Note: Snapshot PDF is the proof copy of corrections marked in EditGenie, the layout would be different from typeset PDF and EditGenie editing view.

Author Queries & Comments:

Q1 : The reference "Rejeski's, 1885" is cited in the text but is not listed in the references list. Please either delete the in- text citation or provide full reference details following journal style.

Response: We have change the year because it was incorrect.And we have to add the reference: Rejeski, W. J. (1985). Perceived exertion: an active or passive process?. Journal of Sport and Exercise Psychology, 7(4), 371-378.

Q2 : The disclosure statement has been inserted. Please correct if this is inaccurate.

Response: Resolved

Q3 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q4 : Please provide missing DOI, if available, for the "Bacon et al., 2012" references list entry. Please provide missing page range for reference "Bacon et al., 2012" references list entry.

Response: Resolved

Q5 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q6 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q7 : Please provide missing DOI, if available, for the "Buchheit, 2010" references list entry. Please provide missing page range for reference "Buchheit, 2010" references list entry.

Response: DOI is unavailable. The manuscript has 9 pages so page range theoretically should be: 278-286.

Q8 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q9 : Please provide missing DOI, if available, for the "Delextrat and Martinez, 2014" references list entry.

Response: Resolved

Q10 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q11 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q12 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q13 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q14 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q15 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q16 : Please provide missing volume number and issue number for reference "Jones et al., 2013" references list entry.

Response: Resolved

Q17 : Please provide missing DOI, if available, for the "Jones et al., 2013" references list entry. Please provide missing page range for reference "Jones et al., 2013" references list entry.

Response: Page range is unavailable

Q18 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q19 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q20 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q21 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q22 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q23 : Please provide missing issue number for reference "Sasaki et al., 2011" references list entry.

Response: Resolved

Q24 : Please provide missing DOI, if available, for the "Sasaki et al., 2011" references list entry. Please provide missing page range for reference "Sasaki et al., 2011" references list entry.

Response: Rage page is: 112-118. DOI is unavailable, so the link to the article is correct.

Q25 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

Q26 : The correct DOI has been replaced with the Cross-ref validation tool. Please check if this is appropriate.

Response: Resolved

High versus low motivating music on intermittent fitness and agility in young well-trained basketball players

INTERNATIONAL JOURNAL OF SPORT AND EXERCISE PSYCHOLOGY

C. BLASCO-LAFARGA ET AL.

Cristina Blasco-Lafarga[a,b], Borja Ricart[a,c], Ana Cordellat[a,b], Ainoa Roldán[a,b], Carlos Navarro-Roncal[a,d], Pablo Monteagudo[a,b,e]

[a] Sport Performance & Physical Fitness Research Group (UIRFIDE), University of Valencia, Valencia, Spain

[b] Physical Education and Sports Department, University of Valencia, Valencia, Spain

[c] Alquería LAB, Valencia Basket, Valencia, Spain

[d] Physical Education and Sports Service, University of Valencia, Valencia, Spain

[e] Education and Specific Didactics Department, Jaume I University, Castellón, Spain

CONTACT Cristina Blasco-Lafarga m.cristina.blasco@uv.es Sport Performance & Physical Fitness Research Group (UIRFIDE), University of Valencia, C/Gascó Oliag, 3, Valencia 46010, Spain; Borja Ricart borjaricart@hotmail.com Alquería LAB – Valencia Basket, Carrer del Bomber Ramon Duart, s/n, 46013 València, Spain

History : received : 2020-5-9 accepted : 2021-2-15

ABSTRACT

The present study aimed to analyse the influence of the music level of motivation, compared to the absence of music, on intermittent fitness and agility, in a group of young well-trained basketball players. On alternate days, thirteen players (14.85 ± 0.68 years, 188 ± 0.05 cm, 75.89 ± 8.02 kg) were assessed of the V-Cut test (agility test including changes of direction) and the 30–15 Intermittent Fitness Test ($30\text{-}15_{IFT}$; maximal running speed under fatigue). There were six testing sessions over three consecutive weeks, with three different randomized conditions: team-selected High Motivating Music (HMM), Low Motivating Music (LMM), and the No-Music condition (NM). Arterial oxygen saturation, Heart Rate, Lactate (BLa), Perceived Readiness, and the Rating of Perceived Effort of the session (RPE_{30}) were registered. As a main finding, HMM largely enhanced performance in the $30\text{-}15_{IFT}$ ($p < .01$) compared to LMM ($d = 1.39$) and NM ($d = 1.29$), with non-significant differences between them ($d = .35$). This resulted in a larger and significant estimated VO_2max ($p < .005$, different from LMM & NM), with a similar HR, a bit lower – although non-significant – BLa_{post}, and no psychophysical differences. Conversely, asynchronous music did not affect the V-Cut test, despite the reduction of time in HMM, followed by LMM. Motivational music confirmed helping well-trained developing

youngsters to display larger performances with similar internal responses (i.e., higher efficiency). Noteworthy, musical preferences were important even in a group approach (basketball). Very short and sub-maximal complex agility tasks, including changes of direction, like the V-Cut do not benefit from the influence of asynchronous music.

KEYWORDS

- Developmental stages
- fatigue
- psychophysiological responses
- V-cut agility test
- 30-15 Intermittent Fitness Test

Introduction

Psychological factors such as motivation, related to an enhanced capacity to act or engage in different achievement tasks (Eccles & Wigfield, 2002), are considered mediators on the physical, technical and tactical abilities of the athletes, affecting their performance in both, high elite (Abdullah et al., 2016) and youth (Mahamud et al., 2005; Weinberg & Gould, 2014). In the last two decades, it has increased the number of studies pointing out the big potential of listening to music in the field of motivation and sport, where any of the elements of music (melody, rhythm, harmony, cultural impact associations, etc.), or their combination, may account and provide positive effects in psychological, physiological, psychophysical and enhanced physical performance parameters (see Terry et al., 2020 for a review). In this context, examining the influence of listening to music before (pre-task) or during (in-task) physical fitness and sports, has raised considerable interest among researchers (Chtourou et al., 2015).

On the one hand, different psychological mechanisms underly the music influence on individuals' affective and emotional responses (Juslin & Sloboda, 2013). Pre-task music has shown to act as a sedative or as a stimulant depending on the functional changes in arousal (Karageorghis & Priest, 2012), whilst in-task music works as a distractor in exercisers reducing the perceptions of effort and fatigue (Hutchinson & Karageorghis, 2013; Terry et al., 2020). More recently, Hutchinson et al. (2018) has highlighted the psychological influence of self-selected music, with improvements on affect-regulated exercise intensity and remembered pleasure following exercise. Besides, music widens the range of emotions (Terry & Karageorghis, 2011), with beneficial changes in the sports players mood (Nikol et al., 2018; Terry & Karageorghis, 2011). *Motivational music*, defined as the music that stimulates or inspires physical activity, opposite to *demotivational music* or *neutral music* (Terry et al., 2020), is no doubt an important intrinsic motivation factor for sport performance (Loizou et al., 2014; Terry et al., 2020).

On the other hand, from a psychophysical perspective, music also helps to reduce or delete perceived exertion and physical pain (Edworthy & Waring, 2006; Karageorghis & Priest, 2012; Nethery, 2002), with the consequence of larger exertion capacity and enhanced work outputs (Karageorghis & Priest, 2012). Any of the previously cited elements of music may influence the neural drive and neural mechanisms of perceiving fatigue while making physical exercise, with the result of changes in heart rate and/or lactate production, skin conductance, neuroendocrine response or even immunological function (Terry et al., 2020). This contributes to motivate and increase sport performance (Terry et al., 2020). Moreover, music increases physiological efficiency (Bacon et al., 2012; Karageorghis & Priest, 2012) or even behaves as an ergogenic aid when distracting from the unpleasant sensations and fatigue above mentioned (Clark et al., 2018; Hutchinson et al., 2018). Therefore, music enhances physical performance and the motor patterns, with the consequence of increased strength, power and endurance, and/or improved work rate (see Terry et al., 2020 for a review).

Notwithstanding, when we delve into music and sport performance with regard to different type of efforts (Atan, 2013; Ballmann et al., 2019; Karageorghis et al., 2019), qualities of music [e.g., rhythms (Atan, 2013), genres (Ballmann et al., 2018; Ballmann et al., 2019)], or individuals' preferences (Nakamura et al., 2010), the studies give light to some particularities or even uncertainties. For instance, Atan (2013) found that nor slow (<80 bpm) nor fast (>120 bpm) music could enhance anaerobic performance, neither change the physiological response to supramaximal exercises (Anaerobic Sprint Test and Wingate anaerobic test). And very recently, Ballmann et al. (2019) found that listening to preferred music had no ergogenic benefit during repeated anaerobic cycling Wingate tests, despite it lowered the perceived exertion and increased the motivation to the exercise. These authors (Ballmann et al., 2019) concluded that the effect of music motivation on anaerobic efforts and power performance deserved further debate. Motivational music, thus, did not result in the improvement of anaerobic performance (Atan, 2013; Ballmann et al., 2019).

In this scenery, accounting that basketball is a sport where the maximal running speed is an important physical capacity, largely conditioned by maximal aerobic power, high anaerobic production and optimal recovery skills (Delextrat & Martinez, 2014; Morán, 2018), the present study aims to examine the influence of music on the intermittent fitness in well-trained young basketball players. More specifically, it analyses the influence of Highly Motivating Music (HMM) vs. Low Motivating Music (LMM), and the No-Music condition (NM), on the performance in the 30-15 Interval Fitness Test (30-15IFT; Buchheit, 2008, 2010). It also aims to analyse this influence in Agility, assessed by means of the V-Cut agility test (Gonzalo-Skok et al., 2015; Muñoz, 2018), because basketball players realise over 1050 movement per match, with the most repeated actions including diagonal accelerations, decelerations, reverses, turns and jumps (Ben Abdelkrim et al., 2007).

Whether team-selected motivational music exerts any influence on the maximal running speed and agility performance (i.e., 30-15_{IFT} and V-Cut test), and their physiological and psychophysical responses in youth well-trained basket players, is still a matter of study. We hypothesise that music will enhance performance in the 30-15_{IFT}, regardless of the levels of motivation of the selected playlist. As a second hypothesis, this higher performance will lead to larger psychophysiological responses in this fitness test.

Methods

Participants

Based on previous studies (Ballmann et al., 2018; Clark et al., 2018; Terry et al., 2020) effect size was set to .6, a moderate influence (Cohen, 1988) of music on performance outcomes. The power calculation for t-test (G*Power: 3.1.9.4) revealed a sample size of 20 subjects (alpha = .05; Power = .8), so 20 well-trained young players, were recruited from a high national and international level basketball club playing at ACB league; Euroleague Turkish Airlines. We looked for a homogeneous sample with regard to age and performance level. Inclusion criteria were to be U-16, at least one national championship participation and regular attendance throughout the season. As exclusion criteria, at risk of injury or having suffered it recently, and/or low values in the Recovery-Stress Questionnaire (RESTQ).

All the players and their legal guardians were provided and signed informed consent. They were also advised to keep their training and nutritional routines, and not to take any stimulant (Energy drink, Caffeine) along this study, which was approved by the Research in Humans Ethics Committee of the University of Valencia, Spain (H1553774899546). The study was conducted in the post-season, when they were still training, but there was no competition, so we ensured the weekend resting. Just in case, they were told not to exercise on the weekend.

Finally, 2 players were excluded on their testing days due to perceived risk of injury, so 18 well-trained young male basketball players participated in the testing procedures. The final sample comprised those 13 (14.85 ± .68 years, 188 ± .05 cm) whose outcomes (physiological, psychophysical and performance outputs) were complete trough the six testing sessions. Body composition and physical characteristics of these participants are summarised in Table 1.

Table 1. Descriptive data of the participants (*n* = 13).

Parameter	Value
Age (year)	14.85 ± 0.68
Height (m)	1.88 ± 0.05
Weight (kg)	75.89 ± 8.02
FM (%)	16.18 ± 3.22
30–15 IFT (km/h)	18.98 ± 0.68
V-Cut (s)	7.15 ± 0.39

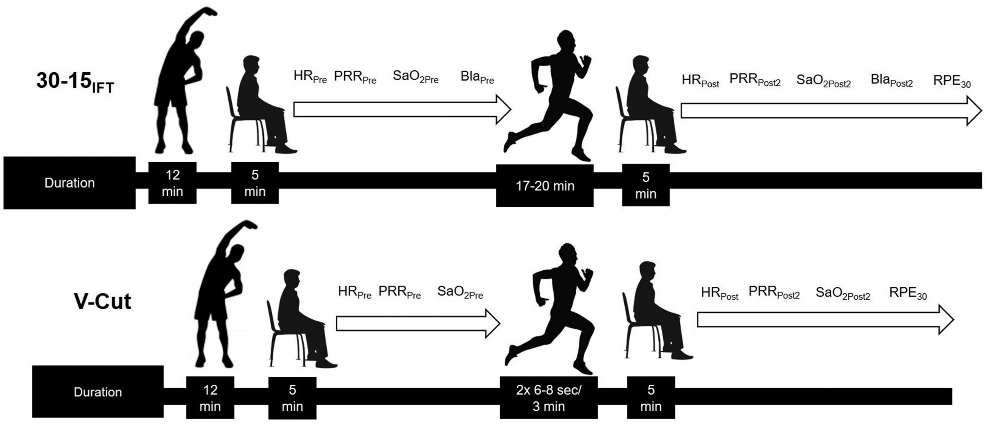
Notes: Data are presented as mean ± SD. Abbreviations: FM: fat mass.

Experimental procedures

To analyse the impact of music, all the players were assessed of the 30-15_{IFT} and the V-Cut test (maximal intermittent running velocity and specific agility respectively) along 3 consecutive weeks, in 6 different sessions. The neuromuscular V-Cut test was performed always on Monday, where players had 48 h rest before the testing session. The 30-15_{IFT} was played on Wednesdays. Importantly, the three music conditions were randomised, and the test was then conducted in the HMM, LMM and NM conditions, with players distributed in time slots (3–5 youngster per slot) to keep the team environment. Noteworthy, the tests were performed always in the same indoor court and with the same environmental conditions 22°.24°, keeping the same sport scientist in every assessment to ensure its reproducibility. The time slot for every group of players remained the same through the six testing conditions. Two weeks before the assessments there was the familiarisation process, although both tests were included in the sports skill battery of tests, and the players had previously performed them. The previous week, body composition and height (Tanita BC-601, Tokyo, Japan; Tallimeter SECA 222) were measured to characterise the sample.

Regarding the experimental protocol (Figure 1), before the test was started, each group of players was required to do an initial 12 min warm up which was exactly reproduced in all the testing sessions, conducted by the same trainer. This comprised: five minutes of runs and displacements, increasing in specificity and intensity – low to medium – (jogging with arms mobility, lateral runs and changes of direction, skipping and defensive movements); four minutes of dynamic stretches (psoas, quads, glutes, abductors, adductors, hamstrings and calves); and three more minutes for higher intensities and jumping tasks (changes of direction, jumps with two feet, jumps on one leg, and single-leg triple hops).

Figure 1. Experimental protocol.



Immediately after, the player rested seated in a chair for the next 5 min, and the pre-test samples of physiological and psychophysical variables were registered to further analyse the impact of music. Once exposed to each test, when it was over, the players went to the same chair from the second to the third minute, for the post-test samples. As shown in Figure 1, the experimental protocol and variables were slightly different in V-Cut test and 30-15_{IFT}.

Music selection and editing

Two weeks before the starting of the testing sessions, 40 tracks were extracted from the top 10 of 4 Spanish radio stations. Different genres (pop, rock, classical, electro, reggae, and trap) and tempos (from 71 to 149 bpm) were chosen by the researchers. Afterwards, all the players were invited to rank the tracks with regard to motivation.

The rank session was conducted in a close classroom in the club facilities, where all the players seated individually and in silence. As in Karageorghis et al. (2006), the participants listened to 90 s of excerpts of the 40 tracks, and were asked to assess individually the extent to which each piece of music would motivate them during a basketball practice, responding to each item of the Brunel Music Rating Inventory-3 (BMRI-3; Karageorghis & Priest, 2008). The audio files were reproduced with a loudspeaker after being standardised at 90Db using a decibel metre. Therefore, although they were group auditions, respectful with the basketball nature, the songs' ranking was individual, with 2 min interspersed between songs to evaluate them through this 1-to-7 Likert questionnaire.

The BMRI-3 (Karageorghis & Priest, 2008) is a tool designed to assess the motivational qualities of musical pieces which comprise six different items (rhythm, instruments, beat, style, melody, tempo), with a total possible score ranging from 6 to 42. Hence, it allowed us to get two track lists of 15 songs for 2 different music conditions, with the top 15 songs in the BMRI-3 ranking considered as Highly Motivating Music: and the 15 with lower punctuation as the Low Motivating Music. Songs 16th to 24th were discarded.

As an example of the track lists, the five tracks with the highest average motivational ratings were: *In My Feelings, Drake* (M = 41.21, SD = 2.43), *Levels, Avicii* (M = 40.56, SD = 4.36), *She Don't Give a FO, Duki* (M = 40.22, SD = 7.90), *Sweet but Psycho, Ava Max* (M = 39.89, SD = 15.30), *One Dance, Drake* (M = 39.72, SD = 12.42). Otherwise, the five tracks with the lowest average were: *Spanish Caravan, The Doors* (M = 6.00, SD = 1.02), *Stairway To Heaven, Led Zeppelin* (M = 6.78, SD = 9.43), *Nothing else matters, Metallica* (M = 7.94, SD = 18.22), *Una Mattina, Ludovico Einaudi* (M = 9.83, SD = 3.41), and *Like a Rolling Stone, Bob Dylan* (M = 10.50, SD = 12.20).

The 30-15 Intermittent Fitness Test and V-cut

As described by his author (Buchheit, 2008), the 30-15_{IFT} consists of 30 s shuttle runs with a 15 s of passive recovery, performed along the 40 m of the basketball court. Velocity starts at 8 km/h for the first 30s-run and increases by .5 km/h each stage. The test was governed by the prerecorded beep at appropriate intervals, which had been previously mixed with the HMM and the LMM playlists, depending on the stage/day and according to the previously randomised order. Each subject was required to complete as many rounds as possible, until he could no longer maintain the required running speed according to the audio signal (i.e., the maximal running speed or Intermittent Fitness Velocity – V_{IFT}-).

The V-Cut test consists of 4 changes of directions in a 5 × 5 m (45°) accelerations, with 25 m of total distance. It was performed twice, with a 3 min' rest. The best performance was chosen for analysis (Gonzalo-Skok et al., 2015), V-Cut times were recorded with photoelectric cells (Velleman PEM10D photocell, response time: 5–100 ms; Chronojump Bosco System, http://chronojump.org, Barcelona, Spain), and a complementary video camera (Casio EX-FH100; Casio) placed centred and transverse, opposite the test area. Kinovea video-analysis software version 0.8.7 (www.kinovea.org, Boston, USA) was used as a complementary tool for time measurements.

Psychophysical and physiological variables

Following the warm-up, arterial oxygen saturation ($SaO2_{pre}$) and Heart Rate (HR_{pre}) were determined with a pulsioximeter attached to the fourth finger of the left hand (WristOx2-3150; Nonin, Plymouth, MN, USA) (Mengelkoch et al., 1994), in a sitting position, jointly with Perceived readiness (PRR_{pre}) (Nurmekivi et al., 2001). A sample of capillary blood lactate (BLa) was also collected from the earlobe (Hildebrand et al., 2000) (Lactate Pro LT-1710 analyser; Arkray Inc, Kyoto, Japan), this last only in the 30-15_{IFT} sessions. As shown in Figure 1, all these variables were collected again 2 min after the tests (PRR_{post2}, HR_{post2}, and $SaO2_{post2}$; BLa_{post2} in the 30-15_{IFT}). In addition, the rating of perceived exertion of the session (RPE_{30}, Borg scale: 0 to >10), was considered to analyse the overall session fatigue 30 min after cessation.

In order to obtain the HR_{max} (maximum HR in the last 30 s of the test), only in the 30-15_{IFT}, continuous HR was registered by means of a Polar RS800CX (Polar Electro, Kempele, Finland) with the transmitter belt adjusted to the thorax after applying the conductive gel. VO_2max was also calculated for further analysis, since Buchheit (2010) stood that it could be estimated from the V_{IFT} according to the following formula:

$${\rm V}{\rm O}_2{\rm max}\,_{{\rm 30}\text{-}{\rm 15IFT}}({\rm ml}^{-1}\; {\rm min}\; {\rm kg}^{-1}) = 28.3 - 2.15G - 0.741A - 0.0357W + 0.0586A \times V_{{\rm IFT}} + 1.03V_{{\rm IFT}}$$

where G is the gender (1 for male, 2 for female); A is the age, in years; W is the weight, in kg and V_{IFT} is the last velocity (Speed) completed in the 30-15_{IFT}, in km/h.

Statistical analysis

The Statistical Package for the Social Sciences software (SPSS version 25.0, IBM, Armonk, NY, USA) was used for the analysis and treatment of the data. Descriptives were calculated and expressed as mean and standard deviation (mean ± SD). Due to the small sample size and after testing for normality (Shaphiro–Wilk normality test), the non-parametric Friedman repeated-measures test for more than two conditions, followed by Wilcoxon matched-pairs *post hoc* tests, were applied looking for differences with regard to music conditions (LMM, HMM and NM) and type of effort (30-15_{IFT} versus V-Cut). Finally, in order to homogenise and analyse these changes, the effect size (ES) was calculated by means of the Cohen's d, where the effect was considered trivial (d = 0–.0.19), small (d = .20–.49), medium (d = .50–.79) or large (d = .80–1.19) and very large (>1.2) (Cohen, 1988). Significance level was set at $p < .05$.

Results

Musical selection

According to the BMRI-3, Table 2 summarises the information about the songs used and discarded to set the sampling conditions.

Table 2. Descriptive data for the three music conditions (n = 50 songs).

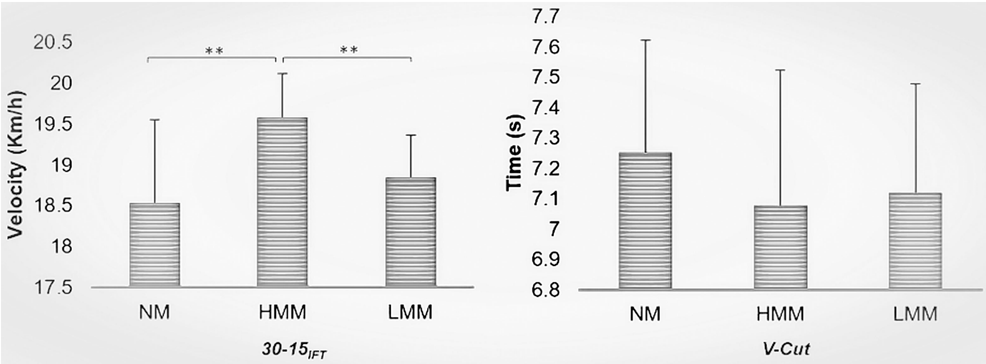
	BMRI-3 (Mean ± SD)	CV %	BPM (Mean ± SD)	CV %
HMM (n = 15)	37.67 ± 2.13	5.65	116.02 ± 17.30	14.73
LMM (n = 15)	12.66 ± 4.43	34.99	113.91 ± 30.68	24.98
DM (n = 10)	27.87 ± 4.11	14.74	110.34 ± 25.30	22.96

Notes: Data are presented as mean ± SD. *Abbreviations*: BMRI-3: Brunel music rating inventory-3; BPM: beats per minute; CV: coefficient of variation; DM: discarded music; HMM: highly motivating music; LMM: low motivating music.

Performance outcomes

As shown in Figure 2, HMM enhanced the performance in the 30-15$_{IFT}$ as compared to the other 2 conditions (p < .01). Given an alpha of .05 and a final sample of 13 subjects, the post hoc analysis revealed a power calculation >.99 (*1-B* error prob.) for HMM vs LMM, and HMM vs NM comparisons, both with large ES (d = 1.39 and 1.29 respectively). The statistical power dropped to .32 in the NM vs LMM comparison, which showed no significant differences with our sample size. ES was also lower (d = .35).

Figure 2. Paired comparison within the three music conditions for the 30–15 IFT and the V-Cut test Note: **p < .01. Abbreviations: HMM = highly motivating music; LMM = low motivating music: NM = no music condition.



Conversely, the reduced times for the HMM condition in the neuromuscular test (V-Cut), followed by LMM, as compared to the NM condition (Figure 2), were not significant at any comparison (p > .05). Statistical power and effect sizes diminished largely. In this order: .40, d = .42 in the HMM vs NM condition; .32, d = .36 in the LMM vs NM condition; and .01, d = .09 when comparing HMM with LMM in the V-Cut test.

Physiological outcomes

As shown in Table 3, the larger maximal running speed in the HMM condition during the 30-15$_{IFT}$ resulted in a larger and significant estimated VO_2max (p < .005 different from LMM & NM), and was followed by a bit lower – although non-significant – BLa_{post} (both considering the absolute and the Delta outcomes). BLa_{pre} outcomes were the highest following the warm-up in the HMM, but also the lowest two-min after the test cessation, resulting in this smallest Delta. Importantly, the 30-15$_{IFT}$ HR_{max} was always maximum (over 95% of the HR reserve), with no differences among music conditions. In addition, the oxygen saturation kept within the desaturation limits (>95%), and the young players were able to recover over 65 bpm in the first two-min in all the testing conditions.

Table 3. Psychophysiological descriptives (mean ± SD) for the V-Cut and the 30-15 IFT in the three music conditions (n = 13).

	HR_{Pre}	HR Max'	HR_{Post2}	VO_{2max}	SaO_2%	SaO_{2_Post2}%	BLa_{Pre}	BLa_{Post2}	BLa Δ
30-15 Intermittent Fitness Test									
NM	94.23 ± 18.09¥	199.53 ± 9.83	133.15 ± 18.54	47.68 ± 2.14*	96.92 ± 1.03	95.85 ± 1.06	2.34 ± 0.60	7.27 ± 2.06	4.93 ± 2.44
HMM	100.77 ± 14.21	199.16 ± 8.55	129.54 ± 12.08	49.64 ± 1.22	96.85 ± 0.60	95.38 ± 1.50	3.64 ± 2.04	6.74 ± 1.75	3.49 ± 2.42
LMM	100.85 ± 14.53	201.66 ± 6.95	129.38 ± 19.10	48.25 ± 1.23*	97.23 ± 0.72	95.92 ± 0.86	2.38 ± 0.78	7.21 ± 1.58	4.83 ± 1.82
Mean	*98.61 ± 15.61*	*200.11 ± 8.44*	*130.69 ± 16.57*	*48.25 ± 1.76*	*97.00 ± 0.78*	*95.71 ± 1.14*	*2.78 ± 1.14*	*7.07 ± 1.79*	*4.42 ± 2.22*
V-Cut Agility Test									
NM	93.15 ± 19.13	–	85.92 ± 12.97	–	96.85 ± 0.98	96.77 ± 0.9	–	–	–

HMM	99.85 ± 19.06	–	86.92 ± 14.37	–	97.31 ± 1.03	96.77 ± 1.01	–	–	–
LMM	104.46 ± 14.44	–	87.77 ± 12.56	–	97.00 ± 0.91	96.77 ± 0.72	–	–	–
Mean	*99.13 ± 17.54*		*86.87 ± 13.30*		*97.05 ± 0.97*	*96.77 ± 0.87*			

¥ *p* < .05 different from LMM; * *p* < .005 different from HMM. *Abbreviations*: BLa: blood lactate; HR: heart rate; Pre: previous to the test; $Post^{2'}$: measured 2 min after the test cessation; SaO_2: oxygen arterial saturation; HMM: highly motivating music; LMM: low motivating music; Max: maximal score in the 30 final seconds of the $30\text{-}15_{IFT}$; NM: no music.

With regard to the V-Cut, and now equal to the performance variables, there were no significant differences whatever the sampling condition.

Psychophysical outcomes

Following a similar trend to BLa, there were no significant differences RPE_{30} (Table 4) in the $30\text{-}15_{IFT}$. Besides, PRR values in the $30\text{-}15_{IFT}$ were between 2 and 3, whilst in the neuromuscular V-Cut test, PRR was about 4. With regard to this latter, there were no significant differences when the V-Cut was performed whatever the sampling condition. Noteworthy, the RPE_{30} in the LMM condition showed significant differences (lower RPE_{30}) compared to HMM and NM.

Table 4. Psychophysical descriptives (mean ± SD) for the V-Cut and the 30–15 IFT in the three music conditions (*n* = 13).

	PRR_{Pre}	PRR_{Post2}	RPE_3	RPE_{30}
	30–15 Intermittent Fitness Test			
NM	4.11 ± 0.46	2.80 ± 0.77	6.85 ± 1.63	3.85 ± 0.31
HMM	4.15 ± 0.42	3.03 ± 0.66	6.69 ± 1.55	3.23 ± 0.24
LMM	4.11 ± 0.46	3.03 ± 0.77	6.62 ± 1.90	3.38 ± 0.24
Mean	*4.12 ± 0.44*	*2.95 ± 0.73*	*6.72 ± 1.65*	*3.49 ± 1.02*
	V-Cut agility test			
NM	4.42 ± 0.44	4.69 ± 0.48	2.77 ± 1.83	2.23 ± 0.32¥¥
HMM	4.23 ± 0.48	4.65 ± 0.42	2.46 ± 1.05	1.54 ± 0.35¥
LMM	4.42 ± 0.44	4.73 ± 0.91	1.54 ± 0.88	0.77 ± 0.28
Mean	*4.35 ± 0.45*	*4.69 ± 0.60*	*2.25 ± 1.39*	*1.51 ± 1.27*

¥ *p* < .01; ¥ ¥*p* < .001 different from LMM. *Abbreviations*: Pre = previous to the test; $Post^{2'}$ = measured 2 min after the test cessation; PRR = perceived readiness ratings; RPE_{30} = rate of perceived exertion of the session, 30 min after the test. HMM = highly motivating music; LMM = low motivating music; NM = no music.

Discussion

Boosted by individuals' believes, expectancies, values and goals (Eccles & Wigfield, 2002), motivation arises as an important strategy to improve the athletes' performance in almost any age and sport discipline. However, little research focuses on the influence of music motivation in the sport developmental stages, and studies remain inconclusive concerning the influence of self-selected motivational music in the domain of anaerobic sport performance. Up to our knowledge, this is the first study to compare the influence of highly motivating music vs. low motivating music, and the absence of music, on intermittent fitness and specific agility in a group of well-trained young basketball players. This is also the first study in analysing the physiological and psychophysical responses associated to this influence in U-16 categories.

As a main finding, HMM, compared to LMM and NM, helped to improved performance in the $30\text{-}15_{IFT}$, a physiological context largely conditioned by maximal aerobic power, high anaerobic capacities, agility and optimal recovery skills (Stork et al., 2019), all of them determinants of basketball. Conversely, LMM did not influenced the performance; nor the enhanced performance in the HMM condition was associated to larger psychophysiological responses, partially contradicting our initial hypotheses. As a second finding, music did not exert any influence in the very short, perceptual, and explosive V-Cut agility test. Our young players benefited from music only in the 30-15$_{IFT}$ HMM condition, confirming that motivating music is effective to improve performance when high levels of fatigue are given, also in mixed aerobic–anaerobic maximal intermittent efforts. As previously suggested (Dyrlund & Wininger, 2008), music preferences mediate this effect, even when the motivational team-selected playlist results from the higher scores after an individual voting.

On the one hand, the 30-15$_{IFT}$ is widely spread in Basketball training and testing (Jeličić et al., 2020). According to his author (Buchheit, 2008; Buchheit et al., 2011), the 30-15$_{IFT}$ structure (i.e., the interspersed recovery periods) allows the players to performed largely over the maximal aerobic speed and the VO$_2$max intensities – 10–20% over – (Buchheit, 2008; Buchheit & Laursen, 2013). In addition, the 30s periods of exercise in the 30-15$_{IFT}$ are close to the cardiorespiratory response times at the beginning of exercise, and the 15s of recovery interspersed provide sufficient but incomplete recovery of energy substrates, as during intermittent games, matching basketball requirements (Buchheit, 2008; Jeličić et al., 2020). We assume that motivating music confirms to be a powerful and useful tool for coaches and physical fitness professionals in basketball, when the players need supplementary resources in long-lasting, mixed aerobic–anerobic intermittent extenuating efforts.

Our results are aligned with previous studies pointing that motiving music can act like a distracting element from fatigue and discomfort (Hutchinson et al., 2018; Hutchinson & Karageorghis, 2013). According to the many benefits of music in the field of sport performance – summarised by Terry et al. (2020) –, we could argue that the tempo of the music and the motor patterns coupled, and even synchronised with their physiological responses to increase the performance. This rhythmic entrainment, – the so-called auditory-motor synchronization –, including the breathing rate and heart beating coordination –, would resulted in increased efficiency/decreased needs of neural drive (Terry et al., 2020). Notwithstanding, the 30-15$_{IFT}$ is a graded test increasing in intensity from slow (8 km/h) to high velocities (18–20 km/h in our study); and the music was pre-recorded and changed equally for all the players throughout the warm-up and the test. Also, of importance, the mean of the music tempo was not so high since 120 b~~m~~pm is the borderline between fast and moderate tempos (Clark et al., 2018; Karageorghis et al., 2011).

Therefore, although the synchronisation between music and the motor tasks underpins this higher performance for a similar physiological exertion, allowing the activity to be more efficient (Nikol et al., 2018), the HMM in our study more likely reduced the physiological feedback signals related to this physical exertion, the consequence of the limited channel capacity of our afferents (Terry et al., 2020). This might distract from fatigue. Moreover, despite during high intensity – in the last stages of the test – there might be a narrowing of the attention and the distracting capacity could be not enough to cope with large fatigue (Clark et al., 2018; Dyrlund & Wininger, 2008; Terry & Karageorghis, 2011), we can induce that the youngsters in our sample had already experienced previous histories of music motivation and success. feeling engaged and confident with increasing their performance in this challenging situation. This is another benefit of music in sports (Hutchinson & Karageorghis, 2013; Terry et al., 2020) and represents a psychological effect related to the motivational qualities of music per se (Stork et al., 2019).

On the other hand, the results of the 30-15$_{IFT}$ point to a very well-trained group of young basketball players, with high mean maximal running speed and high VO$_2$max outcomes, close to other young, but a bit older, team-sports athletes (Buchheit, 2008; Buchheit et al., 2011). It may also account that lactate collection was before the 3 min (i.e., 2 min post-exercise, to make it coincide with the registers of the perception of readiness). The average of lactate at the end of the 30-15$_{IFT}$, with no differences between sampling conditions (HMM, LMM and NM), was lower than the cited studies (Buchheit, 2008; Buchheit et al., 2011) but importantly, their young samples had already developed the glycolic metabolic pathway (Blasco-Lafarga et al., 2017). It has been already shown that young athletes had worsen anaerobic/better aerobic capacities compared to their adult pairs (Blasco-Lafarga et al., 2017). In addition, the better the VO2max, the better the lactate removal capacity in team sports (Jones et al., 2013), so our young basketball players might have recovered faster than less trained athletes, reaching higher performances with less anaerobic resources. The final lactate scores would be a combination of less production/more remotion in these well-trained youngsters. Finally, accounting for the possibility of impaired autonomic resources at the post season, HMM was able to compensate this reduction and help the maximum exertion. The no-differences in any psychophysical and physiological responses despite the significant changes in the maximal running speed are indeed an improvement in efficiency.

With regard to the impact of music on the specific and anaerobic agility V-Cut test, we found no influence, although music has previously shown to improve the jump and/or the sprint under motivating conditions (Arazi et al., 2017; Eliakim et al., 2013). Nor the distracting effect on the perception of discomfort and fatigue, nor the increased neural drive previously associated with music, ought to benefit the approximately seven seconds of this complex task. This points to a short, perceptual, and not maximal effort. The success in the acceleration–deceleration alternance in the 5-m changes of direction implies perception, anticipation and decision making, together with a good core stability, as in most of the agility tests. In fact, the V-Cut test is largely conditioned by knee stability (Gonzalo-Skok et al., 2015), core and muscle coordination – successive acceleration and deceleration patterns – (Sasaki et al., 2011), more than by power or by the rate of force development.

The benefits from the auditory-motor synchronisation in complex tasks (i.e., agility) might be more difficult because the motor patterns are highly specialised and might need an equally specific music. The motivational songs were not selected for a particular aim in our study, limiting its possible benefits (Dyrlund & Wininger, 2008) in agility. In addition, agility includes a lot of mixed internal/external stimuli to pay attention, so the distracting effect may be more diluted, according to the limitations of the information processing theory (Dyrlund & Wininger, 2008). In this context, the parallel processing conceptualisation reinforces this limitation of information processing at a time when the internal and external sources compete (Rejeski~~'s~~, 19~~8~~85 **[Q1]**; in Dyrlund & Wininger, 2008), likely preventing from the music positive influence. This absence of influence may also be related to the absence of external rewards or the need to do their very best in the testing condition, with no feelings of pressure in our experimental design according to previous literature (Eccles & Wigfield, 2002; Newland et al., 2013).

Therefore, it is possible that we need to focus on understanding which qualities of sound account to obtain the better performance: for instance, a specific music to increase performance in an agility task (V-Cut in our study), or motivational well-known songs to cope fatigue ($30\text{-}15_{IFT}$ in our study). Karageorghis et al. (2011) suggested paying attention both to primary qualities such as melody and harmony, and to secondary or extra-musical factors such as gender, experiences, or individual preferences. In fact, these authors include the cultural impact associations of music as one of its qualities, as previously mentioned. In this sense, sport people must be considered a particular population, because experienced athletes, despite being in the developing stages, may have already developed their own performing rhythm (with and/or without music) at different levels of exertion and contextual demands (Guillén & Ruiz-Alfonso, 2015).

It is noteworthy that similar to what happens when fans sing collectively and applaud inside the stadium, music can influence the achievement of the team's victory on the playing field (Bray & Widmeyer, 2000), and the intensity and effort while playing, also in a very young sample. For this reason, keeping in mind that the motivating factor is lost when it becomes routine (Urcola, 2008), it is vital to calculate the right moment and use this resource only when it is really necessary to motivate the athletes/team, especially in the young ages. Our study confirms that music can help to improve sport performance, but more than performance, the psychophysiological benefits from a healthy practice should be crucial in the first years of the sport training. So, motivation through music is an important issue for the overall psychological health of the sport people, especially when talking about young people, but we should not abuse of this positive effect to protect from hyperarousal and the early burnout associated to the overwhelming use of highly demanding efforts in youth.

To conclude, although the current study has several strengths, it is not without limitations. Field studies are close to the real game context, but in turn, there are different threats as external elements that can influence the outcomes. Indeed, 18 players started the study, but only 13 completed the whole protocol since some of them were still overloaded, and besides, it coincided with the final exam period at the high school. (Eighteen players of the same age is a large number for a basketball club). In addition, mental fatigue due to this academic load might also influence the result. On the other hand, larger sample sizes (> 40 or~~,~~ 50 subjects) would have been needed to further understand the de impact of motivating music on the V-Cut test, because of their lower effect sizes. Similarly, on psychophysiological responses.

However, it is not so easy to get that number of such good well-trained young players and fit them in a short-time randomised experimental design. Prevention from injuries and overload is important when working with formation players, so we disclaimed some tests along the study. Moreover, we decided to provide the music through loudspeakers and do group testing (always 3–5 players together) to keep the natural conditions of the basketball, what may have influenced the results. Of outstanding importance, once randomised the music conditions, we kept them constant for all the players to ensure that they were blind about the aim of the study. Since the whole intervention occurred in their club, with many teams playing in consecutive courts, any change in the environment (differences in music, or silence) between timeslots in the same testing session might have given clues and contaminate the study. That is why we rather reproduced the same testing conditions along the whole day.

Conclusions

Summarising, highly motivating music confirms to be a good strategy when individuals need to face large psychophysiological fatigue, helping to display larger performances with similar internal responses. The distracting effect from fatigue and discomfort related to listening music may increase the higher the quality of the selected play list (i.e., higher rate of motivation), leading well-trained players to reach larger sport performances (i.e., maximal running speeds). Noteworthy, musical preferences are important even in a groupal approach (basketball) since low motivating music failed to enhance the performance. Moreover, short and sub-maximal complex agility tasks did neither benefit from Music influence.

Acknowledgments

The authors would like to thank all the players and technicians from the Alquería LAB – Valencia Basket Club who have helped to develop the present study.

Disclosure statement

No potential conflict of interest was reported by the author(s[Q2]).

ORCID

Cristina Blasco-Lafarga http://orcid.org/0000-0001-8798-306X

Ainoa Roldán http://orcid.org/0000-0001-7190-7943

References

Abdullah, M. R., Musa, R. M., Maliki, A. B. H. M. B., Kosni, N. A., & Suppiah, P. K. (2016). Role of psychological factors on the performance of elite soccer players. *Journal of Physical Education and Sport*, *16*(1), 7. https://doi.org/10.7752/jpes.2016.01027

Arazi, H., Ghanbari, E., Zarabi, L., & Rafati, F. (2017). The effect of fast, light and favorite music on physiological function and physical performance of the male athlete students. *Central European Journal of Sport Sciences and Medicine*, *17*, 33–40. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.psjd-28731f7a-f505-4132-97b9-1023996ed7ec https://doi.org/10.18276/cej.2017.1-04

Atan, T. (2013). Effect of music on anaerobic exercise performance. *Biology of Sport*, *30*(1), 35–39. https://doi.org/10.5604/20831862.1029819[Q3]

Bacon, C., Myers, T., & Karageorghis, C. I. (2012). Effect of music-movement synchrony on exercise oxygen consumption. *Journal of Sports Medicine and Physical Fitness*, *52*(4), 359-365. https://www.researchgate.net/profile/Catherine_Bacon2/publication/230564762_Effect_of_music-movement_synchrony_on_exercise_oxygen_consumption/links/56df3cb808aee77a15fcf7b0.pdf[Q4]

Ballmann, C. G., Maynard, D. J., Lafoon, Z. N., Marshall, M. R., Williams, T. D., & Rogers, R. R. (2019). Effects of listening to preferred versus non-preferred music on repeated Wingate anaerobic test performance. *Sports*, *7*(8), 185. https://doi.org/10.3390/sports7080185

Ballmann, C. G., McCullum, M. J., Rogers, R. R., Marshall, M. M., & Williams, T. D. (2018). Effects of preferred vs. nonpreferred music on resistance exercise performance. *Journal of Strength and Conditioning Research*. https://doi.org/10.1519/JSC.0000000000002981

Ben Abdelkrim N., El Fazaa S., El Ati J., Tabka Z. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition * commentary. *British Journal of Sports Medicine*, *41*(2), 69–75. https://doi.org/10.1136/bjsm.2006.032318[Q5]

Blasco-Lafarga, C., Camarena, B., & Mateo-March, M. (2017). Cardiovascular and autonomic responses to a maximal exercise test in elite youngsters. *International Journal of Sports Medicine*, *38*(09|9), 666–674. https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0043-110680 https://doi.org/10.1055/s-0043-110680

Bray, S. R., & Widmeyer, W. N. (2000). Athletes' perceptions of the home advantage: An investigation of perceived causal factors. *Journal of Sport Behavior*, *23*, 1. https://search.proquest.com/docview/215885334?pq-origsite=gscholar

Buchheit, M. (2008). The 30-15 intermittent fitness test: Accuracy for individualizing interval training of young intermittent sport players. *Journal of Strength and Conditioning Research*, *22*(2), 365–374. https://doi.org/10.1519/JSC.0b013e3181635b2e[Q6]

Buchheit, M. (2010). The 30–15 intermittent fitness test: 10 year review. *Myorobie J*, *1*(9), 278-286.[Q7]

Buchheit, M., & Laursen, P. B. (2013). High-intensity interval training, solutions to the programming puzzle. *Sports Medicine*, *43*(10), 927–954. https://search.proquest.com/docview/1494739358?accountid=14777 https://doi.org/10.1007/s40279-013-0066-5

Buchheit, M., Lefebvre, B., Laursen, P. B., & Ahmaidi, S. (2011). Reliability, usefulness, and validity of the 30–15 intermittent ice test in young elite ice hockey players. *Journal of Strength and Conditioning Research*, *25*(5), 1457–1464. https://doi.org/10.1519/JSC.0b013e3181d686b7[Q8]

Chtourou, H., Briki, W., Aloui, A., Driss, T., Souissi, N., & Chaouachi, A. (2015). Relation entre musique et performance sportive : Vers une perspective complexe et dynamique. *Science & Sports*, *30*(3), 119–125. https://doi.org/10.1016/j.scispo.2014.11.002

Clark, J. C., Baghurst, T., & Redus, B. S. (2018). Self-selected motivational music on the performance and perceived exertion of runners. *Journal of Strength and Conditioning Research*, https://doi.org/10.1519/JSC.0000000000002984

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Routledge.

Delextrat, A., & Martinez, A. (2014). Small-sided game training improves aerobic capacity and technical skills in basketball players. *International Journal of Sports Medicine*, *35*, 385–391. https://doi.org/10.1055/s-0033-1349107**[Q9]**

Dyrlund, A. K., & Wininger, S. R. (2008). The effects of music preference and exercise intensity on psychological variables. *Journal of Music Therapy*, *45*(2), 114–134. https://doi.org/10.1093/jmt/45.2.114

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*(1), 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153**[Q10]**

Edworthy, J., & Waring, H. (2006). The effects of music tempo and loudness level on treadmill exercise. *Ergonomics*, *49*(15), 1597–1610. https://doi.org/10.1080/00140130600899104**[Q11]**

Eliakim, M., Meckel, Y., Gotlieb, R., Nemet, D., & Eliakim, A. (2013). Motivational music and repeated sprint ability in junior basketball players. *Acta Kinesiologiae Universitatis Tartuensis*, *18*, 29–38. https://doi.org/10.12697/akut.2012.18.04**[Q12]**

Gonzalo-Skok, O., Tous-Fajardo, J., Suarez-Arrones, L., Arjol-Serrano, J., Casajus, J., & Mendez-Villanueva, A. (2015). Validity of the V-cut test for young basketball players. *International Journal of Sports Medicine*, *36*(11), 893–899. https://doi.org/10.1055/s-0035-1554635

Guillén, F., & Ruiz-Alfonso, Z. (2015). Influencia de la música en el rendimiento físico, esfuerzo percibido y motivación/influence of music on physical performance, perceived exertion and motivation. *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte*, *60*(7), 701–717. https://doi.org/10.15366/rimcafd2015.60.006

Hildebrand, A., Lormes, W., Emmert, J., Liu, Y., Lehmann, M., & Steinacker, J. M. (2000). Lactate concentration in plasma and Red blood CellsDuring incremental exercise. *International Journal of Sports Medicine*, *21*(7), 463–468. https://www.thieme-connect.com/products/ejournals/html/10.1055/s-2000-7412 https://doi.org/10.1055/s-2000-7412

Hutchinson, J. C., Jones, L., Vitti, S. N., Moore, A., Dalton, P. C., & O'Neil, B. J. (2018). The influence of self-selected music on affect-regulated exercise intensity and remembered pleasure during treadmill running. *Sport, Exercise, and Performance Psychology*, *7*(1), 80–92. https://doi.org/10.1037/spy0000115**[Q13]**

Hutchinson, J. C., & Karageorghis, C. I. (2013). Moderating influence of dominant attentional style and exercise intensity on responses to asynchronous music. *Journal of Sport and Exercise Psychology*, *35*(6), 625–643. https://doi.org/10.1123/jsep.35.6.625 **[Q14]**

Jeličić, M., Ivančev, V., Čular, D., Čović, N., Stojanović, E., Scanlan, A. T., & Milanović, Z. (2020). The 30-15 intermittent fitness test: A reliable, valid, and useful tool to assess aerobic capacity in female basketball players. *Research Quarterly for Exercise and Sport*, *91*(1), 83–91. https://doi.org/10.1080/02701367.2019.1648743**[Q15]**

Jones, R. M., Cook, C. C., Kilduff, L. P., Milanović, Z., James, N., Sporiš, G., Fiorentini, B., Fiorentini, F., Turner, A., & Vučković, G. (2013). Relationship between repeated sprint ability and aerobic capacity in professional soccer players. *The Scientific World Journal, 2013*(1), https://doi.org/10.1155/2013/952350.**[Q16][Q17]**

Juslin, P. N., & Sloboda, J. A. (2013). *Music and emotion: On The psychology of music, 3rd ed*. Elsevier Academic Press.

Karageorghis, C. I., Hutchinson, J. C., Bigliassi, M., Watson, M. P., Perry, F. A., Burges, L. D., Melville-Griffiths, T., & Gomes-Baho, T. J. (2019). Effects of auditory-motor synchronization on 400-m sprint performance: An applied study. *International Journal of Sports Science & Coaching*, *14*(6), 738–748. https://doi.org/10.1177/1747954119879359**[Q18]**

Karageorghis, C. I., Jones, L., Priest, D.-L., Akers, R. I., Clarke, A., Perry, J. M., Reddick, B. T., Bishop, D. T., & Lim, H. B. (2011a). Revisiting the relationship between exercise heart rate and music tempo preference. *Research Quarterly for Exercise and Sport*, *82*(2), 274–284. https://doi.org/10.1080/02701367.2011.10599755

Karageorghis, C. I., & Priest, D.-L. (2008). Music in sport and exercise: An update on research and application. *The Sport Journal*, *11*, 3. https://go.gale.com/ps/anonymous?id=GALE%7CA210521313&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=15439518&*p*=HRCA&sw=w

Karageorghis, C. I., & Priest, D.-L. (2012). Music in the exercise domain: A review and synthesis (part I). *International Review of Sport and Exercise Psychology*, *5*(1), 44–66. https://doi.org/10.1080/1750984X.2011.631026**[Q19]**

Karageorghis, C. I., Priest, D.-L., Terry, P. C., Chatzisarantis, N. L., & Lane, A. M. (2006). Redesign and initial validation of an instrument to assess the motivational qualities of music in exercise: The Brunel Music Rating inventory-2. *Journal of Sports Sciences*, *24*(8), 899–909. https://doi.org/10.1080/02640410500298107

Karageorghis, C. I., Terry, P. C., Lane, A. M., Bishop, D. T., & Priest, D.-L. (2011b). The bases expert statement on the use of music in exercise. *The Sport Exercise Scientist*, 18–19. http://eprints.usq.edu.au/id/eprint/19207

Loizou, G., Karageorghis, C. I., & Bishop, D. T. (2014). Interactive effects of video, priming, and music on emotions and the needs underlying intrinsic motivation. *Psychology of Sport and Exercise*, *15*(6), 611–619. https://doi.org/10.1016/j.psychsport.2014.06.009

Mahamud, J., Tuero, C., & Márquez, S. (2005). Características psicológicas relacionadas con el rendimiento: comparación entre los requerimientos de los entrenadores y la percepción de los deportistas. *Revista de Psicología del Deporte*, *14*(2), 237–251. https://www.redalyc.org/pdf/2351/235119230004.pdf

Mengelkoch, L. J., Martin, D., & Lawler, J. (1994). A review of the principles of pulse oximetry and accuracy of pulse oximeter estimates during exercise. *Physical Therapy*, *74*(1), 40–49. https://doi.org/10.1093/ptj/74.1.40**[Q20]**

Morán, D. (2018). *Valoración de la condición física en el equipo de baloncesto femenino de la Universidad de León*. University of Leon. https://buleria.unileon.es/bitstream/handle/10612/7735/MOR%c3%81N%20DIONISIO_DAVID_JULIO_2017.pdf?sequence=1&isAllowed=y

Muñoz, C. (2018). *Efectos del entrenamiento de fuerza utilizando métodos inerciales y pesos libres en un equipo de baloncesto profesional*. Institut Nacional d'Educació Física de Catalunya (INEFC)]. http://hdl.handle.net/10459.1/64767

Nakamura, P. M., Pereira, G., Papini, C. B., Nakamura, F. Y., & Kokubun, E. (2010). Effects of preferred and nonpreferred music on continuous cycling exercise performance. *Perceptual and Motor Skills*, *110*(1), 257–264. https://doi.org/10.2466/pms.110.1.257-264

Nethery, V. (2002). Competition between internal and external sources of information during exercise: Influence on RPE and the impact of the exercise load. *Journal of Sports Medicine and Physical Fitness*, *42*(2), 172. https://search.proquest.com/docview/202683164?accountid=14777

Newland, A., Newton, M., Finch, L., Harbke, C. R., & Podlog, L. (2013). Moderating variables in the relationship between mental toughness and performance in basketball. *Journal of Sport and Health Science*, *2*(3), 184–192. https://doi.org/10.1016/j.jshs.2012.09.002

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**[Q21]**

Nurmekivi, A., Pihl, E., Jürimäe, T., Karu, T., & Lemberg, H. (2001). Blood lactate recovery and perceived readiness to start a new run in middle-distance runners during interval training. *Perceptual and Motor Skills*, *93*(6), 397–404. https://doi.org/10.2466/pms.2001.93.2.397**[Q22]**

Sasaki, S., Nagano, Y., Kaneko, S., Sakurai, T., & Fukubayashi, T. (2011). The relationship between performance and trunk movement during change of direction. *Journal of Sports Science and Medicine*, *10(1)*, 112-118. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3737904/**[Q23][Q24]**

Stork, M. J., Karageorghis, C. I., & Ginis, K. A. M. (2019). Let's go: Psychological, psychophysical, and physiological effects of music during sprint interval exercise. *Psychology of Sport and Exercise*, *45*, 101547. https://doi.org/10.1016/j.psychsport.2019.101547 **[Q25]**

Terry, P. C., & Karageorghis, C. I. (2011). Music in sport and exercise. In **T. Morris & P. C. Terry** (Eds.), *The new sport and exercise psychology companion* (pp. 359–380). Fitness Information Technology.

Terry, P. C., Karageorghis, C. I., Curran, M. L., Martin, O. V., & Parsons-Smith, R. L. (2020). Effects of music in exercise and sport: A meta-analytic review. *Psychological Bulletin*, *146*(2), 91–117. https://doi.org/10.1037/bul0000216**[Q26]**

Urcola, J. L. (2008). *La motivación empieza en uno mismo: Aspectos básicos para motivar a los demás y motivarse a sí mismo*. ESIC Editorial.

Weinberg, R. S., & Gould, D. S. (2014). *Foundations of sport and exercise psychology*. Human Kinetics.