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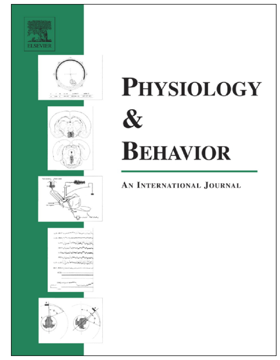

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Listening to neutral or self-selected motivational music during warm-up to improve short-term maximal performance in soccer players: Effect of time of day

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Abstract

The present experiment examined the effects of listening to different types of music during warm-up on the diurnal variation of short-term maximal performance (STMP) in soccer players, using a 3×2 mixed design with factors "Condition" (warm-up with self-selected motivational-music (WUMM) *vs*. warm-up with neutral-music (WUNM) *vs*. warm-up without-music (WUWM) and "Time of Day" (07h00 vs. 17h00). In a random order, twelve male soccer players performed a 5-m shuttle run test after a 10 min of WUMM, a 10 min of WUNM and a 10 min WUWM at 07h00 and 17h00. The higher distance (HD) and total distance (TD) were measured during the test, and the rated perceived exertion (RPE) and the feelings states (FS) were obtained immediately after the warm-up and the test. The results revealed that HD and TD were higher at 17h00 than 07h00 in all conditions ($p<0.01$). At 07h00 and 17h00, TD and HD were higher after WUMM and WUNM than WUWM and after WUMM than WUNM ($p<0.01$). This improvement was greater at 07h00 than 17h00 (*e.g.*, 6.97% vs. 5.26% for TD). Moreover, FS were more positive after WUNM than WUWM only at 07h00, after WUMM than WUWM at the two time-of-day ($p<0.01$), and after WUMM than WUNM at 17h00 ($p<0.01$). After the 5-m shuttle run test, FS were more negative and the RPE scores were higher with WUMM than WUWM at 07h00 ($p<0.01$). The findings suggested that STMP and feelings depend on types of music listened during a warm-up. A warm-up with self-selected motivational-music improves STMP and feelings at 07h00 and 17h00 with greater enhancement in the morning. However, a warm-up with neutral-music improves STMP and feelings only at 07h00.

***Keywords*:** Diurnal; Exercise; Fatigue; Arousal; Music.

1. Introduction

In recent years, music has been gaining increasing importance in the exercise and sports context [1]. Due to its ability to act as a stimulant and/or relaxant [2], this auditory stimulus can present several benefits. Firstly, listening to music can promote higher level of motivation, counteract the negative dimensions of mood (*e.g.*, anxiety, depression, anger, tension) and further boost motor coordination [3]. Secondly, listening to music can reduce the perceived effort [4] and fatigue [5, 6] in athletes. Thirdly, listening to music could optimize the period of consecutive recovery among physical efforts [7, 8].

More than one hundred scientific works have explored relationships between different types of music and sports-exercises [9]. The majority of these studies have been established on sub-maximal aerobic performance. For example, Karageorghis et al. [10] showed that during inclined treadmill-walking at 75% of maximal heart rate reserve, listening to motivational music (compared to neutral music and no-music) improve in-task affect throughout the exercise bout only and lowered perceived levels of exertion in the very early stages of the task. Similarly, but during an exercise at a self-chosen intensity on a treadmill, Terry et al. [11] demonstrated that listening to motivational music was clearly associated with more positive mood responses and feelings states (FS) compared to neutral music and no-music.

Otherwise, another group of studies have investigated the effect of music on supra-maximal anaerobic performance [8, 12]. Findings from these empirical researches do not always seem to be consistent. Some studies have shown that performances during the Wingate test are independent of music [*e.g.*, 12], whereas others observed a positive effect. For example, Eliakim et al. [8] showed that listening to motivational music during recovery after an intense exercise was associated with significant greater number of steps, lower absolute lactate levels, and greater decrease of the rated perceived exertion (RPE) compared to a recovery without music. Recently, Chtourou et al. [13] observed also that sprinter's performances (*i.e.*, Peak and mean power during a 30-s Wingate test), vigor and RPE scores (after Wingate test) were significantly higher after a warm-up with neutral music in comparison with a warm-up without music.

On the other hand, it is known that the supra-maximal short-term performance fluctuate with the time-of-day (TOD) with higher values in the afternoon compared to the morning and a morning-afternoon difference of 3% to 21% [14]. In this context, Chtourou et al. [15] showed that vertical jump performances were better in the afternoon than in the morning. Likewise, some previous studies reported that peak and mean power during a 30-s Wingate test were significantly higher in the afternoon than the morning [*e.g.*, 16, 17]. A plausible explanation for such diurnal variation could be attributed to the lack of athletes' motivation in the morning [18, 19].

The question then arise is how we could improve performance and motivation in the morning hours especially for athletes who participate to morning training and/or competition?

While many studies have investigated music effects on STMP, surprisingly little is known about the effect of music on the diurnal variation of STMP. To our best knowledge, there is only one scientific work [20] that has been interested to this topic. Findings of this study proved that a warm-up with a neutral music (compared to a warm-up without music) improves performances during 30-s Wingate test in both the morning and afternoon with a reduction of the morning-afternoon difference. Moreover, results showed that listening to music allows overcoming the morning worst performances. However, in this study, Chtourou et al. [20] have utilized imposed music that limit the practical significance of the results. As the self-selected motivational music effects have been linked to increases in individual perceptions of self-esteem and sense of confidence, enhancing arousal [3] and facilitating motor coordination [21], it seems then important to explore such type of music (*i.e.*, self-selected motivational music) effects on the diurnal variation of STMP.

In view of these observations, the current study was conducted to investigate the effect of listening to two types of music (*i.e.*, neutral and self-selected motivational and) during warm-up on the diurnal variation of the 5-m multiple shuttle run test performance, RPE and FS in soccer players. It was hypothesized that listening to music during the warm-up (*i.e.*, both types of music) at the two TOD could enhance STMP and reduce the morning-afternoon differences. It was, also, hypothesized that a WUMM is more effective than WUNM in improving physical outcomes and reducing the TOD effect on STMP.

2. Materials and methods

2.1. Participants

In collaboration with three soccer coaches, twelve male soccer players (21.82±2.47 years, 1.78±0.04 m, 71.26±4.24 kg) voluntarily participated in the present study. The choice of soccer players was matched with the required performance test (*i.e.*, 5-m multiple shuttle run). Such kind of test was designed to test match related fitness in various team sports including soccer, rugby, hockey, Gaelic football and hurling [22, 23, 24, 25]. All participants were recruited based on the following inclusion criteria: (i) they were semi-professional players engaged with teams from the second division of the Tunisian football league, (ii) they were accustomed to a training workload of five training sessions (for an average of 2-h per session scheduled in the morning and the afternoon hours), and (iii) they had standard times for sleeping habits (21 h00 min±1 h20 min), measured by the Horne and Östberg self-assessment questionnaire [26]. The two above mentioned requirements were applied following the Rae et al. [27] recommendations, that is, the participants' chronotype and their regular time-of-day of training should be considered when investigating the diurnal variation of performance. Exclusion criteria were: smoking, drinking alcohol or caffeine. The study was realized per groups during a normal in-season training period. Prior to start the investigation, participants were informed about the experimental procedures and the possible risks and discomforts associated with the study protocol. Next, they filled a written informed consent before participation. The experiment was conducted according to the Declaration of Helsinki and approval was gained from the local Institutional Ethics Committee.

2.2. Experimental design

Participants attended the athletics track after an initial familiarization session. They performed six test sessions, in a random order, separated at minimum by 48 hours of recovery: two WUMM (at 07h00 and 17h00), two WUNM (at 07h00 and 17h00), and two simple warm up without music (WUWM; at 07h00 and 17h00).

The experimental test sessions were conducted as follows: 10 min warm-up on a 400m athletics track (with music or without music depending on the condition), afterward, participants performed a 5-m multiple shuttle run test.

The FS scores [28] was recorded after the warm-up and at the end of the 5-m multiple shuttle run test. It is an 11-point, single-item scale ranging from +5 (very good) to −5 (very bad) with a midpoint of 0 (neutral). The RPE scores, using the 0 to 10 points modified Borg scale [29], was recorded after the warm-up and at the end of the 5-m multiple shuttle run test.

2.2.1 Music conditions

To stimulate competitive conditions, music was played only during the warm-up. Due to the high-intensity characteristics of the experimental task, a high tempo music (> 120−140 bpm) was chosen for the study (*i.e*, WUMM and WUNM). The selection′s criteria were based on the five recommendations of Karageorghis and Terry [6]. In the WUNM condition, the music played for each participant was pre-selected with a tempo of 140 beats/minutes. Conversely, in the WUMM condition, the music played for each participant was self-selected. In fact, participants were asked to download their own music with which they feel more inclined to do a high intensity exercise. They were informed in this condition to choose a high tempo music (> 120−140 bpm) [21]. This procedure was based on studies that have shown that allowing participants to choose their own music had greater benefits on their performance than assigning neutral music [30, 31]. Music was played using personal headphones. The headphones were worn during the WUWM; but no sound was played. The music was switched off at the end of the warm-up.

2.2.2 5-m multiple shuttle run test

The 5-m multiple shuttle run test allows to estimate the lactic anaerobic capacity [32]. Six beacons were placed 5 m apart in a straight line to cover a total distance of 25 m. The participants were instructed to perform maximally throughout the test. They began the test in line with the first beacon; then, upon an auditory signal, they sprinted 5 m to a second beacon (A), touched the ground adjacent to that beacon with their hand and returned back to the first beacon, touching down on the ground adjacent to the beacon with their hand again. Then, they sprinted 10 m to a third beacon (B) and back to the first beacon (Figure 1), etc., until 30- s of exercise had been completed. The participants were, then, allowed 35-s recovery during which they walked back to the first beacon. They performed these 30-s maximal sprints six times.

This test allows us to calculate:

- The total distance (TD) (m) = the total distance covered during the 6 × 30-s shuttles;
- The higher distance (HD) (m) = the greatest distance covered during a 30-s shuttle;
- The fatigue index (FI) (%) = calculated according to the following equation:

$$\left[\frac{\left[\frac{(\text{shuttle 1} + \text{shuttle 2})}{2}\right] - \left[\frac{(\text{shuttle 5} + \text{shuttle 6})}{2}\right]}{\left[\frac{(\text{shuttle 1} + \text{shuttle 2})}{2}\right]}\right] \times 100$$

3. Statistical analyses

Statistical tests were processed using STATISTICA Software (StatSoft, France). Mean and SE (standard error) values were calculated for each variable. After verifying that the assumptions required for parametric tests were not violated using the Shapiro-Wilk test for distribution normality, a two-way ANOVA (3 [conditions] × 2 [TOD]) with repeated measures was used to analyze the 5-m multiple shuttle run test performance, the FS and the RPE scores. When ANOVAs revealed a significant difference, Post-hoc Bonferroni was applied. Partial eta-squared (ηp^2) were calculated to assess the practical significance of the results. The level of significance was set at $p < 0.05$.

4. Results

4.3 Total distance (TD) during the 5-m multiple shuttle run test

There was a significant main effect of TOD ($F = 66.17$, $p < 0.001$, $\eta_p^2 = 0.85$) and conditions ($F = 88.94$, $p < 0.001$, $\eta_p^2 = 0.88$). Moreover, there was a significant interaction between these two factors (F = 4.47, $p < 0.05$, $\eta_p^2 = 0.28$). TD during the 5-m multiple shuttle run test was significantly higher in the afternoon than in the morning ($p < 0.01$) during WUWM, WUNM and WUMM conditions (amplitude: 3.66%; 3.72% and 1.90% respectively). TD during the 5-m multiple shuttle run test was significantly higher during WUNM and WUMM than WUWM condition in the morning ($p < 0.01$ and $p < 0.001$ respectively) (Δ-change: 3.51% and 6.97% respectively) and in the afternoon ($p < 0.01$ and $p < 0.001$ respectively) (Δ-change 3.56% and 5.26% respectively). In addition, TD was significantly higher during WUMM than WUNM at the two TOD ($p < 0.001$ and $p < 0.01$ respectively) (Δ-change: 3.58% and 1.76% respectively).

4.2 Higher distance (HD) during the 5-m multiple shuttle run test

There was a significant main effect of TOD ($F = 34.84$, $p < 0.001$, $\eta_p^2 = 0.76$) and conditions ($F = 49.02$, $p < 0.001$, $\eta_p^2 = 0.81$). However, no-significant interaction between these two factors was observed ($F = 1.79$, $p > 0.05$, $\eta_p^2 = 0.14$). HD during the 5-m multiple shuttle run test was significantly higher in the afternoon than the morning ($p < 0.001$) during WUWM, WUNM and WUMM conditions (amplitude: 13.05%; 3.94% and 3.71% respectively). HD was significantly higher during the 5-m multiple shuttle run test at the two TOD after WUNM and WUMM compared to WUWM ($p < 0.001$) (Δ-change: 2.69% and 7.23% respectively in the morning; 3.58% and 7.86% respectively in the afternoon). Similarly, HD was significantly higher during WUMM than WUNM at the two TOD ($p < 0.001$) (Δ-change: 4.66% and 0.40% respectively in the morning; 4.44% and 2.87% respectively in the afternoon).

4.3 Fatigue index (FI) during the 5-m multiple shuttle run test

There was no-significant main effect of TOD ($F = 1.87$, $p > 0.05$, $\eta_p^2 = 0.14$) and conditions ($F = 2.84$, $p > 0.05$, $\eta_p^2 = 0.20$). Moreover, no-significant interaction between these two factors was observed ($F = 2.51$, $p > 0.05$, $\eta_p^2 = 0.18$).

4.5 Feelings scores

4.5.1 FS scores after Warm-up

There was a significant main effect of TOD (F = 6.06, $p < 0.05$, $\eta_p^2 = 0.35$) and conditions (F = 18.37, $p < 0.001$, $\eta_p^2 = 0.62$). However, no-significant interaction between these two factors was observed (F = 1.57, $p > 0.05$, $\eta_p^2 = 0.12$). FS scores were not significantly different between the two TOD during WUWM condition ($p > 0.05$). However, FS scores were significantly positive in the afternoon than the morning during WUMM ($p < 0.05$). Compared to WUWM, FS scores were significantly higher during WUNM in the morning ($p < 0.05$) and during WUMM at the two TOD ($p < 0.001$). Similarly, during WUMM, FS scores were significantly more positive than WUNM condition in the afternoon ($p < 0.01$).

4.5.2 FS scores at the end of the 5-m multiple shuttle run test

There was a non-significant main effect of TOD (F = 2.28, $p > 0.05$, $\eta_p^2 = 0.17$) and a significant main effect of conditions (F = 11.01, $p < 0.001$, $\eta_p^2 = 0.50$). However, a non-significant interaction between these two factors was observed (F = 0.24, $p > 0.05$, $\eta_p^2 = 0.02$). FS scores were not significantly different between the two TOD during the three experimental conditions ($p > 0.05$). In addition, there were non-significant differences at the two TOD between WUWM and WUNM conditions and between the two conditions of music ($p > 0.05$). However, FS scores were significantly negative during WUMM than WUWM condition only in the morning ($p < 0.01$).

4.5 Rate of perceived exertion

4.5.1 RPE scores after warm-up

There was a significant main effect of TOD (F = 59.4, $p < 0.001$, $\eta_p^2 = 0.84$) and no-significant effect of conditions (F = 0.16, $p > 0.05$, $\eta_p^2 = 0.01$). Moreover, a non-significant interaction between these two factors was observed (F = 0.10, $p > 0.05$, $\eta_p^2 = 0.01$). RPE scores were significantly lower in the afternoon than the morning after all experimental conditions ($p < 0.05$). However, there was a non-significant difference at the two TOD between the three experimental conditions ($p > 0.05$).

4.5.2 RPE scores at the end of the 5-m multiple shuttle run test

There was a significant main effect of TOD ($F = 14.14$, $p < 0.01$, $\eta_p^2 = 0.56$) and conditions ($F = 16.78$, $p < 0.001$, $\eta_p^2 = 0.60$). However, a non-significant interaction between these two factors was observed ($F = 2.01$, $p > 0.05$, $\eta_p^2 = 0.15$). The RPE scores were not significantly different between the two TOD during the three experimental conditions (p > 0.05). However, RPE scores were significantly higher only during WUMM than WUWM condition in the morning (p < 0.01).

5. Discussion

The main goal of this study was to investigate the effect of listening to two types of music during warm-up (i.e., WUMM *vs*. WUNM) on the diurnal variation of the 5-m multiple shuttle run test performance, RPE and feelings states in soccer players. The main findings showed that a WUMM and a WUNM can enhance STMP and the feelings score in the morning and the afternoon, and, might reduce the morning-afternoon differences in STMP. However, listening to music did not affect RPE score in the two TOD.

5.1 Diurnal variations after the WUWM condition

TD and HD measured during the 5-m multiple shuttle run test were higher in the afternoon compared to the morning. However, a non-significant effect of TOD on the FI was observed. These results are consistent with those of Souissi et al. [33] during the 30-s Wingate test. Although the exact underlying mechanisms of these diurnal fluctuations are still unknown, some studies have hypothesized a causal link between the diurnal fluctuations of core temperature and STMP [*e.g.*, 34]. Indeed, the increase in body temperature in the afternoon hours may produce a decline in muscle viscosity, a metabolic reaction growth, and an increase in the extensibility of connective tissue as well as in the conduction velocity of action potentials [34]. However, these diurnal modifications could explain better motor coordination in the afternoon compared to the morning and an increase in the subject′s ability to adopt high pedal rates and, thus, produce higher STMP in the afternoon [35]. Another explanation for the diurnal variations in STMP could be related to motivation to perform maximal exercises in the morning [35, 18]. In this framework, it has been reported that higher afternoon motivation and arousal could contribute to the higher muscle power observed at this TOD [35, 12].

5.2 Diurnal variations after the WUNM and WUMM conditions

As mentioned above, the lower level of motivation in the morning could, in part, be responsible for the diurnal variation of STMP [18, 19]. In this context, it is legitimate to suppose that listening to music during pre-exercise improve athletes' motivation, decrease their discomfort related to the test and, thereby, allows them to produce more effort. The results of the present study are in line with a consistent body of research showing the benefits of listening to music on sub-maximal exercise performance [*e.g.*, 10, 6]. In contrast, the results of the present study differ from those of a previous study showing that performances measured during supra-maximal exercise are independent of music [*e.g.*, 12].

It is possible that additional factors such as time of music use (*i.e.*, either during exercise, warm-up or recovery), fitness level of participants fitness, and the music selections (*i.e.*, synchronous or asynchronous music) may explain these studies' discrepant results [*e.g.*, 6, 36]. According to Eliakim et al. [36] the positive effect of listening to music on performance decreased markedly with the increased fitness level of the subject. Considering the music selection, both asynchronous and synchronous music were efficacious in the context of long duration exercise performances [*e.g.*, 6]. However, there has been a distinct lack of studies into the effects of music on short-duration exercise tasks that taxes both the aerobic and anaerobic pathways.

Findings of the present study support those of previous empirical research demonstrating that listening to the two types of music (*i.e.,* self-selected motivational or neutral) during warm-up can enhance performance (TD, HD) in the morning and the afternoon. Moreover, results indicated that TD and HD increases after a WUMM and WUNM in comparison with WUWM were higher in the morning hours. In parallel, Chtourou et al. [20] proved that listening to a neutral music during the warm-up improves muscle power in the morning and the afternoon. The authors revealed that listening to music allows overcoming the morning worst performances. Simpson and Karageorghis [3] showed that music might exert an ergogenic effect during a trial of 400-m. Likewise, Eliakim et al. [36] observed that warm-up with music increased the subsequent peak power during the Wingate test (10.7 ± 0.3 vs. 11.1 ± 0.3 W·kg^{-1}) in highly trained adolescent volleyball players. Similarly, Jarraya et al. [37] examined the effect of the WUNM on physical performance during the Wingate test and observed that peak and mean power were significantly higher after the warm-up with music compared to WUWM. Recently, Chtourou et al. [13] investigated the effect of listening to music during a warm-up on STMP in 24 participants (twelve sprinters and twelve long-distance runners). The authors showed that listening to music may enhance the subsequent STMP in sprinters. However, music has a non-significant effect on performance of long-distance runners. The ergogenic effect of music could be related to better individual perceptions of self-esteem and sense of confidence and to an enhancement of arousal [1]. Nevertheless, Pujol and Langenfeld [12] showed that performances during the Wingate test were independent of music. The discrepancies between these findings might be due to the difference between subjects′ fitness levels. In fact, previous reports have demonstrated that music had greater ergogenic effects in untrained participants or during the initial stages of a training program, and that the influence of music on performances decreased markedly with increased fitness levels [36, 38]. Moreover, these discrepancies could also be due to the use of music during the exercise or during the warm-up [3].

The present results suggest that the use of self-selected motivational music while warming-up engender more important gains in comparison with the imposed music for STMP during the 5-m multiple shuttle run test in the morning and the afternoon. Findings are in agreement with the results of previous studies showing that music during consecutive recovery period could optimize physical performance [7, 8].

Concerning the FI, during the present study, it was not affected by the music protocol during the 5-m multiple shuttle run test. These results are consistent with those of Chtourou et al. [20] and Eliakim et al. [36].

The present study's findings and those of Eliakim et al. [7, 8] provide evidence for the importance of listening to music during warm-up before a major competition. Several mechanisms may explain the ergogenic impact of music on STMP. It has been reported that music during the warm-up was used to motivate and to arouse participants in order to perform exercises with optimum efficiency [20, 36]. During the Wingate test, Chtourou et al. [20] have suggested that power output could be partly attributed to the participant's motivation level. The music's motivational effects have also been linked to increases in individual perceptions of self-esteem and sense of confidence [6]. Moreover, music has been shown to be effective in reducing perceived levels of exertion, enhancing arousal levels and facilitating motor coordination [20, 6].

Following the warm-up, results showed that players in the WUMM condition reported a positive FS scores than those in the WUWM condition at the two TOD. By contrast, after performing the 5-m multiple shuttle run test, players reported a positive FS scores with WUWM than with WUMM in the morning.

The RPE scores after the warm-up were not significantly different between the two conditions with music and WUWM. The current data are at odds with those of Chtourou et al. [20] and Eliakim et al. [36] during which participants underwent a Wingate test. After the 5-m multiple shuttle run test, in agreement with Atkinson et al. [39] and Chtourou et al. [20], the RPE scores were higher after WUNM than WUWM in the morning. However, Eliakim et al. [36] and Jarraya et al. [37] were unable to show that the RPE scores were unaffected by listening to music. The disparity between these results is likely due to the relation between RPE values and the exerciser psychological status (*i.e.*, the situation in which the exercise is being performed and the disposition of the exerciser). In fact, situational and dispositional factors such as personality type, level of motivation, and focus of attention can influence the RPE score during exercise [40].

Limitations, strength and practical applications

As a first initiative, the present research offers insight into the role of listening to different types of music during warm-up (*i.e.*, self-selected motivational-music *vs*. neutral-music) on the diurnal variation of short-term maximal performance (STMP), feelings states (FS) and the rated perceived exertion (RPE). The results showed that STMP and FS depend on these two types of music listened during a warm-up. Indeed, while a warm-up with self-selected motivational-music improves STMP and FS at 07h00 and 17h00 with greater enhancement in the morning, performing a warm-up with neutral-music improves STMP and FS only at 07h00. Despite the important results reported in this original paper, a possible limitation could be related to the applied protocols. Thus, caution would be needed to generalize the role of listening to music on STMP in other settings and other sports. It would, therefore, be worthwhile in future studies to explore this pattern of results in other sport activities and with other athletes, in order to confirm and to explain the positive effects of listening to a self-selected motivational-music during warm-up on STMP and FS.

To sum up, the current study has important implications for practice in the sense that they encourage soccer coaches to advise their players to listen to a self-selected motivational-music both in the morning and the afternoon before performing short-term maximal repetitive efforts.

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Declarations of interest

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Table 1. Mean ± SE for the total distance (TD) (m), the higher distance (HD) (m) and the fatigue index (FI) (%) recorded during the 5-m multiple shuttle run test at 07h00 and 17h00 during the three experimental conditions (without music (WUWM), neutral-music (WUNM), and self-selected motivational music (WWMM)).

		07h00	**17h00**
TD	WUWM	719.98±8.34	747.4±5.02$^{€}$
	WUNM	746.20±7.28$^{£}$	775.05±5.27$^{€£}$
	WUMM	773.95±5.76$^{£\mu}$	788.97±7.32$^{€£\mu}$
HD	WUWM	126.84±0.93	130.84±0.10$^{€}$
	WUNM	130.35±0.80$^{£}$	135.71±1.08$^{€£}$
	WUMM	136.73±0.80$^{£\mu}$	142.01±2.21$^{€£\mu}$
FI	WUWM	4.60±1.32	7.02±2.02
	WUNM	6.92±1.99	7.13±2.05
	WUMM	7.48±2.16	8.14±2.35

€: significant difference compared to the morning in the same condition.

£: significant difference compared to WUWM at the same time-of-day.

μ: significant difference compared to WUNM at the same time-of-day.

Table 2. Mean ± SE for FS scores (AU) recorded after the warm-up and at the end of the 5-m multiple shuttle run test (Each 30-s run) at 07h00 and 17h00 during the three experimental conditions (without music (WUWM), neutral-music (WUNM), and self-selected motivational music (WWMM)).

		07h00	**17h00**
Warm-up	WUWM	1.25±0.21	2.25±0.30
	WUNM	2.5±0.15$^{£}$	3.25±0.17
	WUMM	3.25±0.21$^{£}$	4.75±0.13$^{€£\mu}$
Each 30-s run	WUWM	-1.58±0.37	-2.16±0.50
	WUNM	-2.41±0.28	-2.83±0.32
	WUMM	-3±0.32$^{£}$	-3.25±0.27

€: significant difference compared to the morning in the same condition.

£: significant difference compared to WUWM at the same time-of-day.

µ: significant difference compared to WUNM at the same time-of-day.

Table 3 Mean ± SE for RPE scores (AU) recorded after the warm-up and at the end of the 5-m multiple shuttle run test (Each 30-s run) at 07h00 and 17h00 during the three experimental conditions (without music (WUWM), neutral-music (WUNM), and self-selected motivational music (WWMM)).

		07h00	**17h00**
Warm-up	WUWM	2.16±0.11	1.16±0.16€
	WUNM	2.08±0.14	1.08±0.19€
	WUMM	2.08±0.19	1.08±0.19€
Each 30-s run	WUWM	3.5±0.26	4.92±0.62
	WUNM	4.58±0.55	5.92±0.43
	WUMM	5.75±0.44£	6±0.62

€: significant difference compared to the morning in the same condition.

Figure 1. 5-m multiple shuttle run test.

Highlights

- A warm-up with self-selected motivational-music improves physical performance and feelings states at 07h00 and 17h00.
- A warm-up with self-selected motivational-music improves physical performance and feelings states especially at 07h00.
- A warm-up with neutral-music improves physical performance and feelings states only at 07h00.

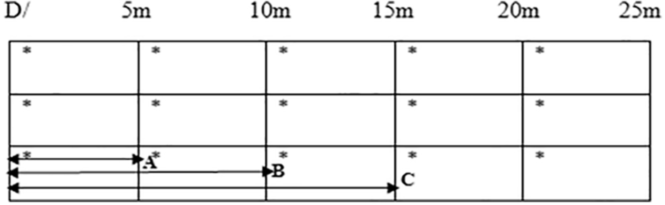

Figure 1