



# Effect of listening to music on repeated-sprint performance and affective load in young male and female soccer players

Mohamed Tounsi<sup>1</sup> · Hamdi Jaafar<sup>2,3</sup> · Asma Aloui<sup>4</sup> · Zouhair Tabka<sup>1</sup> · Yassine Trabelsi<sup>1</sup>

Received: 12 July 2018 / Accepted: 27 November 2018 / Published online: 2 January 2019  
© Springer-Verlag Italia S.r.l., part of Springer Nature 2019

## Abstract

**Purpose** The aim of the current study was to compare the effect of listening to music during warming-up on repeated-sprint performance and affective load in young male and female soccer players.

**Methods** 33 Tunisian highly trained soccer players [19 men (age:  $17 \pm 0.3$  years, BMI:  $21.9 \pm 1.4$  kg m<sup>-2</sup>) and 14 women (age:  $17 \pm 0.2$  years, BMI:  $21.3 \pm 3.5$  kg m<sup>-2</sup>)] took part in two experimental sessions with or without listening to music during warming-up. High-tempo music (> 130–140 bpm) was chosen. The players then performed a repeated-sprint test (six 40-m sprints with 180° direction change interspersed with a 20-s passive recovery period). Best and mean sprint times, performance decrement, as well as affective load scores were measured.

**Results** The analysis of variance for repeated measures revealed a significant improvement in best and mean time only in females ( $P < 0.05$ ). Moreover, no significant effect of music was observed on performance decrement and affective load in both males and females (all  $P > 0.05$ ).

**Conclusions** Female academy soccer players seemed to derive the greatest benefit from motivational music during repeated-sprint exercise compared to their male counterparts.

**Keywords** Performance · Motivation · Sex

## Introduction

Total energy expenditure during exercise is managed by a pacing strategy (i.e., the manner in which an athlete distributes work and energy throughout exercise) ensuring that the exercise bout is completed maximally [1, 2]. According to the central governor model [1], this pacing strategy is thought to be controlled by the brain and primarily selected according to internal information (e.g., from peripheral physiological systems) [1, 3]. However, it has

been demonstrated that external information such as prior knowledge of sprint number [4] as well as auditory (e.g., music) [5, 6] and visual (e.g., picture) [7, 8] sensory information may have a crucial role in determining this pacing strategy during high-intensity exercises.

Likewise, pre-task motivational music may have a strong effect on pacing during high-intensity exercises [5, 6, 9]. According to Karageorghis et al. [10], the high motivational components of music would presumably enhance the subject's motivational level to produce a high level of motor output. Of note, the literature revealed controversial results regarding the effect of pre-task motivational music on performance during short-term high-intensity exercises. Indeed, some authors reported that motivational music enhanced the ability to produce mechanical power output [5, 11]. For instance, the power output during the Wingate test was higher after music-warm-up condition compared to no-music condition in physical education students [5], elite adolescent volleyball players [6], young male sprinters [12, 13], and well-trained athletes [14]. However, other studies showed no beneficial outcomes of music warm-up on sport performance [15–18]. In these previous studies,

✉ Mohamed Tounsi  
m.tounsi@hotmail.fr

<sup>1</sup> Department of Physiology and Lung Function Testing, Faculty of Medicine Ibn-El-Jazzar, University of Sousse, Sousse, Tunisia

<sup>2</sup> Institut du Savoir Montfort-Recherche, Ottawa, Canada

<sup>3</sup> Faculty of Medicine, Biochemistry, Microbiology and Immunology Department, University of Ottawa, Ottawa, Canada

<sup>4</sup> High Institute of Sport and Physical Education, University of Gafsa, Gafsa, Tunisia

authors have used laboratory tests to explore the effects of music on sprint performance in participants with different physical fitness levels (i.e., trained versus untrained).

On the other side, both men and women did not react similarly to emotional stimuli [19]. In fact, some reports have examined the effect of external stimuli in both sexes upon various human systems such as skin conductance [20], heart rate [21], reflex modulation, and facial electromyographic activity [22]. The literature revealed that women are more emotionally perceptive and experiencing emotions with greater frequency and intensity compared to their male counterparts [23, 24]. These findings support the hypothesis that the effect of motivational music on sprint performance may differ between sexes.

Furthermore, it has been shown that male and female soccer players are comparable in physiological, metabolic, and anthropometric characteristics [25], although the lack of information regarding the level of technical ability and physical fitness. Recently, it has been observed that speed dribbling without and with ball was better in male than female soccer players [26]. Moreover, intermittent sprinting and multi-directional changing actions have been shown to be frequent in elite soccer games [27]. Nevertheless, the effect of listening to music during warming-up on repeated-sprint performance as well as affective responses in male and female athletes remains unclear. Thus, this study aimed to compare repeated-sprint exercise performance between young trained male and female soccer players after listening to motivational music during warming-up. We hypothesize that women would derive the greatest benefit from motivational music during repeated-sprint exercise compared to their male counterparts.

## Materials and methods

33 young elite soccer players volunteered to participate in this study: 19 men (age:  $17 \pm 0.3$  years, body mass index:  $21.9 \pm 1.4$  kg m<sup>-2</sup>) and 14 women (age:  $17 \pm 0.2$  years, body mass index:  $21.3 \pm 3.5$  kg m<sup>-2</sup>). They were affiliated with clubs belonging to the Tunisian Professional League. Participants trained five times per week, with an average of 70 min per training session, and official games usually played on weekends (i.e., 1 day to rest). All participants and their parents signed a consent form prior to the commencement of data collection. The experimental protocol was conducted in May, which coincided with the final phase of the competitions of the season. The study was approved by the Institutional Review Board and the experimental protocol conforms to the principles outlined in the Declaration of Helsinki.

## Design

The experimental design of the present study consisted in randomly performing a repeated-sprint ability (RSA) test, on a grass surface, with or without listening to music during the warm-up period (i.e., pre-task music). Only one test session per week was administered due to the training schedule. All test sessions were conducted at the same time of the day as the time of measurement could affect performance outcomes. Throughout the study period, subjects were instructed to (1) follow their normal diet, (2) refrain from intense physical activity for 24 h before each experimental session, (3) keep their usual sleep habits, and (4) wear the same training shoes in all testing sessions so as to negate the effect of different shoe designs and support they may provide for individual performance.

Before the RSA test, each player performed a low-intensity warm-up of 15 min. To reproduce the competitive conditions, the players listened to music only during the warm-up period. Criteria for selection of the piece of music were based on the five recommendations of Karageorghis et al. [10]. Specifically, due to the exercise type (repetition of high-intensity sprints), high-tempo music (> 130–140 bpm) was chosen for this study [10, 28]. In the no-music condition, players wore headphones during the warm-up, but no music was played.

The RSA test consists in performing six 40-m sprints with 180° direction change interspersed with a 20-s passive recovery period [29]. The participant starts from a line, performs a 20-m sprint, touches a cone with his hand, and returns to the starting line as fast as possible. Five seconds prior to the commencement of each sprint, the player assumes the ready position and awaits the start signal announced by a countdown given by the experimenter. Strong verbal encouragement was provided to each participant during all exercise bouts. Sprint times were recorded using a photocell system (Brower Timing Systems, Salt Lake City, UT, USA). Three performance-related indices were calculated based on sprint times: the best sprint time (RSA<sub>b</sub>, s), the mean sprint time (RSA<sub>m</sub>, s), and the RSA percent decrement (RSA<sub>d</sub>, % =  $[(RSA_m/RSA_b) \times 100] - 100$ ) [29].

Participants were asked to rate their subjective perceived exertion (RPE) using the 6–20-point Borg scale [30] after warming-up and RSA exercise. According to Baron et al. [31] and considering affect as bipolar, RPE scores allowed to calculate the affective load (AL) defined as the difference between the coexisting negative and positive affective responses associated with exercise. AL could be rated between -14 and +14. For instance, if the RPE score is equal to 6 (very very light), unpleasant affective responses would be close to 0 whereas the pleasant

affective responses would be close to maximal value so that the AL would be close to  $-14$ . Conversely, if the RPE score is equal to 20 (very very hard), unpleasant affective responses would be close to maximal value and pleasant affective responses would be close to 0, so in this case AL would be close to  $+14$ . A negative AL score indicates the dominance of pleasant affective responses, whereas a positive score indicates the dominance of unpleasant ones.

## Statistical analysis

Statistical analyses were carried out using Statistica Software 10.0 for Windows (StatSoft, Tulsa, USA). Mean and standard deviation ( $\pm$ SD) values were calculated for each variable. All data were assessed for normality using the Kolmogorov–Smirnov distance test. Data were then analyzed using a mixed model (Sex  $\times$  Condition) analysis of variance (ANOVA) for repeated measures. If a significant effect was found, a post hoc comparison using the Fisher's least significant difference test was performed. The Cohen's *d* effect size with corresponding 95% confidence interval (95% CI) was calculated by dividing the absolute mean change by the pooled standard deviation. Threshold values for the interpretation of the Cohen's *d* effect size were: 0–0.19 (trivial), 0.20–0.49 (small), 0.50–0.79 (medium),  $> 0.79$  (large). The significance level was set at  $P < 0.05$  for all analyses.

## Results

### Affective load score

The AL scores for warming-up and RSA exercise in male and female soccer players are displayed in Table 1.

The two-way ANOVA performed on post-warming-up AL scores revealed a significant Sex  $\times$  Condition interaction ( $F_{1,31} = 5.04$ ,  $P = 0.032$ ) and significant main effects

of Sex ( $F_{1,31} = 5.15$ ,  $P = 0.030$ ) and Condition ( $F_{1,31} = 10.01$ ,  $P = 0.003$ ). The post hoc test showed that AL scores were significantly higher after warming-up with music compared to no-music condition in male ( $-11.68 \pm 1.53$  and  $-13.37 \pm 0.96$ , respectively,  $P < 0.05$ ), but not in female soccer players ( $P > 0.05$ ). Likewise, AL scores were significantly higher in male compared to female soccer players after warming-up with music ( $P < 0.01$ ; Table 1).

Regarding post-RSA test AL scores, the two-way ANOVA revealed a significant main effect of Sex ( $F_{1,31} = 8.22$ ,  $P = 0.007$ ). The post hoc test revealed that AL scores were significantly higher in women compared to men. No significant main effect of Condition and Sex  $\times$  Condition interaction was observed (all  $P > 0.05$ ; Table 1).

### RSA test performance

Performance measures from the RSA test in the two experimental conditions are presented in Table 2.

For RSA<sub>b</sub>, the two-way ANOVA revealed significant main effects of Sex ( $F_{1,31} = 103.63$ ,  $P < 0.001$ ) and Condition ( $F_{1,31} = 5.81$ ,  $P = 0.022$ ). No significant Sex  $\times$  Condition interaction was observed ( $P > 0.05$ ).

The two-way ANOVA performed on RSA<sub>m</sub> revealed significant main effects of Sex ( $F_{1,31} = 135.86$ ,  $P < 0.001$ ) and Condition ( $F_{1,31} = 4.18$ ,  $P = 0.049$ ) on this parameter. There was a trend for significant Sex  $\times$  Condition interaction ( $F_{1,31} = 3.91$ ,  $P = 0.057$ ). The post hoc test revealed that RSA<sub>m</sub> was significantly better after warming-up with music compared to no-music condition in female ( $P = 0.016$ ), but not in male soccer players ( $P > 0.05$ ).

The analysis of fatigue index measured by means of RSA<sub>d</sub> revealed a significant main effect of Sex ( $F_{1,31} = 6.11$ ,  $P = 0.019$ ). No significant main effect of Condition and Sex  $\times$  Condition interaction was observed for this parameter (all  $P > 0.05$ ).

**Table 1** Affective load (AL) scores measured after warm-up and repeated-sprint test (RSA) for male and female soccer players in both conditions

	Without music (mean $\pm$ SD)	With music (mean $\pm$ SD)	Effect size (95% CI)	Rating
AL post-warm-up				
Males	$-13.37 \pm 0.96$	$-11.68 \pm 1.53^*$	1.76 (0.74 to 2.79)	Large
Females	$-13.29 \pm 0.99$	$-13.00 \pm 1.04$	0.29 (–0.48 to 1.06)	Small
AL post-RSA				
Males	$06.84 \pm 2.34$	$05.79 \pm 2.20$	$-0.45$ (–1.04 to 0.14)	Small
Females	$08.00 \pm 1.57^{\S}$	$07.86 \pm 1.46^{\S}$	$-0.09$ (–0.63 to 0.45)	Trivial

95% CI confidence interval at 95%

\*Significantly different from without music condition ( $P < 0.05$ )

$^{\S}$ Significantly different from male soccer players ( $P < 0.05$ )

**Table 2** Best sprint time (RSA<sub>b</sub>), mean sprint time (RSA<sub>m</sub>), and the RSA decrement score (RSA<sub>d</sub>) for male and female soccer players in the two conditions

	Without music (mean ± SD)	With music (mean ± SD)	Effect size (95% CI)	Rating
<b>RSA<sub>b</sub> (s)</b>				
Males	7.09 ± 0.24	7.06 ± 0.27	-0.13 (-0.51 to 0.25)	Trivial
Females	8.42 ± 0.47	8.29 ± 0.50*	-0.26 (-0.48 to -0.05)	Small
<b>RSA<sub>m</sub> (s)</b>				
Males	7.32 ± 0.28	7.32 ± 0.25	-0.01 (-0.28 to 0.26)	Trivial
Females	8.85 ± 0.45	8.70 ± 0.50*	-0.31 (-0.62 to 0.01)	Small
<b>RSA<sub>d</sub> (%)</b>				
Males	3.23 ± 1.16	3.69 ± 1.92	0.39 (-0.46 to 1.24)	Small
Females	5.14 ± 2.54	5.02 ± 2.76	-0.05 (-0.46 to 0.37)	Trivial

95% CI confidence interval at 95%

\*Significantly different from without music condition ( $P < 0.05$ )

## Discussion

The aim of the present study was to compare the effect of listening to music prior to a repeated-sprint exercise on performance and affective load responses in male and female young soccer players.

When the warm-up was performed with music, RSA<sub>m</sub> measured in female soccer players was improved compared to the no-music condition (+ 1.6 ± 2.7%). However, no significant difference was observed between the two experimental conditions for male participants (0 ± 2.1%).

An examination of the literature shows that listening to music generally improves performance, although the psychophysiological mechanisms underlying the music–performance relationship have not been well documented [32]. Some authors reported improvement in power output after warming-up with music compared to control condition [5, 6]. In highly trained young volleyball players, Eliakim et al. [6] found a significant difference between music and no-music condition for peak power during the Wingate test. However, similar mean power output was observed in the two conditions. These authors suggested that music affects warm-up and may have a transient beneficial effect on performance during short-term high-intensity exercises. However, others showed no significant effect of pre-task music on performance [15, 18]. For instance, Yamamoto et al. [18] observed no significant effect of listening to music on power output during a single supramaximal cycle sprint despite the increased plasma catecholamine level,

which is a cause of stress-released hormones [33], particularly during exercise.

The discrepancies between previous studies' results could be due to some methodological issues. Indeed, the Wingate test was the most used method to examine the effect of motivational music on short-term high-intensity performance. This test consists in a single sprint on cycle ergometer against a fixed braking force. However, various braking forces were used and they were probably not optimal to maximize power output for all subjects [34, 35]. Moreover, some reports suggested that untrained subjects responded significantly more to music than the trained during the initial stages of a training program, and beneficial outcomes of music decreased markedly with increased fitness levels [5, 6]. Furthermore, Chtourou et al. [5] reported that the effects of music on performance depend on the motivational level of subjects.

As shown in the present study, some authors suggested that sex may moderate the response to music during physical activity or exercise training [36–38]. For instance, Karageorghis et al. [37] showed that coordinating circuit training with motivational music in a synchronous manner particularly benefitted female sports science students rather than their male counterparts in terms of the number of repetitions and pleasant affective responses. The authors assigned their findings to the possible role of subject's experience with music during their formative years. Indeed, female subjects were more likely to engage in music-based activities and demonstrated a greater desire to engage in dance-related activity [37]. In the present study, it could be assumed therefore that female subjects' improved performance in the music condition accounted for the motivational properties of the selected piece of music and the experience with music-based activities.

The present study's results showed that performance decrement was similar in both conditions. These findings could be attributed to the fact that participants may have adopted muscular recruitment strategies ensuring that the exercise bout is completed maximally and without a catastrophic biological failure [1]. However, our results showed that sprint decrement scores were lower in male than female soccer players, which indicates that they were more fatigue resistant than their female counterparts. These findings are in agreement with the results reported in a recent study [39]. In contrast, Laurent et al. [40] observed that female athletes produced significantly lower blood lactate and had a significantly lower decrement in sprint performance than male athletes, suggesting greater fatigue resistance and faster recovery in women. As sprint decrement has been shown to be related to aerobic fitness [41], the greater aerobic capacity usually observed in male athletes could explain this difference in performance decrement during a repeated-sprint exercise.

Moreover, the higher performance decrement observed in our female soccer players was concomitant with higher AL scores compared to their male counterparts, indicating that women exhibited higher unpleasant affective responses when performing repeated-sprint exercises. Furthermore, considering their corresponding levels of competition and training regimens, the training history of male compared to female soccer players cannot account for the differences in performance decrement and AL scores. In the literature, men have been reported to have greater levels of the muscle buffering agent, carnosine, than women [42], which could help offset the large changes in hydrogen ion accumulation that occur during repeated-sprint exercises [41]. However, a clear effect of sex on performance decrement during short-term high-intensity exercises has to be established.

Previous findings support our results concerning AL scores [43–45]. AL scores were negative after warming-up, indicating the dominance of pleasant affective responses in both groups. However, positive scores were observed after the repeated-sprint exercise, indicating the dominance of unpleasant affective responses. These findings are in agreement with the proposal of Baron et al. [31]. Indeed, during low-intensity exercise (i.e., warm-up exercise), unpleasant affective responses were close to minimal values whereas pleasant affective responses were close to maximal values so that the AL scores were close to minimal values (i.e., negative values). However, during high-intensity exercise (i.e., repeated-sprint exercise), unpleasant affective responses were close to maximal values whereas the pleasant affective responses were close to minimal values so that AL scores were increased to maximal values (i.e., positive values).

The present findings have implications for practitioners, particularly, as the assessment of repeated-sprinting can provide a specific and valid information on players' specific fitness and performance status [46]. Music chosen by female soccer players during training and sports conditioning sessions or before competitions should have high motivational qualities to ensure better responsiveness during high-intensity exercises.

## Conclusion

Listening to motivational music during warming-up had a greater effect on female soccer players' performance during repeated-sprint exercise compared to male subjects. This would suggest that female athletes seem to derive the greatest benefit from motivational stimuli compared to their male counterparts. Furthermore, motivational music had no effect on performance decrement and affective load responses to high-intensity exercise in both sexes. Further research in the area of psychophysiology should seek to examine the effects of auditory stimuli in conjunction with indices of

cardiovascular functioning (e.g., heart rate variability) to clarify the exact mechanisms responsible for the potential sex differences and the role of auditory stimuli in eliciting the observed psychological and physiological responses.

**Acknowledgements** The authors would like to thank all the participants of this research for their valuable time and contribution. Many thanks are due to Dr. Davide Malatesta (University of Lausanne) for his critical and helpful discussion during the preparation of the manuscript.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

## References

1. Noakes TD, St Clair Gibson A, Lambert EV (2005) From catastrophe to complexity: a novel model of integrative central neural regulation of effort and fatigue during exercise in humans : summary and conclusions. *Br J Sports Med* 39(2):120–124
2. Gibson ASC, Noakes TD (2004) Evidence for complex system integration and dynamic neural regulation of skeletal muscle recruitment during exercise in humans. *Br J Sports Med* 38(6):797–806
3. Gibson ASC, Lambert EV, Rauch LH, Tucker R, Baden DA, Foster C, Noakes TD (2006) The role of information processing between the brain and peripheral physiological systems in pacing and perception of effort. *Sports Med* 36(8):705–722
4. Billaut F, Bishop DJ, Schaefer S, Noakes TD (2011) Influence of knowledge of sprint number on pacing during repeated-sprint exercise. *Med Sci Sports Exerc* 43(4):665–672
5. Chtourou H, Chaouachi A, Hammouda O, Chamari K, Souissi N (2012) Listening to music affects diurnal variation in muscle power output. *Int J Sports Med* 33(1):43–47
6. Eliakim M, Meckel Y, Nemet D, Eliakim A (2007) The effect of music during warm-up on consecutive anaerobic performance in elite adolescent volleyball players. *Int J Sports Med* 28(4):321–325
7. Coudrat L, Rouis M, Jaafar H, Attiogbé E, Gélat T, Driss T (2014) Emotional pictures impact repetitive sprint ability test on cycle ergometre. *J Sports Sci* 32(9):892–900
8. Jaafar H, Rouis M, Coudrat L, Gélat T, Noakes TD, Driss T (2015) Influence of affective stimuli on leg power output and associated neuromuscular parameters during repeated high intensity cycling exercises. *PLoS One* 10(8):e0136330
9. Barwood MJ, Weston NJ, Thelwell R, Page J (2009) A motivational music and video intervention improves high-intensity exercise performance. *J Sports Sci Med* 8(3):435–442
10. Karageorghis CI, Priest DL, Terry PC, Chatzisarantis NL, Lane AM (2006) Redesign and initial validation of an instrument to assess the motivational qualities of music in exercise: the Brunel Music Rating Inventory-2. *J Sports Sci* 24(8):899–909

11. Eliakim M, Bodner E, Eliakim A, Nemet D, Meckel Y (2012) Effect of motivational music on lactate levels during recovery from intense exercise. *J Strength Cond Res* 26(1):80–86
12. Chtourou H, Jarraya M, Aloui A, Hammouda O, Souissi N (2012) The effects of music during warm-up on anaerobic performances of young sprinters. *Sci Sports* 27(6):e85–e88
13. Chtourou H, Hmida C, Souissi N (2017) Effect of music on short-term maximal performance: sprinters vs. long distance runners. *Sport Sci Health* 13(1):213–216
14. Jarraya M, Chtourou H, Aloui A, Hammouda O, Chamari K, Chaouachi A, Souissi N (2012) The effects of music on high-intensity short-term exercise in well trained athletes. *Asian J Sport Med* 3:233–238
15. Atan T (2013) Effect of music on anaerobic exercise performance. *Biol Sport* 30(1):35–39
16. Pujol TJ, Langenfeld ME (1999) Influence of music on Wingate Anaerobic Test performance. *Percept Mot Skills* 88(1):292–296
17. Loizou G, Karageorghis CI (2015) Effects of psychological priming, video, and music on anaerobic exercise performance. *Scand J Med Sci Sports* 25(6):909–920
18. Yamamoto T, Ohkuwa T, Itoh H, Kitoh M, Terasawa J, Tsuda T, Kitagawa S, Sato Y (2003) Effects of pre-exercise listening to slow and fast rhythm music on supramaximal cycle performance and selected metabolic variables. *Arch Physiol Biochem* 111(3):211–214
19. Bradley MM, Codispoti M, Cuthbert BN, Lang PJ (2001) Emotion and motivation I: defensive and appetitive reactions in picture processing. *Emotion* 1(3):276–298
20. Lithari C, Frantzidis CA, Papadelis C, Vivas AB, Klados MA, Kourtidou-Papadeli C, Pappas C, Ioannides AA, Bamidis PD (2010) Are females more responsive to emotional stimuli? A neurophysiological study across arousal and valence dimensions. *Brain Topogr* 23(1):27–40
21. Bianchin M, Angrilli A (2012) Gender differences in emotional responses: a psychophysiological study. *Physiol Behav* 105(4):925–932
22. Kring AM, Gordon AH (1998) Sex differences in emotion: expression, experience, and physiology. *J Pers Soc Psychol* 74(3):686–703
23. Lang PJ, Kozak MJ, Miller GA, Levin DN, McLean A Jr (1980) Emotional imagery: conceptual structure and pattern of somato-visceral response. *Psychophysiology* 17(2):179–192
24. Bradley MM, Cuthbert BN, Lang PJ (1996) Picture media and emotion: effects of a sustained affective context. *Psychophysiology* 33(6):662–670
25. Davies JA, Brewer J (1993) Applied physiology of female soccer players. *Sports Med* 16:180–189
26. Perroni F, Gallotta MC, Pisano S, Reis VM, Emerenziani GP, Guidetti L, Baldari C (2018) Gender differences in anthropometric parameters and technical performance of youth soccer players. *Sport Sci Health* 14(2):399–405
27. Perroni F, Pintus A, Frandino M, Guidetti L, Baldari C (2018) Relationship among repeated sprint ability, chronological age, and puberty in young soccer players. *J Strength Cond Res* 32(2):364–371
28. Brownley KA, McMurray RG, Hackney AC (1995) Effects of music on physiological and affective responses to graded treadmill exercise in trained and untrained runners. *Int J Psychophysiol* 19(3):193–201
29. Rampinini E, Bishop D, Marcora SM, Bravo DF, Sassi R, Impellizzeri FM (2007) Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *Int J Sports Med* 28(3):228–235
30. Borg GA (1982) Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 14(5):377–381
31. Baron B, Moullan F, Deruelle F, Noakes TD (2011) The role of emotions on pacing strategies and performance in middle and long duration sport events. *Br J Sports Med* 45(6):511–517
32. 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. *Sci Sports* 30(3):119–125
33. Möckel M, Röcker L, Störk T, Vollert J, Danne O, Eichstädt H, Müller R, Hochrein H (1994) Immediate physiological responses of healthy volunteers to different types of music: cardiovascular, hormonal and mental changes. *Eur J Appl Physiol Occup Physiol* 68(6):451–459
34. Jaafar H, Rouis M, Coudrat L, Attiogbé E, Vandewalle H, Driss T (2014) Effects of load on Wingate test performances and reliability. *J Strength Cond Res* 28(12):3462–3468
35. Jaafar H, Rouis M, Attiogbé E, Vandewalle H, Driss T (2016) A comparative study between the Wingate and force-velocity anaerobic cycling tests: effect of physical fitness. *Int J Sports Physiol Perform* 11(1):48–54
36. Crust L (2008) Perceived importance of components of asynchronous music during circuit training. *J Sports Sci* 26(14):1547–1555
37. Karageorghis CI, Priest DL, Williams LS, Hirani RM, Lannon KM, Bates BJ (2010) Ergogenic and psychological effects of synchronous music during circuit-type exercise. *Psychol Sport Exerc* 11(6):551–559
38. Priest DL, Karageorghis CI, Sharp NC (2004) The characteristics and effects of motivational music in exercise settings: the possible influence of gender, age, frequency of attendance, and time of attendance. *J Sports Med Phys Fitness* 44(1):77–86
39. Dent JR, Edge JA, Hawke E, McMahon C, Mündel T (2015) Sex differences in acute translational repressor 4E-BP1 activity and sprint performance in response to repeated-sprint exercise in team sport athletes. *J Sci Med Sport* 18(6):730–736
40. Laurent CM, Green JM, Bishop PA, Sjökvist J, Schumacker RE, Richardson MT, Curtner-Smith M (2010) Effect of gender on fatigue and recovery following maximal intensity repeated sprint performance. *J Sports Med Phys Fitness* 50(3):243–253
41. Bishop D, Edge J, Goodman C (2004) Muscle buffer capacity and aerobic fitness are associated with repeated-sprint ability in women. *Eur J Appl Physiol* 92(4–5):540–547
42. Mannion AF, Jakeman PM, Dunnett M, Harris RC, Willan PLT (1992) Carnosine and anserine concentrations in the quadriceps femoris muscle of healthy humans. *Eur J Appl Physiol Occup Physiol* 64(1):47–50
43. Kilpatrick M, Kraemer R, Bartholomew J, Acevedo E, Jarreau D (2007) Affective responses to exercise are dependent on intensity rather than total work. *Med Sci Sports Exerc* 39(8):1417–1422
44. Smith JC, O'Connor PJ (2003) Physical activity does not disturb the measurement of startle and corrugator responses during affective picture viewing. *Biol Psychol* 63(3):293–310
45. Tian Q, Smith JC (2011) Attentional bias to emotional stimuli is altered during moderate- but not high-intensity exercise. *Emotion* 11(6):1415–1424
46. Selmi MA, Haj Sassi R, Haj Yahmed M, Giannini S, Perroni F, Elloumi M (2018) Normative data and physical determinants of multiple sprint sets in young soccer players aged 11–18 years: effect of maturity status. *J Strength Cond Res* (in press)