerobic, endurance and high-intensity performances indicate that this ergogenic effect is not just related to auditory influences but associated with personal choice. Preferred music triggers a stronger neurochemical response through the dopaminergic reward system and facilitates psychological priming, which can increase self-esteem and risk-taking. That's why generic playlists typically don't compare to listening to a playlist curated by an athlete. Lastly, the evidence for enlisting music not only to distract (psychologically) but also to stabilize and promote recovery from a metabolic perspective in highly trained athletes implies that there may even be physiological benefits of potentially returning more quickly to homeostasis.

## 7. Conclusions

Music serves as an effective, legal, and non-pharmacological strategy to optimize physical performance and psychophysiological responses in physically active individuals. It consistently enhances endurance duration, increases peak and mean power output, and lowers the subjective sense of effort (RPE), particularly during submaximal exercise. Moreover, it acts as a critical buffer against the aversiveness of high-intensity protocols like HIIT, enhancing enjoyment and adherence.

The most important determinant for realizing these advantages is individual preference. Self-selected music not only enhances physical status, but it also promotes mental preparation and metabolic recovery. In summary, if music is to be employed as a legitimate ergogenic aid, practitioners need to desist from using generic background stimuli and instead implement the provision of athlete-selected motivational playlists that match an individual's musical preferences with their training objectives.

**Disclosure**

Authors do not report any disclosures.

**Authors' contribution:**

Conceptualization: Klaudia Brzoza, Filip Matusiak

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Writing- rough preparation: Klaudia Brzoza

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*All authors have read and agreed with the published version of the manuscript.*

**Funding statement:** The study did not receive special funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflict of Interest Statement:** The authors declare no conflict of interest.

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