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An Examination of Music's Effects on Athletic Performance

The significant influence of music within the human race can be seen throughout history, spanning geographical and cultural boundaries. Its uses and venues have varied widely, ranging from the ecclesiastical to entertainment to war. That a media has the versatility to provoke peaceful, relaxing feelings in one setting while stimulating the aggression necessary to go into battle in another shows just how powerful music is. It continues to be a major player in everyday life for people throughout the world and evolves seamlessly to meet the needs of those who listen.

One area that music has morphed to become a substantial part of is athletics and exercise. It is played during warm-ups before competition, like the NBA's Chicago Bulls famously did at their home games during their championship runs in the 1990s, during competition, like before a baseball player bats, and after competition, as seen when college football teams sing their school song with their fans after a victory. Music is often used as a training tool when exercising and preparing for competitions as well. On a daily basis it is commonplace to see people with their earbuds in at the gym or out for a jog.

Because of its prevalence in the sporting world, research has been undertaken in order to better understand what effect music has on athletic performance and what biological pathways these effects may act through. It makes sense that music improves athletic performance or else people would not utilize it as part of their training and competition routines, but in order to quantify the supposed benefits and determine how and why these benefits occur, more objective results are necessary. Various sports have been studied in order to gain a better understanding of what kind of impact music has on athletic performance including running¹, swimming⁴, cycling¹¹, rowing⁸, volleyball³,

Golf⁶, and netball⁷, as well as circuit exercise and training¹⁰. In addition to examining different sports, contrasting music has been used in these studies to determine whether different types of music may have unique effects on performance and varying testing methods have been implemented in order to better suggest the biological pathways that music acts through.

Music's benefits on athletic performance have been suggested to manifest themselves ergogenically, psychologically, and psychophysically. Ergogenic benefits improve athletic/exercise performance by either delaying fatigue or increasing work capacity. Psychological benefits increase feelings of pleasure and improve thought and behavioral processes. And psychophysical benefits decrease the perception of physical effort. Researchers have performed studies examining each of these three areas and the impact that music may have through them. Positive results have been consistently produced in each of these categories, spanning each sport of interest. Reported ergogenic benefits include increased anaerobic power in volleyball³, running pace¹⁰, swimming pace⁴, rowing pace⁸, and improved golf scores⁶. Psychological benefits have been seen in mood responses and feeling state during running⁹ and swimming⁴. And psychophysical benefits have been observed in improved flow state, which is defined as a state of optimal physical and mental functioning, in netball⁷ and rating of perceived exertion in running¹⁰.

Furthermore, considering the components that make up music is another important step towards determining how music affects athletic performance and which aspects of music might have the most impact. A few of the musical variables that have been analyzed are tempo, structure, beat², synchronicity^{4,9}, and whether or not the music is self-selected⁹. Tempo refers to the speed of the music, typically measured in beats per

minute (bpm), and research has suggested tempo to be a determining factor in regards to physiological stimulation¹. Fast music tends to increase heart rate, blood pressure, and muscle tension while slow music generally decreases them¹. Most music that is considered to be motivational and utilized in sporting competitions and training has a fast tempo. This makes sense as most athletic endeavors require increased heart rate, blood pressure, and muscle tension and a number of studies support this notion^{5,8}. Interestingly though, a slow tempo was found to improve athletic performance in rowers in comparison to a no music control⁸. Additionally, movement patterns often are gradually modified to correspond to the tempo of the music being listened to². Brainstem neurons have a tendency to fire synchronously with tempo which has been suggested as a correlation between tempo and movement patterns¹. A practical example involving tempo and athletic performance was seen when the well-known Ethiopian distance runner Haile Gebrselassie smashed the indoor world record for 2000 m in February 1998, while synchronizing his stride rate to the rhythmical pop song *Scatman*, which was played over loudspeakers.

This example also ties in with synchronicity, another facet of music whose impact on athletic performance has been examined. Synchronous music is meant to specifically use the rhythmic and temporal aspects of the music as a sort of metronome to regulate movement patterns⁵. Ergonomical benefits of synchronous music were found in rowers whose rowing strokes per minute were significantly higher when listening to fast music, leading to faster finish times when compared to their performances when listening to slow music or no music. Psychological benefits have been reported as well with runners experiencing more positive feelings when listening to synchronous music during training

runs, leading to an increase in average run distance¹⁰. Another study, which examined circuit training, used a metronome as a control rather than no music as most studies have done. While synchronous music led to increased measures of athletic performance in comparison to the metronome, they were not statistically significant, suggesting that tempo and beat are beneficial components of music⁵.

Asynchronous music, on the other hand, is generally played in the background to make the environment more pleasurable but there is no conscious synchronization between the tempo of the music and movement patterns⁵. A study of netball players suggested asynchronous music to have a positive psychophysical impact, increasing their perception of flow, which led to a consistent improvement in their shooting performance. The participants indicated that the music had a positive impact on their ability to control their emotions and cognitions during performance⁷. Asynchronous music played during warm-ups was also seen to improve anaerobic performance, as measured by the Wingate Anaerobic Test, in volleyball players when compared to a no music control³.

Music preference can vary considerably from person to person, so music preference is another variable that researchers have considered when quantifying the impact that music has on athletic performance. In a study of running performance in elite triathletes, mixed results were found in regards to music selection. Self-selected motivational music produced a greater psychological benefit, with feeling states being more positive, as measured by the Feeling Scale, than neutral music. But neutral music produced a greater psychophysical benefit, with lower RPE than motivational music. Ergonomically, the results were seemingly contradictory as lower blood lactate concentrations were seen during motivational music while time to exhaustion was longer

for neutral music⁹. Generally, lower blood lactate concentrations lead to longer time to exhaustion. Regardless, both the motivational and neutral music in this study produced significant increases in performance measures when compared to the no music control. Similar findings were reported in sprint rowers whose competition times were faster with different types of music in comparison to the no music control⁸.

Overall, the current literature strongly suggests that music enhances athletic performance through ergonomical, psychological, and psychophysical means. While the biological mechanisms behind these benefits are yet to be fully understood, various proposals have been formulated. One suggestion involves the Cognitive Model of Behavioral Control, which proposes that the cognitive system is made up of two processing systems: a lower level system that controls routine, automatic behaviors and a higher level system that is analytical and is activated when novel demands are present. Pates et al. (2003) suggest that music inhibits the higher level system, allowing athletes to attain a flow state". In regards to synchronous music, Karageorghis et al. (2010) proposed that the supplemental motor area of the brain learns the rhythm of the music and entrains movement patterns from it, effectively reducing the metabolic cost of exercise by promoting greater neuromuscular or metabolic efficiency⁵. A common theme is reduced use of energy expensive higher level thought processing so that more energy is available to perform the physically demanding athletic task at hand.

Further exploration into music's positive impact on athletic performance is bound to continually fine tune the understanding of the biological mechanisms involved. This will allow athletes to be better able to optimally cater their music selection in order to maximize the ergonomical, psychological, and psychophysical benefits. With the considerable

amount of money and competition surrounding sports, athletes are looking for every possible way to increase their performance. Especially with stricter and improved drug testing, natural ergonomic aides like music are crucial to maximizing potential. That being said, music will continue to be prevalent in athletics and has the potential to take on an even more substantial role as athletes are provided with more complete information on how music can enhance their athletic performance.

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