Chapter 23
Music in Sport: From Conceptual Underpinnings to Applications

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Chapter Overview

This chapter provides an overview of the key concepts, theory, underlying mechanisms, empirical research, and application relevant to the use of music in sport. The chapter begins with a colorful introduction to the subject matter, in which the use of music in sport is set within a historical frame. Thereafter, a theoretical model is presented that coaches and practitioners can use as a reference point in the design of music-related interventions. This leads into consideration of the mechanisms—emotional, perceptual, and rhythm-related—that underlie the effects of music in sport. Throughout the chapter, the taxonomy of pretask, in-task, and post-task applications of music serves as a common denominator to aid the absorbability of the material. This is reflected in both a critical appraisal of recent literature and consideration of applied aspects. The key contribution of this chapter is that comprehensive guidelines are provided to facilitate athletes and coaches in their application of music. The centrepiece of these guidelines is a new framework that presents factors relevant to optimizing music selection in sport.

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Introduction

In the first two decades of the 21st century, technological advances in personal listening devices sparked an explosion in the use of music by athletes. As a consequence, the influence of music on the athlete's psyche has captured the interest of researchers and practitioners alike. Music has, of course, been widely used since ancient times for a broad variety of purposes: to soothe bawling infants, to rejuvenate senior citizens, to punctuate civil ceremonies, to send soldiers into the fray, and even as a form of therapy (Thaut, 2008). The well-known neuropsychologist, Daniel Levitin, wrote that music is unusual among human activities for both its ubiquity and its antiquity (Levitin, 2008).

Greek philosophers from the 5th century BC were widely known to "prescribe" music. The mode or key in which the music was written was thought to carry specific benefits. For example, Plato declared that the Dorian mode was conducive to steadfast endurance, whereas the Phrygian mode was considered appropriate for acts of peace and acquiescence. Mathematician *par excellence* Pythagoras is credited with discovering the 12-note *chromatic scale*—think of all of the notes from C to C on a piano. Most contemporary Western musicians and composers borrow from the Pythagorean system of tuning which is over 2500 years old.

The modern Olympic Games have served a seminal role in formalizing the link between music and sporting endeavor. Prominent composers such as Claude Debussy, John Williams, and Vangelis have been stirred by the Olympic ideals. Vangelis's *Chariots Of Fire* stands as one of the defining compositions in fusing music with the notion of athletic prowess. The piece was popularized through association with the eponymous movie that depicts the story of two athletes who graced the 1924 Paris Olympics: Eric Liddell, a devout Scottish Christian who ran for the glory of God, and Harold Abrahams, an English Jew who ran to combat prejudice.

Music has been integral to many Olympic events such as rhythmic gymnastics or figure skating, and the best-known artists of the day performed at the opening and closing ceremonies of each Olympiad. Among the most memorable performances was that of the late, great American songstress Whitney Houston with *One Moment In Time*, the anthem of the 1988 Seoul Olympics. But it is not only Olympiads that provide a vehicle for musical expression in the sporting realm.

Pay a visit to your local football, soccer, or rugby team on a weekend and you will hear chants that have been passed down through generations of fans. At Liverpool FC it's the anthemic *You'll Never Walk Alone*, which was popularized by Gerry and the Pacemakers in the 1960s. At Yale's football stadium, it's the distinctive long cheer taken from Aristophanes' play *The Frogs* (c. 405 BC):

> Brekekekex, ko-ax, ko-ax, Brekekekex, ko-ax, ko-ax,
> O-op, O-op, parabalou, Yale, Yale, Yale,
> Rah, rah, rah, rah, rah, rah, rah, rah, rah, Yale!
> Yale! Yale!

Oftentimes, musicians compose pieces for a particular team or even a special sporting occasion. One of the best-known examples to embrace both a team *and* a sporting occasion is *Three Lions (It's Coming Home)*, which became the hit song associated with the Euro '96 Soccer Championships. The chorus belted out by the England faithful—"It's coming home, it's coming home, football's coming home"—alluded to the fact that England, considered to be the spiritual home of soccer (known as "football" in the UK), had not won a major championship since the 1966 World Cup. The music lent a certain aura to Euro '96 that bridged the gap between a mere soccer tournament and a stage for the nation's hopes and dreams.

Athletes have made extensive use of music in order to fuel their performances and the music-and-sport literature reveals a common taxonomy that has been applied to the categorization of related interventions. The taxonomy is predicated on when such interventions are used: *Pretask*, *in-task*, and *post-task*. Pretask music generally serves a "psych-up" or "psych-down" function and can be used to prime athletes or engender an optimal level of activation either for training or competition. Sometimes pretask music is used to regulate a particular mindset without having either a psych-up or psych-down function. In terms of the psych-down function, music is a particularly potent tool in tempering precompetition anxiety. The celebrated British athlete, Dame Kelly Holmes, generated a great deal of media interest for her use of the soulful ballads of Alicia Keys at the 2004 Athens Olympics. The expectations of an entire nation can weigh rather heavily on an athlete's shoulders but Holmes prevailed, and made history by winning two middle-distance golds (800 m and 1500 m).

The in-task application of music takes two forms—*synchronous* and *asynchronous*. Synchronous music entails synchronization between an athlete's movement patterns and the rhythmical qualities of a piece of music. In light of technological advances, Karageorghis (2020) delineated two distinct forms of synchronization: (a) *Active synchronization* entails a motor process in which an athlete or group of athletes/team consciously synchronize their movement rate with the rhythmical qualities of music; and (b) *passive synchronization* entails a process in which a digital interface adapts the tempo of music in real-time or assigns a track at a tempo to match the movement rate of an athlete or group of athletes/team. Asynchronous music is akin to ambient music where there is no conscious or planned synchronization taking place. Such music can, however, be played loudly, while we tend to think of ambient music as just being part of the sonic background.

When used in-task, a central role of music is to lower perceived exertion and thereby increase the amount of work performed (i.e., to engender an ergogenic effect). It is notable that in-task music can temper the shift toward negative affect (i.e., displeasure) that is typically associated with more intense exercise (see Bird et al., 2019; Stork et al., 2019). Music also provides a rhythmic cue that serves a metronomic function in terms of regulating movement patterns; particularly when used in the synchronous mode (Grahn, 2012; Karageorghis et al., 2019).

Post-task music is proposed to aid recovery from competition or training (Terry & Karageorghis, 2011). This application has been dichotomized by Jones et al. (2017) into *respite music* (used in between high-intensity interval bouts) and *recuperative music*, which is used at the end of a training session or competition to guide the athlete back toward homeostasis. The respite function was recently redefined by Karageorghis (2020) in terms of *active* (movement based) and *passive* (static) forms of recovery. This, however, creates an interesting conceptual anomaly, as respite–active music is also a form of in-task application! Nonetheless, the goal of respite–active music is to facilitate recovery following high-intensity activity, such as circuit training or sprint-interval training.

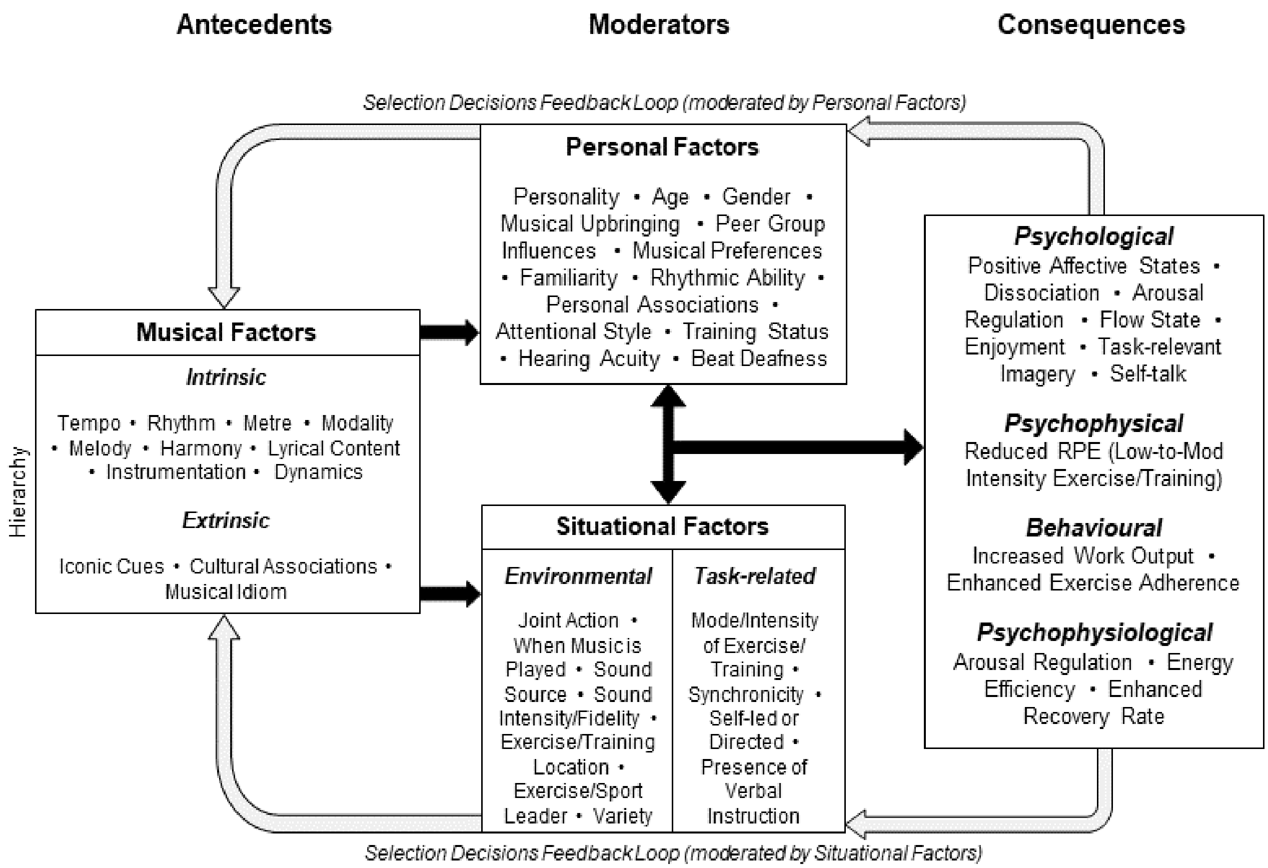
This chapter will consider theoretical underpinnings for the application of music in sport, outline underlying neurophysiological mechanisms, provide a critical review of recent sport-related studies using the aforementioned taxonomy, and present a broad range of applications to hopefully inspire athletes and their coaches.

A Theoretical Model for Music Applications in Sport

Karageorghis (2016) published a theoretical model detailing the antecedents, moderators, and consequences of music use in exercise and sport (see Figure 23.1). Herein, we will focus solely upon the implications of the model for sport participation and training. Moreover, we will not discuss every detail of the model; the interested reader is referred to the original 2016 publication and also to chapter 2 of the Karageorghis (2017) text. The model embraced several aspects of previous models (e.g., Karageorghis et al., 1999; Terry & Karageorghis, 2006), but took an ecumenical and fully integrative approach, particularly in relation to proposed antecedents and moderators. Moreover, the model is *heuristic* in nature and not *mechanistic*, meaning that it provides a fisheye view to facilitate fluid understanding of what is, in actuality, a highly complex array of relationships, processes, and neural mechanisms.

Figure 23.1

A Theoretical Model of the Antecedents, Moderators, and Consequences of Music Use in the Exercise and Sport Domain



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The antecedents or precursors are the intrinsic and extrinsic qualities of music, moderators are those factors that influence the strength of the relationship between a musical stimulus and an athlete's responses to it (e.g., age and attentional style), and consequences relate to the main outcomes associated with music use during sport-related activities (e.g., arousal regulation, reduced rating of perceived exertion [RPE], or enhanced recovery). The model is predicated on ~50 years of empirical research (see Karageorghis & Priest, 2012a, 2012b; Karageorghis & Terry, 1997; Lucaccini & Kreit, 1972; Smirmaul, 2017; Terry et al., 2020, for reviews).

The model includes variables relating to athletes themselves, the nature of the task in which they are engaged, and the specifics of the sporting context (see Figure 23.1). Moreover, both individual and group-based training are considered. Given that the model is heuristic in nature and thus embraces a broad range of factors, only segments of it can be tested in any single empirical study. The complexity of relationships represented within the model is such that individual hypotheses are not made explicit in pictorial form; rather these are summarized in narrative form (see Karageorghis, 2016). The model postulates a series of reciprocal interactions and feedback loops among the antecedents, moderators, and consequences of music use. Input, in this instance, music, is identified, coded, and moderated by a broad range of personal and situational factors.

To touch on intrinsic musical factors (see Antecedents in Figure 23.1), the temporal aspects of music such as tempo, rhythm, and meter can bear strong influence on an athlete's level of activation. Contrastingly, aspects such as modality (e.g., major vs. minor) and harmony (how notes are combined) may be salient in terms of evoking affective responses (Juslin, 2013). Rhythm and tempo will lead to differential responses depending on the age or personality profile of athletes and the nature of the task in which they are engaged (e.g., Franěk et al., 2014; Karageorghis et al., 2019; Liljeström et al., 2013).

It is thought that extraverts are likely to prefer stimulative music (cf. Eysenck, 1967; McCown et al., 1997), which is characterized by a fast tempo (> 120 bpm), prominent rhythmical features, and exaggerated bass tones. Along similar lines, the melodic and harmonic qualities of music will lead to differential responses depending on an athlete's cultural background. Lyrics contain semantic information and their effects on the athlete will depend on the way they receive them as well as the relevance of lyrics to a given athletic task (Karageorghis, 2017; Sanchez et al., 2014).

Among the extrinsic properties of music, iconic cues pertain to how structural elements of a piece of music relate to the tone of certain emotions. For example, music that is slow and soft may sound "relaxing" because there are intrinsic commonalities with sedation and restiveness (see e.g., North & Hargreaves, 2008). Because such cues are grounded in the structure of music, it is expected that the same music should hold similar "iconic meaning" for different athletes (i.e., irrespective of their ethnic or cultural background). Cultural associations are often forged through the mass media and are, therefore, likely to be relevant to large sections of the population. Taking the earlier-cited example of Vangelis's *Chariots Of Fire*, the piece immediately conjures images of athletes striding over the sands at St. Andrews, Scotland and of striving for Olympic glory. Such imagery is fused in the collective consciousness due to the immediate associations with Hugh Hudson's Oscar-winning movie.

The model depicts a reciprocal relationship between personal and situational factors given that, in a sport setting, the music should be *functional* or carefully coordinated with the tasks and specifics of the session (cf. Kodzhaspirov et al., 1986). Moderators such as personal preferences and attentional style (e.g., associative vs. dissociative; see Hutchinson & Karageorghis, 2013) will interact with the social environment to determine an athlete's response to music. There is a wealth of empirical evidence showing that gender and age moderate athletes' response to pieces of music (e.g., Crust, 2008; Karageorghis et al., 2010, Karageorghis, Bigliassi et al., 2018). There is a tendency for women to rate the rhythmical qualities and danceability of music more highly than men; nonetheless, men tend to value the importance of cultural associations to a greater degree than women, and prefer styles that might be described as "heavier" (e.g., Colley, 2008; Hallett & Lamont 2017).

To touch on the consequences (see the right-hand side of Figure 23.1), the two strongest and most consistent appear first (psychological and psychophysical), followed by behavioral consequences, and finally, psychophysiological consequences, that are the least consistent (see Karageorghis & Priest, 2012b; Terry et al., 2020). Several empirical studies show that athletes appear to experience several of the consequences in unison. For example, appropriate music use can result in enhanced affect that is coupled with greater work output (Karageorghis et al., 2010; Olson et al., 2015; Terry et al., 2012).

In Figure 23.1, you will notice the inclusion of a feedback loop from the consequences back to the music factors. This relates to how the consequences that an athlete might experience influence their future music-selection decisions, and how this process is moderated by personal factors and situational factors. Accordingly, the model predicts that an athlete's response to music will be evaluated by them with reference to the moderator factors, and that their evaluation will serve to shape future selection decisions. The implication is that an athlete is more likely to reselect pieces of music that are deemed to lead to positive consequences and vice versa.

Mechanisms that Underlie the Effects of Music in Sport

Following a 30-year period in which a large number of observational and descriptive-type studies entered the music-in-sport literature, the past 20 years have witnessed a steady stream of studies and chapters that have addressed the underlying mechanisms (e.g., Bigliassi et al., 2018; Grahn & Brett, 2007; Karageorghis et al., 2017; Kornysheva et al., 2010). This subsection will outline a typology of three mechanisms that are commonly advanced to explain how music takes effect in the sport context: (a) in influencing athletes' affective and emotional states; (b) as a dissociative technique, particularly during endurance events/sessions; and (c) as a facilitator of auditory-motor synchronization and rhythmic action.

Affect and Emotions

The common reasons athletes give for using music include the control of arousal, the regulation or modulation of affective states, and the elicitation of specific emotions (e.g., liveliness, calmness, or aggression; Laukka & Quick, 2013). We use the term *affect* to refer to a neurophysiological state that is consciously accessible as a simple primitive, nonreflective feeling (Russell & Barrett, 1999). We use the term *emotion* with reference to feelings that are typically brief, intense, and attributable to a discernible cause (Beedie et al., 2005). For more on the conceptual distinctions between affect and emotion, please see Chapter 12 (Zenko & Ladwig, 2021).

Juslin (2013) offered a theoretical framework that proposed eight psychological mechanisms through which music influences affective and emotional responses. In the interests of brevity, we will focus here on just four of these mechanisms and duly refer the reader to Juslin's paper for the full complement. The *brain stem reflex* refers to the process by which the fundamental acoustic properties of music stimulate responses through signaling a potentially important or urgent event. For example, fast, loud music would automatically stimulate the listener by activating the central nervous system irrespective of how the music is subsequently appraised. This stimulation results in elevated heart rate (HR), blood pressure, body temperature, skin conductance, and muscle tension (Chapados & Levitin, 2008). Soft, slow music has the converse effect and thus decreases sympathetic arousal.

The second mechanism offered by Juslin (2013) is the biomusicological process of *rhythmic entrainment*. The rate of movement and bodily pulses such as HR and respiration rate are drawn toward synchronization with the rhythmical qualities of music. Invariably, athletes express a preference for musical tempo to remain relatively high during intense training sessions (Karageorghis & Jones, 2014; Laukka & Quick, 2013). Along similar lines, given the propensity for brainwaves to entrain with tempo (e.g., Will & Berg, 2007), music can have a priming effect pretraining or as part of an athlete's precompetition routine (Loizou & Karageorghis, 2015; Pettit & Karageorghis, 2020). Slow, calming music can also be used to combat the symptoms of precompetition anxiety (Kuan et al., 2018; Laukka & Quick, 2013).

Scherer and Zentner (2001) highlighted that music can influence the human organism by serving as a trigger for emotional associations, a process that may rely on subcortical mechanisms. Related to this notion, the third of Juslin's (2013) hypothesized mechanisms, *evaluative conditioning*, refers to the repeated pairing of a particular piece of music with other positively or negatively valenced stimuli. For example, a specific piece may, through repetition, become inextricably linked with part of an athlete's pre-event routine. This is a form of classical conditioning, wherein a previously neutrally valenced conditioned stimulus (i.e., a piece of music) gains the ability to evoke the same emotional response as a positively valenced unconditioned stimulus (i.e., a sense of being mentally ready).

Visual imagery is another particularly relevant mechanism from a sports perspective (Kuan et al., 2018). Juslin (2013) explained this in terms of emotions induced due to the music evoking memories of an individual's specific life events (e.g., imaging a previously successful sporting performance conjures the associated emotions). Music is effective in stimulating visual imagery (e.g., McKinney & Tims, 1995), and athletes are generally adept in using visual imagery to, for example, induce relaxation or achieve an appropriate precompetition mindset (Gregg et al., 2005; Karageorghis, Bigliassi et al., 2018). It appears plausible, therefore, that emotional responses to music listening originate, in part at least, from the visual images generated by the listener (Lundqvist et al., 2009).

Dissociation and Perception of Exertion

Music is a stimulus that promotes *dissociation* or an outward-type of focus and so it can distract athletes from pain as well as from fatigue-related cues. Neural mechanisms that influence the perception of exertion are thought to underlie some of the documented effects of music in the sport context. The afferent nervous system, which transmits impulses (e.g., pain and fatigue) toward the spinal column and brain, exhibits a limited channel capacity (analogous to internet bandwidth). Consequently, sensory stimuli such as music may inhibit the physiological feedback signals associated with physical exertion (Hernández-Peón et al., 1961; Rejeski, 1985). A study using electroencephalography (EEG) showed that music is effective in downregulating theta waves (4–7 Hz) in the frontal, central, parietal, and occipital regions of the brain (Bigliassi et al., 2016). This process has been directly associated with the suppression of fatigue-related symptoms (see Craig et al., 2012).

The aforementioned sensation-inhibiting capacity of music is far less pronounced at higher physical activity intensities (i.e., > 75% VO_2max) when the signal strength of physiological feedback is more potent (Ekkekakis, 2003; Tenenbaum, 2001). Nonetheless, even during high-intensity physical activity, affective stimuli such as music appear to retain some influence on how athletes feel and therefore how they interpret the sensations of physical effort and fatigue (e.g., Olson et al., 2015; Terry et al., 2012). In recent neurophysiological work, again using EEG, it was demonstrated that music reduced brain connectivity across frontal and central regions of the cortex (i.e., the sensorimotor regions); a phenomenon that is associated with reduced exercise consciousness (Bigliassi et al., 2017).

Rhythmic Responses to Music

From an evolutionary perspective, it seems that humans have developed a genetic predisposition to respond to music (Levitin, 2008; Patel, 2008; Phillips-Silver & Keller, 2012) and this is important in helping to explain the potential benefits of music in the realm of sport. The coupling of perception and movement is guided by recurrent patterns in the structure of music (Leman et al., 2013). Coupling pertains to the connection between agents that enables them to communicate and receive information about each other's actions (Himberg, 2017). In the case of entrainment, coupling is normally mutual or bidirectional, allowing two agents to perceive and influence each other.

In the application of synchronous music to an activity such as running, until recently, the coupling was unidirectional, as the athlete could follow the musical rhythm, but the rhythm did not alter in response to their movement rate. Athletes can now use accelerometers and digital interfaces that facilitate mutual synchronization (e.g., Moens et al., 2014; D-Jogger); this relates directly to the earlier-described notion of *passive synchronization*. The central processing demands that pertain to passive synchronization are, conceivably, of a lesser order when compared to unidirectional coupling (i.e., active synchronization), albeit comparative studies have yet to emerge in the music-in-sport literature.

It has been proposed that a central pattern generator or pacemaker in the brain may serve to regulate temporal functioning and govern the rhythm response—the innate human predisposition to synchronize movement with musical rhythms (Schneider et al., 2010). This mechanism would coordinate afferent nerve signals with their efferent counterparts that control movement, and also regulate locomotion, neurovascular control, and sensory integration. The supplementary motor area of the brain is another likely seat of the rhythm response, as this sector is activated both during the perception of musical rhythms and in the rhythmic ordering of motor tasks (Zatorre et al., 1996).

The process of synchronizing movement with music, often referred to as auditory-motor synchronization (Bood et al., 2013; Karageorghis et al., 2019; Schmidt-Kassow et al., 2013), is a form of rhythmic entrainment (see Juslin, 2013). In mechanistic terms, training in synchrony with music can lower the metabolic cost of the activity by promoting greater neuromuscular and kinetic efficiency (Bacon et al., 2012; Roerdink, 2008; Terry et al., 2012). Now that we have covered some of the key underlying mechanisms, we will go on to critically review empirical research studies in the area of music and sport.

The Scientific Study of Music in Sport

In recent decades, numerous studies have explored the application of music as a regulator of emotion and as an ergogenic aid in the sporting realm (see Terry et al., 2020). Karageorghis and Priest (2012a, 2012b) highlighted the advantages of applying music to athletes' precompetition routines as well as to their training regimens. More recently, a meta-analysis by Terry et al. (2020) that embraced sport and exercise, showed that music had a small but significant effect on physical performance (g = 0.31). We will review the literature in line with the taxonomy of pretask, in-task, and post-task applications of music in sport.

Pretask Music

Many of the studies exploring the effects of music prior to sports performance have focused on the dichotomy of stimulative vs. sedative music (e.g., Eliakim et al., 2007; Karageorghis, Bigliassi et al., 2018). Albeit many of sports' governing bodies have prohibited the use of personal music devices in the competitive arena, pretask music has been commonly used during warm-up and as part of a pre-event routine. In his review, Smirmaul (2017) suggested that research into pretask music lacked systematic organization, was methodologically constrained, and appeared only infrequently in the broader sports science literature. Moreover, he highlighted that the findings pertaining to the pretask application of music were inconclusive in terms of ensuing ergogenic effects.

It appears that, as might be expected, pretask music has a more pronounced effect on brief or anaerobic tasks, such as grip strength or Wingate Anaerobic Test (WAnT) performance, when compared to tasks of longer duration (Smirmaul, 2017). In an early related study, Hall and Erickson (1995) administered a stimulating musical piece (*Gonna Fly Now* by Bill Conti) and found that it contributed to faster times over a 60-m dash when compared to a no-music control. The researchers *only* administered a stimulative music condition and so we do not know the effects of an alternative music condition or sound per se on sprint performance (e.g., sedative music or crowd noise).

Yamamoto et al. (2003) reported that 20 min of slow-tempo music lowered levels of arousal prior to an all-out effort on a cycle ergometer, whereas fast-tempo music had the converse effect. Neither condition had any influence on performance (i.e., power output). The slow-tempo music did, however, decrease plasma norepinephrine concentration, while the fast tempo increased plasma epinephrine, which is implicated in the fight-or-flight response. Eliakim et al. (2007) examined the influence of stimulative music played while participants warmed-up to perform the WAnT and did not find any ergogenic effect. Nonetheless, the music did elevate HR levels prior to execution of the task (i.e., the music upregulated physiological arousal).

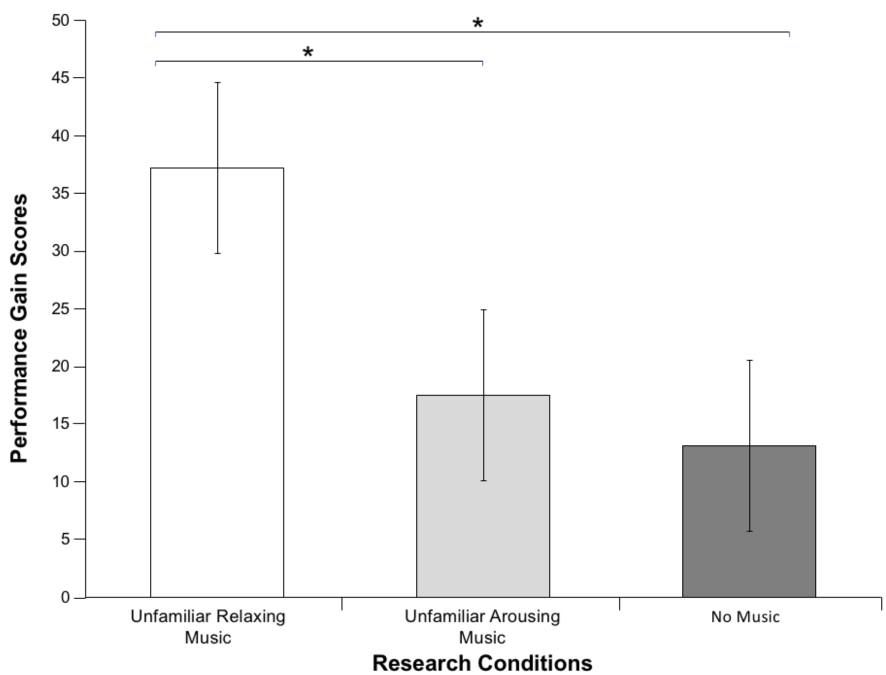
More recently, Karageorghis, Cheek et al. (2018) conducted a study into grip strength that entailed five pretask music conditions, which were administered to male athletes: fast/loud (126 bpm/80 dBA), fast/soft (126 bpm/70 dBA), slow/loud (87 bpm/80 dBA), slow/soft (87 bpm/70 dBA) music, and a no-music control. They found that fast-tempo music played at a high intensity led to the highest grip-strength scores, whereas at a low-intensity, it led to much lower grip strength. In addition, affective valence scores were highest with fast/loud music. Thus, the use of fast/loud pretask music could enhance affective valence and arousal levels when athletes prepare for a simple or gross motor task (e.g., sprinting or powerlifting).

The application of music in the context of target-based sports (e.g., archery, bowls, darts, and shooting) is done primarily with a view to downregulate arousal levels prior to competition. Kuan (2014) conducted a study with unfamiliar relaxing and arousing music applied to elite shooters and weightlifters. He found that unfamiliar, relaxing music was more conducive to mental imagery than arousing music prior to a simulated competition in both contexts. The mental imagery accompanied by relaxing music led to performance gains for both sets of athletes.

In a follow-up study, Kuan et al. (2018) investigated the effects of relaxing and arousing music during imagery training in preparation for dart-throwing performance (Figure 23.2). Participants were assigned to one of three conditions: unfamiliar relaxing music, unfamiliar arousing music, or a no-music control. Measures of galvanic skin response, peripheral temperature, and HR showed that, as expected, listening to relaxing music served to lower arousal (see Figure 23.3, Figure 23.4, and Figure 23.5). Notably, the relaxing music elicited the greatest performance gains as well as more adaptive profiles on the revised Competitive State Anxiety Inventory-2 (CSAI-2R; i.e., precompetition anxiety was perceived as being more facilitative to performance).

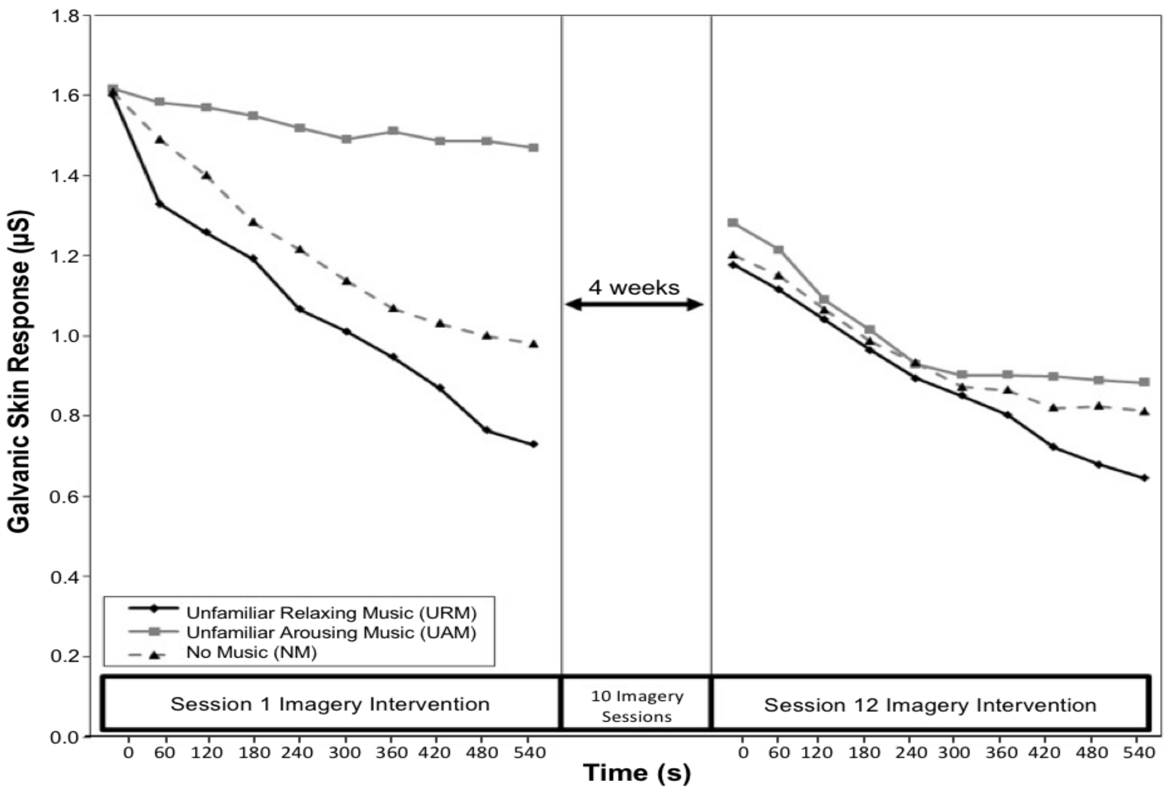
Figure 23.2

Dart-throwing Performance Gain Scores for Unfamiliar Relaxing Music, Unfamiliar Arousing Music and No-music Conditions



Note. *$p < .05$. Error bars represent standard deviation. Reproduced from Kuan, G., Morris, T., Kueh, Y. C., & Terry, P. C. (2018). Effects of relaxing and arousing music during imagery training on dart-throwing performance, physiological arousal indices, and competitive state anxiety. *Frontiers in Psychology, 9,* 14, https://doi.org/10.3389/fpsyg.2018.00014 under a Creative Commons Attribution Licence (CC BY).

Figure 23.3
Mean Galvanic Skin Response (GSR) From t_0 to t_{540} in Sessions 1 and 12



Note. Measures were only taken in Session 1 and Session 12. Reproduced from Kuan, G., Morris, T., Kueh, Y. C., & Terry, P. C. (2018). Effects of relaxing and arousing music during imagery training on dart-throwing performance, physiological arousal indices, and competitive state anxiety. *Frontiers in Psychology, 9,* 14, https://doi.org/10.3389/fpsyg.2018.00014 under a Creative Commons Attribution Licence (CC BY).

A recent study by Rebadomia et al. (2019) that integrated a brainwave entrainment technique with music showed that alpha (12 Hz) wave-synchronized music substantially increased participants' throwing distances (shot put, discus, and javelin) and the theta (4–7 Hz) wave-synchronized music significantly reduced throwing distance. Although the study is limited given that it employed a quasi-experimental design and there were only six participants, it supported earlier findings (e.g., Kuan, 2014; Kuan et al., 2018) showing that the use of relaxing music can influence performance in both fine-motor and power/motoric sports.

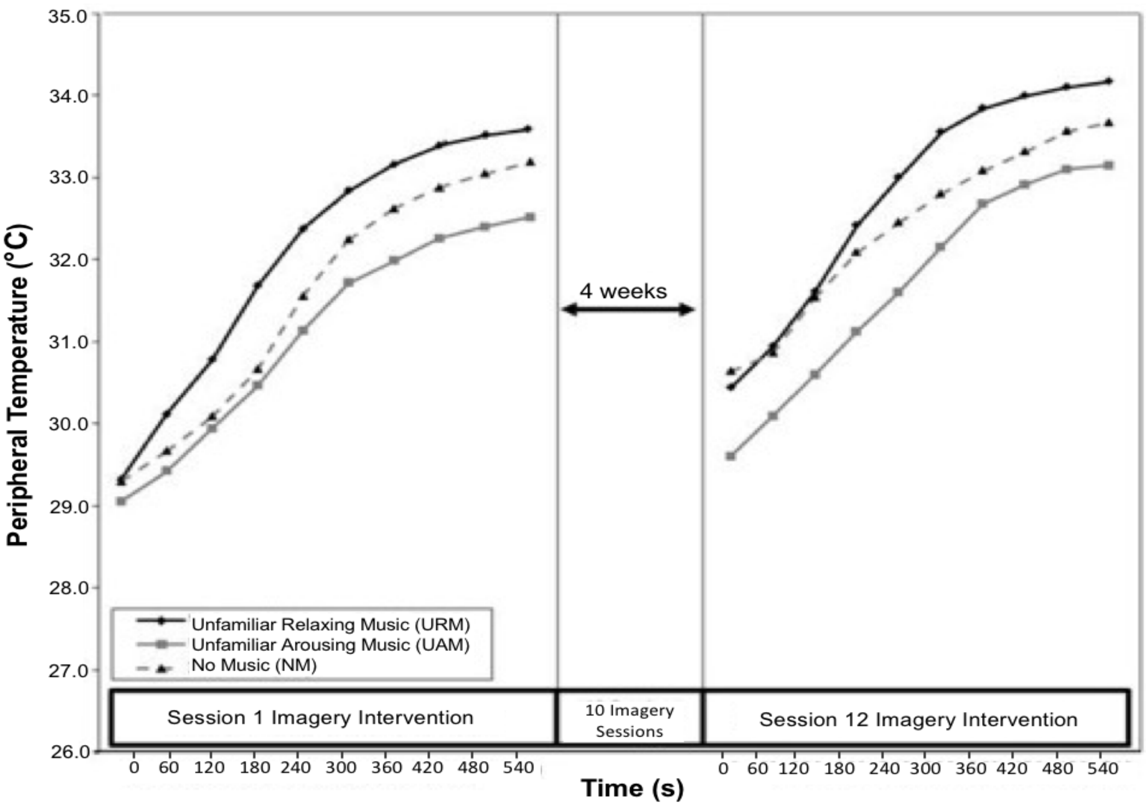
Research has shown that pretask music can be used to: (a) manipulate emotional states; (b) enhance athletic performance in short-duration sports (e.g., sprint events); (c) promote task-relevant imagery; and (d) assuage precompetition anxiety. There is, however, relatively limited research in this area, creating considerable scope for further applied work into how music can help athletes to attain optimal preperformance states.

In-Task Music

Music is a tool that can be applied in-task for training and, in some instances, competition. Several studies support the application of music for continuous, endurance-type performance. Researchers have been interested in two main in-task applications of music—synchronous and asynchronous.

Figure 23.4

Mean Peripheral Temperature (PT) From t_0 to t_{540} in Sessions 1 and 12



Note. Measures were only taken in Session 1 and Session 12. Reproduced from Kuan, G., Morris, T., Kueh, Y. C., & Terry, P. C. (2018). Effects of relaxing and arousing music during imagery training on dart-throwing performance, physiological arousal indices, and competitive state anxiety. *Frontiers in Psychology, 9,* 14, https://doi.org/10.3389/fpsyg.2018.00014 under a Creative Commons Attribution Licence (CC BY).

Synchronous Music

Synchronous in-task music is used for psychological benefits as well as an ergogenic aid, and often accompanies endurance-based tasks such as running or indoor cycling (Karageorghis & Priest, 2012b). The application of synchronous music is more likely to result in ergogenic effects than the asynchronous application (Karageorghis & Priest, 2012a; 2012b). When athletes train in sync with music, they tend to work harder and for longer (Terry et al., 2012).

A number of studies have explored the effects of synchronous music during endurance-based activities such as running and cycle ergometry. Terry et al. (2012) tested elite Australian triathletes who performed a treadmill running task. Participants endured for longer in the presence of two synchronous music conditions (motivational vs. neutral). The researchers found that time-to-exhaustion was 18.1%

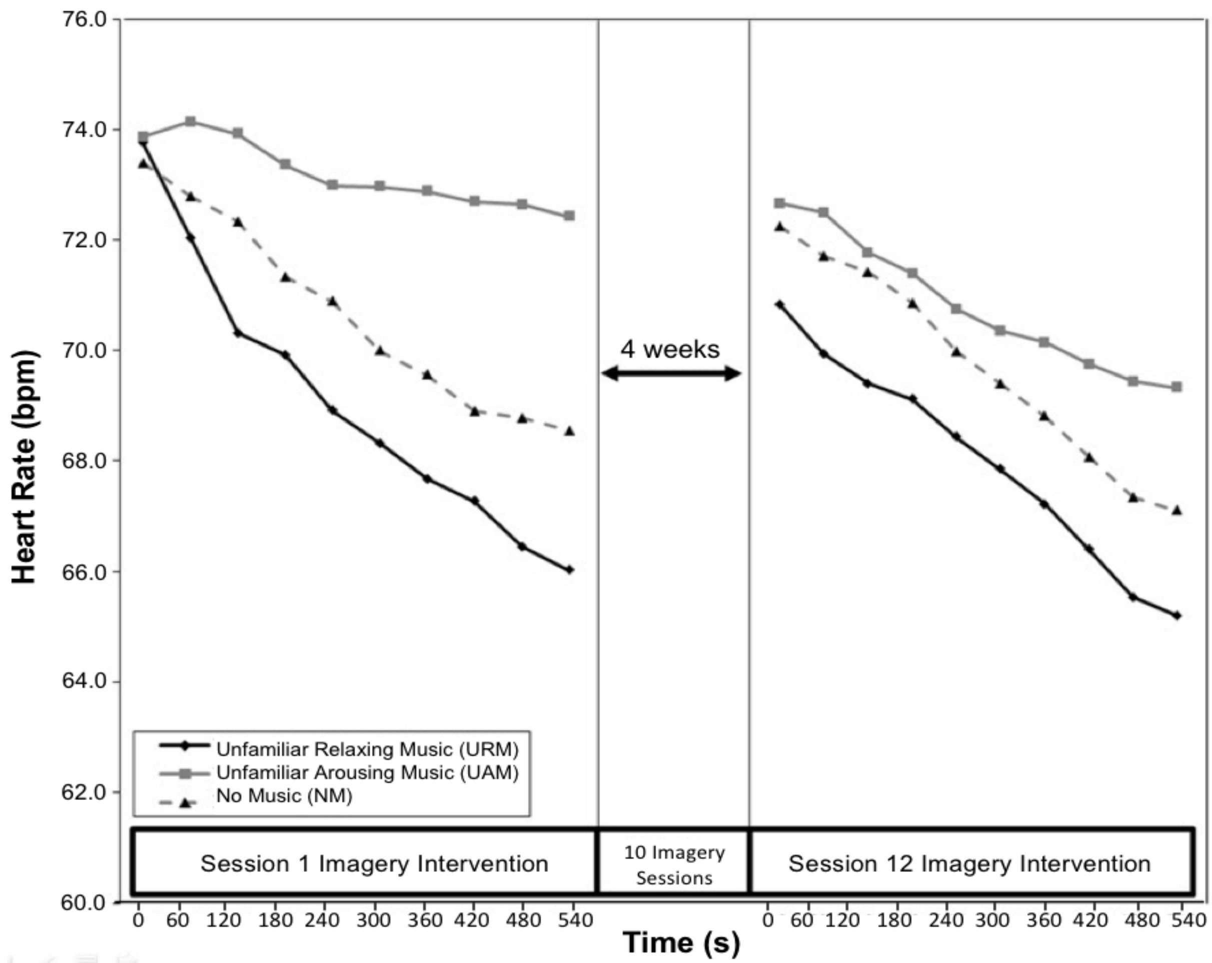
and 19.7% longer when running in sync with motivational and neutral music, respectively, when compared to a no-music control. Furthermore, mood responses and feeling states were more positive under motivational music compared to either neutral or no-music conditions. A potential limitation was that the sterile laboratory environment may have been so unstimulating for the demanding endurance-based task, that the music served as a welcome distraction from rather dull surroundings.

Karageorghis et al. (2010) examined the effects of synchronous music using more complex motor tasks than running or cycle ergometry. They used a series of strength-endurance, circuit-type tasks performed to exhaustion under three conditions (each at a tempo of 120 bpm): motivational music (i.e., that inspires movement), motivationally neutral music, and an auditory metronome. Exercises such as sit-ups, standing squats, and heel raises are a staple of many athletes' training regimens. Interestingly, Karageorghis et al. (2010) found that women recorded significantly higher strength-endurance performance and affective valence scores than men, when exposed to the two music conditions. There is scope for further examination of gender differences in response to music while experimentally manipulating the complexity of motor tasks.

Photo by Anete Lusina from Pexels

Figure 23.5

Mean Heart Rate (bpm) From t_0 to t_{540} in Sessions 1 and 12



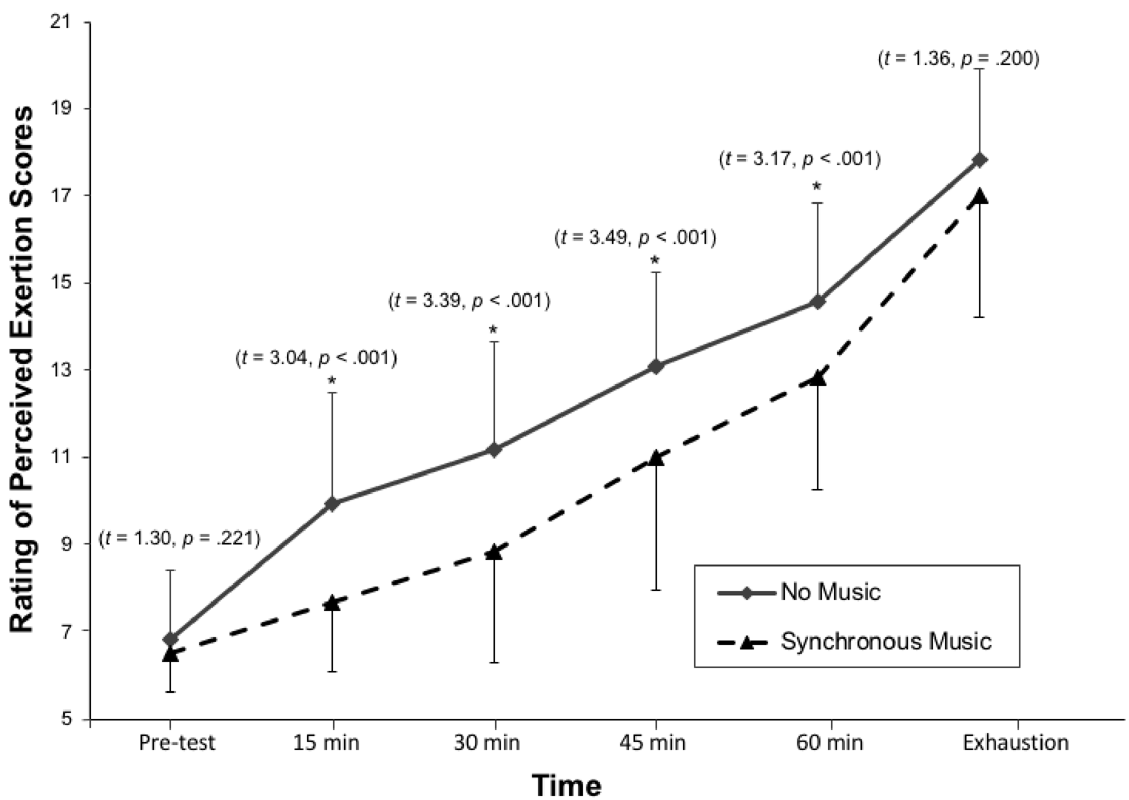
Note. Measures were only taken in Session 1 and Session 12. Reproduced from Kuan, G., Morris, T., Kueh, Y. C., & Terry, P. C. (2018). Effects of relaxing and arousing music during imagery training on dart-throwing performance, physiological arousal indices, and competitive state anxiety. *Frontiers in Psychology, 9,* 14, https://doi.org/10.3389/fpsyg.2018.00014 under a Creative Commons Attribution Licence (CC BY).

In an applied study, Karageorghis et al. (2019) examined the effects of synchronous music over a one-month period of speed-endurance training. Twelve recreational athletes were assigned to one of two groups: (a) Sprint training coordinated with synchronous music; or (b) a control condition with conventional sprint training and no music. The findings showed that, after a month of training, participants in the synchronous music group executed the 400-m time trials 5.07% faster than the control group. The authors suggested that longer periods of monitoring and application of synchronous music would provide greater insight into the possible benefits of synchronous music protocols in a sport training context.

The effects of synchronous music on psychophysiological parameters and running performance in hot and humid conditions was investigated by Nikol et al. (2018). Runners completed two running trials in simulated situations, recreating 31°C heat coupled with 70% humidity, under conditions of synchronous music and no music. Participants ran on a treadmill located inside a climate chamber for 60 min at 60% $V0_2$max and continued to run at 80% $V0_2$max, until they reached voluntary exhaustion. Time to exhaustion was 66.59% longer in the synchronous music condition when compared to control. Moreover, RPE scores were lower at each time point (15, 30, 45, and 60 min) of the steady-state part of the protocol (i.e., 60% $V0_2$max) in the synchronous music condition (see Figure 23.6). The results illustrate how runners can benefit from synchronous music under hot and humid conditions. However, the study did not include an asynchronous music condition and so it is not known whether synchronization per se was responsible for the observed effects. The study highlights the need for more studies that compare synchronous vs. asynchronous music (see also, Terry et al., 2020).

Figure 23.6

Participants' Rating of Perceived Exertion Under Two Conditions



Note. Error bars represent standard deviation. Created using data from Nikol, L., Kuan, G., Ong, M., Chang, Y-K, & Terry, P. C. (2018). The heat is on: effects of synchronous music on psychophysiological parameters and running performance in hot and humid conditions. *Frontiers in Psychology, 9,* 1114, https://doi.org/10.3389/fpsyg.2018.01114 under a [Creative Commons Attribution Licence (CC BY)](https://creativecommons.org/licenses/by/4.0/).

Asynchronous Music

The asynchronous application of music has, by a wide margin, attracted the greatest research interest in the music-and-sport literature (see Terry et al., 2020). This application of music occurs when human movement is not consciously synchronized with the rhythmical qualities of music (Karageorghis & Terry, 1997). There have been studies into the psychological, psychophysical, psychophysiological, and ergogenic effects of asynchronous music in a sporting context (e.g., Birnbaum et al., 2009; Karageorghis et al., 2013). The main benefit of using asynchronous music is that it can create a more pleasant training environment and enhance training experiences. Its application can reduce RPE by ~10%, but only during submaximal training intensities, given that physiological cues predominate attention during high-intensity tasks, such as all-out rowing ergometry (Karageorghis & Priest, 2012a). Asynchronous music can also enhance positive affect or reduce negative affect; even at relatively high work intensities (e.g., Hutchinson et al., 2018; Karageorghis & Jones, 2014).

Stork et al. (2015) conducted a study that applied asynchronous music to the WAnT, with four 30-s "all-out" bouts. The peak and mean power achieved by participants was higher in the music condition when compared to a no-music control. A potential limitation of the study is that self-selected music was used, and therefore the psychoacoustic properties of the music were not standardized across participants. Stork et al. (2019) conducted a follow-up study on the effects of experimenter-selected asynchronous music on Sprint Interval Training (SIT). Their findings showed that postexercise enjoyment was higher with the music condition when compared to podcast and no-audio controls. Also, the affective responses throughout the SIT trial were more positive in the music condition. These findings are relevant to athletes who engage in high-intensity, interval-type training.

Research has shown that in-task music can be used to: (a) engender an ergogenic effect (particularly when used in the synchronous mode); (b) enhance athletic performance when applied longitudinally; (c) reduce RPE by ~10% in submaximal training tasks; and (d) enhance affect at a range of training intensities. There is a dearth of research comparing synchronous vs. asynchronous music and this should be a focus for future studies.

Post-Task Music

The use of post-task music for movement-based recovery, also known as *active recovery*, or static recovery, often referred to as *passive recovery*, is an approach that has seldom been examined by researchers (Karageorghis, 2017). One of the most common uses of post-task music for athletes is to regulate or modulate affective valence and arousal (i.e., engender positive feelings) after intense training or competition (Karageorghis, 2016). You will recall that post-task music can be applied in respite forms (i.e., in between high-intensity exercise bouts) and as a recuperative tool (i.e., at the end of a training session or competition).

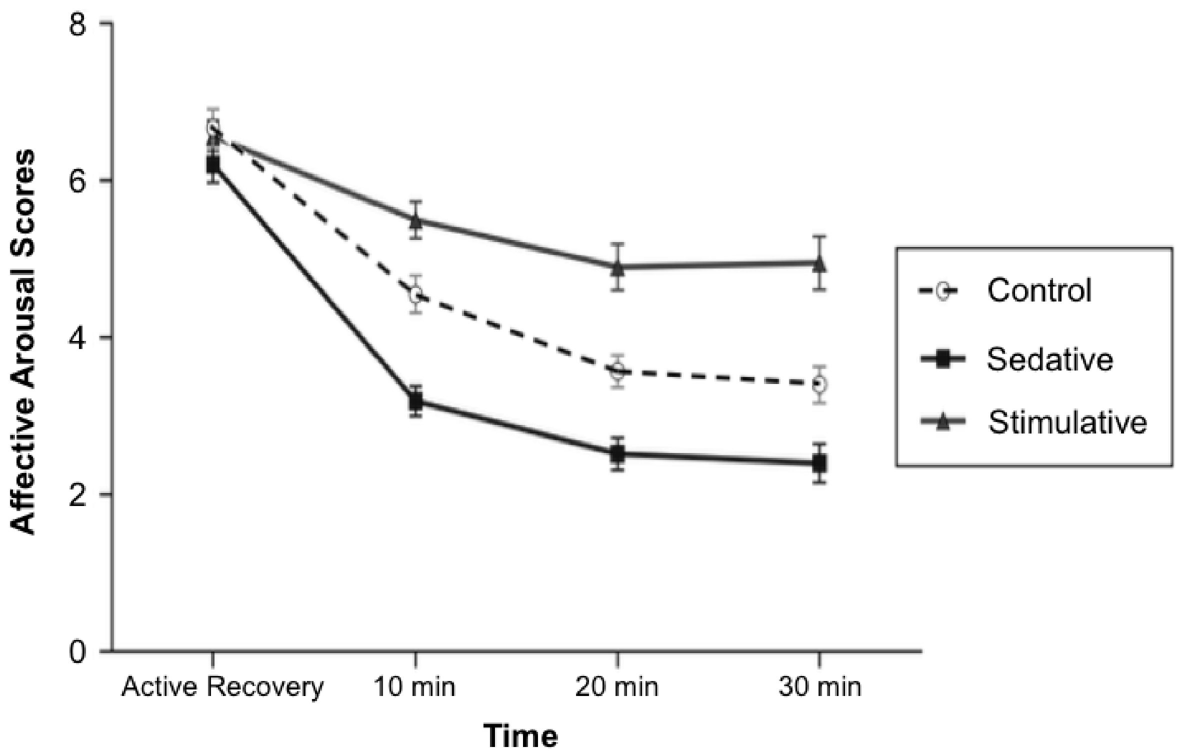
Jones et al. (2017) examined the psychophysiological effects of *respite–passive music* (i.e., music used for static recovery) on acute recovery from high-intensity, 5-min running bouts performed by male middle-distance runners. Upon completion of each running bout, participants were exposed to slow-tempo music (55–65 bpm), fast-tempo music (125–135 bpm), or a no-music control. A range of measures were taken that included affective responses, RPE, gas exchange, and pulmonary ventilation. The researchers found that fast-tempo music resulted in higher scores on the Feeling Scale (i.e., enhanced affective valence) over the entire 3-min static recovery period compared to a no-music control.

Karageorghis et al. (2021) investigated the effects of *respite–active music* (i.e., music used for active recovery). They administered medium-tempo (120–125 bpm), fast-tempo (135–140 bpm), and no-music control conditions using a high-intensity interval training (HIIT) protocol. They reported that the medium-tempo music condition improved affective valence during exercise and active recovery. Both medium- and fast-tempo music increased dissociation, exercise enjoyment, and remembered pleasure relative to the control condition. In addition, medium-tempo music was shown to reduce RPE during recovery periods. Jones et al. (2020) contrasted two music conditions (respite–active and continuous) with a no-music control using a HIIT protocol. In contrast to Karageorghis et al., they found that music did not influence affective valence during either exercise bouts or recovery periods. Nonetheless, Jones et al. reported that the continuous application of music resulted in greater post-task enjoyment and remembered pleasure than respite–active music. In this instance, the music tempo, which was in the range 120–140 bpm, may not have been optimal for use in active recovery toward the high end of this range.

Finally, with the notion that slow, sedative music can facilitate the recovery process that follows exhaustive exercise (i.e., a recuperative music application), Karageorghis, Bruce et al. (2018) investigated the effects of two music conditions vs. a no-music control on psychological and psychophysiological recovery indices. The two music conditions were slow, sedative music (M_{tempo} = 71 bpm) and fast, stimulative music (M_{tempo} = 129 bpm). The authors found that slow, sedative music facilitated the downregulation of affective arousal (see Figure 23.7). The greatest decrease in affective arousal between active and passive recovery phases was evident in the slow, sedative condition. Women had a more pronounced reduction in arousal than men in response to the slow, sedative music condition. HR measures showed that fast, stimulative music inhibited the return of HR toward resting levels. There was a main effect of condition for affective valence suggesting that the slow, sedative condition induced more positive affective responses when compared with the control and fast, stimulative conditions.

Figure 23.7

Twoway Condition × Time Interaction for Affective Arousal (p < .001)



Note. Adapted from Karageorghis, C. I., Bruce, A. C., Pottratz, S. T., Stevens, R. C., Bigliassi, M., & Hamer, M. (2018). Psychological and psychophysiological effects of recuperative music post-exercise. *Medicine & Science in Sports & Exercise, 50*(4), 739–746, https://doi.org/10.1249/MSS.0000000000001497 under a Creative Commons Attribution Licence (CC BY).

Research has shown that post-task music can be used to: (a) enhance affective responses following exhaustive training sessions; (b) improve the experience of training sessions predicated on HIIT-type protocols; and (c) facilitate physiological recovery but notably not when the tempo is high.

Post-task music has been the least investigated music application and so there is potential for a broad range of research. A particularly valuable line of work would be to use physiological (e.g., blood lactate), psychophysiological (e.g., electroencephalography; EEG), and neurophysiological (e.g., functional near-infrared spectroscopy; *f*NIRS) measures alongside subjective measures of recovery (e.g., the Feeling Scale; Hardy & Rejeski, 1989).

How to Apply Music in Sport

Athletes are able to derive benefit from the use of music before, during, or even after sport, as detailed in the earlier sections of this chapter. Invariably, athletes' needs will differ and so the first thing to make clear is that there is no simple, "one-tune-fits-all"-type solution. In this section, we explore how music can be used for performance enhancement, considering, among other factors, athletes' preferences, sport-specific requirements, and a range of musical factors (e.g., rhythm and lyrics).

Using Music Before Sport

For coaches and athletes wanting to harness the power of music, careful consideration of the use of pretask music is a good point of origin. Commencing a training session or competition in the "right" physical and mental state is often crucial for performance success. Music can help in fine-tuning an athlete's emotional state and controlling their thought patterns before sport (Bishop, 2010).

Many athletes benefit from starting a competition with an elevated level of arousal. Fast and loud music induces physiological changes such as increases in HR, blood pressure, and muscle tension. This happens irrespective of how much athletes actually *like* the music (see e.g., Chapados & Levitin, 2008). Fast, loud music can therefore help a sprinter to rocket out of the starting blocks and may provide a tennis player with a mental edge over an opponent. For sprinters, The Prodigy's *Run With The Wolves* (166 bpm) might represent a good example, and for tennis players, Black Eyed Peas' *Boom Boom Pow* (130 bpm). The latter track was famously used by Andy Murray (former world #1 men's singles player).

To Each Their Own

Not all athletes need or want to be as happy as a lark just before a training session or competition. Some will choose to listen to dark and aggressive music, such as heavy metal, in order to feel confident and strong (Karageorghis, 2017). Powerlifters might pick tracks such as Linkin Park's *One Step Closer* (95 bpm), while snowboarders might go for *Lords Of The Boards* by the Guano Apes (104 bpm) to feel self-assured before a sharp descent or a 70-foot jump.

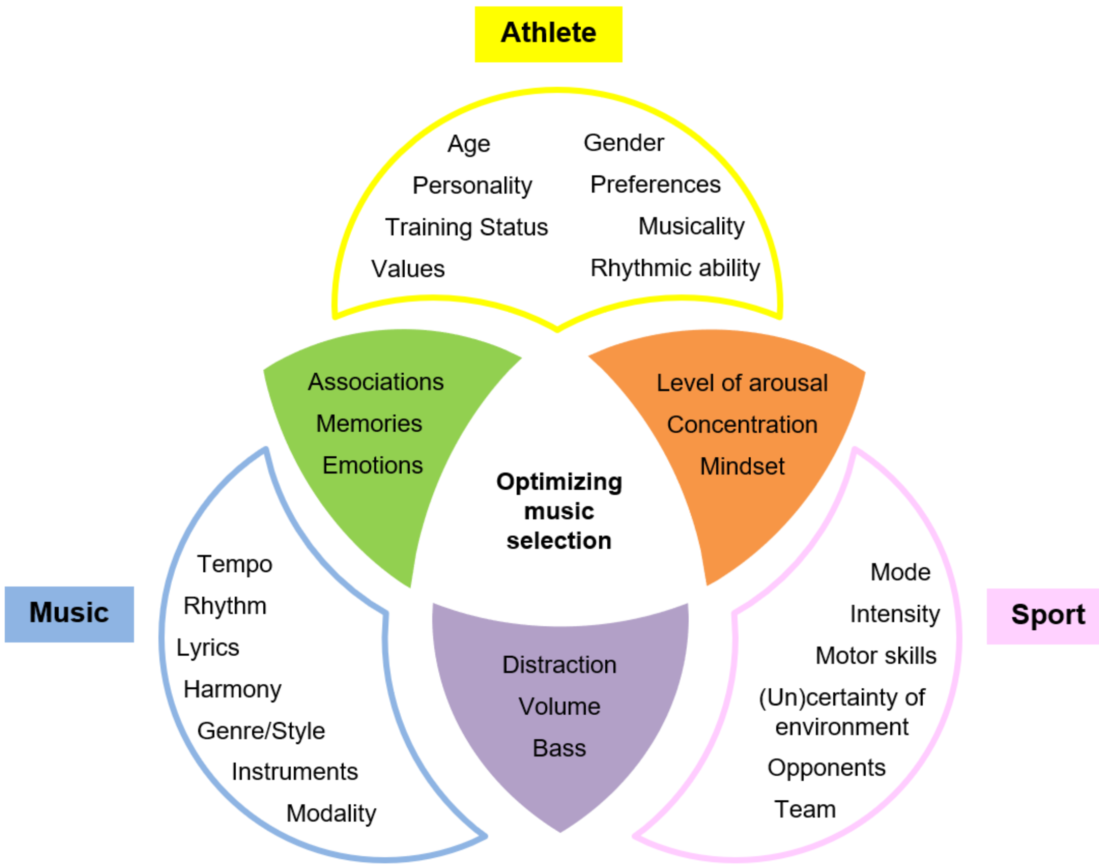
Each athlete needs to experience a level of arousal that is compatible with their upcoming task(s), but even for rather similar tasks, their personal preferences can differ. Some may interpret their heightened arousal as positive excitement, while others may dislike these sensations and feel anxious or stressed. Music can steer athletes toward a positive interpretation of their feelings of excitement, pressure, or anxiety before sporting competition (Smirmaul, 2017).

Figure 23.8 depicts how the athlete's characteristics, components of the sport, and attributes of a musical piece relate to one another in determining the optimal musical choice for performance enhancement in sport. It's not *always* music of the fast/loud variety that does the trick. Music that is soft and slow can help an athlete to relax and attain a calm mindset (Bishop et al., 2007), which might be beneficial for athletes who prefer to begin their training or competition in a relatively placid state.

Music chosen for the downregulation of arousal can be sourced from many musical genres, depending on an athlete's preferences (e.g., pop, folk, or reggae). Pieces with relatively simple and slow rhythms tend to work well in terms of decreasing affective and physiological arousal (Karageorghis, 2016). Classical music, ballads, or ethnic songs can all work effectively. Athletes might try Johann

Pachelbel's well-known *Canon in D* (72 bpm), Katie Melua's *Nine Million Bicycles* (82 bpm), or *Empire* by Shakira (80 bpm).

Figure 23.8
Factors Relevant to Optimal Music Selection in Sport



The Importance of Familiarity

Familiar music can simply make athletes "feel good" (i.e., enhance their affective valence). Listening to pretask music that triggers happy memories or reminds athletes of their role models/heroes, can positively impact their emotional state and increase self-efficacy (Bishop et al., 2007; Karageorghis, Cheek et al., 2018).

Perhaps basketball players will have a penchant for LeBron James and Kevin Durant's rap *It Ain't Easy* (88 bpm), while soccer players prefer *World At Your Feet* by Embrace (124 bpm). Gymnasts might settle their nerves with Ludovico Einaudi's *Nuvole Bianche* (133 bpm), a soothing piano piece that conjures images of the Olympic performance of gymnast Lieke Wevers in 2016. Other tracks with positive extramusical associations include Katy Perry's *Roar* (90 bpm) and Kanye West's *Touch The Sky* (106 bpm; ft. Lupe Fiasco).

A Musical Aide-Mémoire

By facilitating the recall of previous successful or enjoyable sporting experiences, music can bolster motivation and self-confidence. Through the earlier-described process of *evaluative conditioning*

(Juslin, 2013), familiar music can even evoke psychological and physiological reactions of which an athlete is not consciously aware (Terry et al., 2020).

Musical pieces can be selected to help athletes remember crucial tactical or technical instructions. In learning correct technique for the shot put, for example, young athletes can use the lyrics of *Push It* (130 bpm) by Salt-N-Pepa. This encourages them to “push” rather than try to “throw” the shot; the most common technical error. When music is an integral aspect of performance, such as in ice dancing and synchronized swimming, athletes can use the soundtrack of their routine to mentally rehearse their performance as part of their precompetition preparations.

The minutes just before a game or competition can be particularly stressful. Music can help athletes to remain suitably focused on the task at hand (Laukka & Quick, 2013). Athletes can also use motivational or inspiring lyrics to prompt use of a personal mantra. Repeating part of a chorus from uplifting pieces such as Sia’s *The Greatest* (96 bpm; feat. Kendrick Lamar) or singing along to the lyrics of *The Power* (109 bpm) by Snap! can bolster an athlete’s self-efficacy and serves to distract them from unhelpful thoughts.

Building Team Cohesion

As all members of a team should feel comfortable with a playlist used to promote cohesion, selecting music in team sports can be a challenging process. It is, nonetheless, well worth getting at least some buy-in from all team members (see e.g., Karageorghis, Bigliassi et al., 2018). Team songs can be played during the team’s travels or as a sonic background in the changing room. Simply moving in synchrony during a warm-up routine increases social harmony as well as a sense of belonging (Cross et al., 2019). Music can thus instill a strong sense of esprit de corps, enhancing a team’s cohesion and collaboration (Høigaard et al., 2013).

A team anthem or collective playlist can remind athletes of previous successes as well as past collective struggles. This can strengthen the belief of individual players in the team’s abilities, enhancing commitment and resilience even during periods of repeated losses (Morgan et al., 2017). Athletes who believe in their team’s abilities and its members’ qualities are more disposed toward “giving their all” (Ronglan, 2007). A team might choose to use a track such as *Firework* by Katy Perry (124 bpm) or the New Radicals’ *You Get What You Give* (114 bpm) to strengthen the perception of team cohesion in the prematch phase.

With a Little Help From Our Fans

Music can motivate a crowd of sports fans, creating an atmosphere of passion and excitement. On home turf, this is an integral part of the home advantage phenomenon (Karageorghis, 2017). The sound of a supportive crowd belting out a well-known chorus or chanting a player’s name can raise athletes’ spirits and the sense of collective efficacy (Bray & Widmeyer, 2000; Karageorghis & Terry, 2011). In many sports, individual athletes or teams select a “walk-on song” that represents their values and enables fans to identify more closely with them. Such applications of music can be valuable in creating a sense of community among athletes, spectators, pundits, and even sponsors.

The New Zealand rugby team’s haka is a good example of the use of music (also incorporating tribal chanting and dance) to increase team spirit. Fans the world over know and look forward to the traditional battle-chant with which the All Blacks express their determination and lay down the challenge to their opponents. Many teams can be at least mildly intimidated by such bravado and indeed the central purpose for the All Blacks is to fill their adversaries with dread.

Using Music During Sport

Many sportspeople have noticed that their training sessions pass easier when they listen to music. Precisely how beneficial music can be depends on many factors, such as an athlete's personality, as well as the intensity and duration of their effort. Whether or not music can be helpful also depends on the complexity and type of task that is being executed. We will go on to explore how the power of music can be tapped during sport or training.

Dissociation and Distraction

During sport activities of low-to-moderate intensity, music can reduce feelings of discomfort and fatigue by hindering the transmission of sensory information from the body to the brain (Bigliassi et al., 2017). Athletes thus perceive their effort as being lower in relative terms. Given that athletes base their intended speed or power output on these perceptions of effort (Venhorst et al., 2018), music can make them run faster or push harder, compared to when music is not available (Karageorghis, 2016). Note that during very high intensities (e.g., sprinting or "Insanity" sessions) music is relatively ineffective in reducing perceived exertion.

Maintaining Appropriate Focus

Even if it does not affect athletes' perceived exertion, musical distraction can make it seem as though time is passing by faster. It also facilitates positive thoughts (Karageorghis, 2016) and thus can render the experience of mundane activities such as circuit training or repetitive drills in sports like volleyball or tennis, more pleasurable.

During long training sessions, such as running or swimming, athletes should select tracks with a steady beat. Concentrating on a regular rhythm helps athletes to stay focused on the task at hand and maintain regularity in their movement patterns. This approach has been shown to make endurance activities more energy efficient, particularly when the music is used synchronously (Bacon et al., 2012). Pieces with a predictable structure and simple melodic themes "suck athletes in" and can lock with their movement pattern. Good examples include Fedde Le Grand's *Put Your Hands Up 4 Detroit* (128 bpm) and *Pump It Up* by Endor (129 bpm).

Supramaximal Efforts

When athletes train or compete at high intensities, music cannot block pain and discomfort from entering their focal awareness (Karageorghis et al., 2011; Terry et al., 2020). Nevertheless, listening to easy-to-absorb, preferred music can increase athletes' motivation, enjoyment, and affective state (Stork et al., 2019). During high-intensity training such as SIT, appropriate music is fast (>125 bpm; Maddigan et al., 2019), uplifting, loud (> 70 dBA), and characterized by a steady beat (Karageorghis, 2016). Lyrics are *somewhat* less important, as it is hard for athletes to process lyrical content during highly strenuous training sessions (Karageorghis, 2017). Good examples include Daft Punk's *Harder, Better, Faster, Stronger* (126 bpm) or *Party Rock Anthem* by LMFAO (130 bpm; feat. Lauren Bennett and GoonRock).

Music as a Pacemaker

Moving in time with the beat of a popular song comes rather naturally to most people (Buhmann et al., 2016; Terry et al., 2012). This form of synchronous application of music can help an athlete to maintain an even pace throughout an endurance-based training session and increase their movement efficiency (Bacon et al., 2012; Terry et al., 2012). To use music in a synchronous way, the rhythm and tempo of the chosen tracks need to complement an athlete's movement pattern and rate (Karageorghis et al., 2017). Regular and well-pronounced beats make it easier for athletes to follow the music's meter.

Many runners have experienced how music with the "right" rhythm can seem to slightly hasten their pace and thus bolster their performance (Van Dyck & Leman, 2016). For example, the great Ethiopian distance runner, Haile Gebrselassie, believed that running to the track *Scatman* (136 bpm) by Scatman John provided exactly the rhythmic stimulus he needed to maintain an optimal pace. He used this track as the sonic backdrop to an indoor world best for 2000 m in 1998. Also, for cyclists training indoors, music can help them to sustain an optimal cadence and maintain power output throughout lengthy training sessions (Waterhouse et al., 2010).

Some sports present particular challenges when it comes to syncing movement to the beat. In rowing, for example, athletes execute a full-body movement that leads to a stroke rate of ~25 strokes per min. Their preferred music, however, is often far in excess of 30 beats per minute! A good solution is to select a moderate-tempo track, such as Shakira's *Hips Don't Lie* (feat. Wyclef Jean) or Q-Tip's *Breathe And Stop*—both at a tempo of 100 bpm—and to execute one full stroke over each set of four beats (i.e., a musical measure or bar).

Music in the Competitive Arena

In many artistic sports, music is an integral part of performance. In gymnastics or ice dance, success depends greatly on the judges' evaluation—the correspondence between a piece of music and an athlete's movement pattern is thoroughly scrutinized. Soundtracks for sport routines usually comprise some fast, rhythmic sections that correspond with the most difficult, demanding, and fast-paced movements. They also include more sedate sections, during which an athlete can catch their breath before the next burst of effort. The music punctuates each movement sequence and it seems as though the athlete merges with their auditory accompaniment. A great example concerns Gabrielle Douglas's floor routine during the 2012 London Olympics, wherein she used a high-energy mash-up of *Memories* (130 bpm) by David Guetta feat. Kid Cudi, and Yolanda Be Cool's *We No Speak Americano* (125 bpm) for an impressive acrobatic tumbling series.

Mindlessly using music as acoustic wallpaper is not an approach we would recommend. Music can be an unwanted distraction when athletes are learning new motor skills, or when they need to concentrate on complex decision-making processes (Karageorghis & Terry, 2011). The absence of music could also be preferable when athletes are receiving feedback from their coach or when they need to communicate with teammates.

Using personal in-task music is often not permitted during competitions (e.g., in track and field; Van Dyck & Leman, 2016). We would thus encourage endurance athletes to complete a couple of training sessions each week without music. This makes them less reliant on music and can prepare them for the (likely unpleasant) sensations they will encounter while competing.

Respite and Recuperative Music

Respite Music

In many sports, athletes have a brief period of time in between consecutive physical tasks, ranging from repeated sprint efforts or several games on one day (e.g., in a tournament setting). Well-chosen respite music can help athletes to make optimal use of this (brief) period of recovery (Jones et al., 2017).

Music applied during training can encourage athletes to take sufficient time to recover before going again or initiating another set of activity. This is important in sports where athletes need near maximal power output to perform optimally (e.g., sprint events in swimming or track and field). When training intensity is extremely high (e.g., during supramaximal intervals), respite music could be most effective when used in between intervals. At these moments, athletes can concentrate on the music, which has been found to assuage negative affect (Karageorghis et al., 2021).

Moderately stimulating and optimistic (happy) music with a simple melodic structure and catchy lyrics can be ideal. We would suggest a medium tempo for respite music (i.e., 115–125 bpm); this will help in maintaining the level of psychomotor arousal required for the next task. Examples of suitable tracks include *Get Lucky* by Daft Punk feat. Pharrell Williams and Nile Rodgers (116 bpm) and *Express Yourself* by Madonna (116 bpm).

Recuperative Music

When the referee's final whistle sounds or the coach "calls it a day", athletes have made their last big effort and the best they can do is focus on optimizing their recovery until the next time they enter the fray. Interestingly, there are also musical solutions for the enhancement of recovery and recuperation.

Recuperative music of the slow, sedative variety can accelerate decreases of physiological arousal toward an athlete's resting values. It can also have important psychological effects, as it increases feelings of wellbeing, calmness, and revitalization (Karageorghis, Bruce et al., 2018). Moreover, it reduces stress and might disrupt athletes' negative rumination. Being able to relax and detach from sport is relevant to recovery (Balk & Englert, 2020). Hence, recuperative music might also enhance athletes' long-term wellbeing and motivation. A recuperative playlist for use directly after sporting activity should ideally have a slow tempo that descends from track to track (~90 bpm–~60 bpm; see Table 23.1).

Table 23.1

A Selection of Music Tracks for Recovery

Artist	Track	Tempo (bpm)
Amy Winehouse	Help Yourself	90
Red Hot Chili Peppers	Scar Tissue	89
Corinne Bailey Rae	The Scientist	85
Gregory Porter	Everything You Touch Is Gold	75
will.i.am	Good Morning	60

Most athletes will combine their sport with full-time work or study, and struggle to find sufficient time for rest and recuperation in their crowded schedules. Late-evening training sessions or competitions and spending time in unfamiliar surroundings for away fixtures can make it difficult for athletes to sleep. Relaxing music can be part of a structured bedtime routine that promotes a restful night's sleep. Many types of soft, sedative, and slow music can work, such as Erik Satie's *Gymnopédies* (various tempi) or Enya's *A Day Without Rain* (71 bpm).

Conclusions

This chapter has explored concepts, theoretical approaches, underlying mechanisms, empirical research, and applications relevant to the use of music in the domain of sport. Music is a potentially powerful tool that can be used before, during, or after sport. Across a broad range of applications, music is important in regulating emotion, boosting confidence, and optimizing focus. By reminding members of a team of shared experiences and values, music can instill a sense of esprit de corps, while also bringing players closer to the fans.

In-task music can serve as a type of pacemaker and enable athletes to dissociate from fatigue-related symptoms or unhelpful thoughts and feelings, when their results, performance, or both, might be disappointing. Nonetheless, it should be noted that with overuse, the potency of a piece of music can be diminished. Athletes might lose interest in a playlist or even develop a strong aversion toward it; particularly if it gets associated with failure, anxiety, or frustration. It is therefore advisable for athletes and coaches to have several options at their fingertips (i.e., a variety of playlists). When music is not permitted, athletes can use auditory imagery to hear or sing a piece in their mind. Even when music is imagined, its rhythm can serve as a pacing aid or a catchy lyric can provide a personal mantra.

Carefully selecting pieces of music for use before, during, and after sport is a worthwhile pursuit. Athletes will, invariably, go through a process of trial-and-error to discover which selections work best for them, and when. Analyzing the effects different tracks have on their mindset and thought processes might even teach athletes more about the way their mind and body interact toward the goal of attaining excellence.

Learning Exercises

1. Think of three pieces of music that are associated with sporting endeavor. With reference to the “Music Factors” box in Figure 23.1 (A Theoretical Model of the Antecedents, Moderators, and Consequences of Music Use in the Exercise and Sport Domain) consider why these pieces have such an association.

2. Pick three running stride rates for an athlete (typically, a range of 150–180 strides per minute [spm] is used) and then select a piece of music for each stride rate that would facilitate auditory-motor synchronization. Consider that one step can be taken on each beat (i.e., with music at 150–180 bpm) and that one stride cycle can be taken on each beat (i.e., with music at 75–90 bpm).

3. If pretask music is typically used to recreate an athlete’s ideal mindset, how might we go about establishing—with some accuracy—what an athlete’s ideal mindset might be? This exercise will require some reading in relation to mood–performance relationships in sport or individual zones of optimal functioning.

4. A rowing coach wants to improve the training atmosphere for dry-land workouts. What advice might you offer the coach in order to assist them in optimizing the application of asynchronous music for their athletes?

5. Given the limited scope of research into post-task music to date, can you speculate as to what type of future research might be beneficial in terms of advancing this line of work?

6. A sprinter wants to use music as the auditory backdrop for precompetition imagery. Can you suggest a few suitable tracks and describe why you think they would be beneficial in this context?

7. Using Figure 23.8 (Factors Relevant to Optimal Music Selection in Sport), construct a brief playlist for yourself to be used in the precompetition stage or a playlist for an athlete/team of your choice.

8. Have a look at Table 23.1 (A Selection of Music Tracks for Recovery) and construct a similar playlist, either for yourself or for an athlete of your choice.

9. Select a sport-related workout of your choice (e.g., circuit training, HIIT, pyramid weights session) and construct a playlist—including the bpm of each track—in relation to the pretask, various in-task, and post-task phases. You might draw upon the examples in this chapter for inspiration.

Further Reading

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