

## The Effects of Music on High-intensity Short-term Exercise in Well Trained Athletes

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### Abstract

**Purpose:** The purpose of this investigation was to assess the effects of listening to music during warm-up on short-term supramaximal performances during the 30-s Wingate test in highly trained athletes.

**Methods:** Twelve young male athletes (20.6±1.8 yrs, 177±4.4 cm and 72.3±5.3 kg) underwent two Wingate tests in separate sessions with a recovery period of 48 h in-between, either after a 10 min of warm-up with (MWU) or without (NMWU) music. High tempo music (>120 to 140bpm) was selected for the study. Heart rate (HR) and rate of perceived exertion (RPE) were recorded after the warm-up (for HR = average of warm-up) and immediately after the Wingate test.

**Results:** HR, RPE and the fatigue index during the Wingate test are not affected by the incorporation of music during warm-up. However, power output ( $P_{peak}$  and  $P_{mean}$ ) was significantly higher after MWU than NMWU ( $P<0.05$ ). The relative increases were  $4.1 \pm 3.6$  and  $4.0 \pm 3.7$   $W \cdot kg^{-1}$  for  $P_{peak}$  and  $P_{mean}$  respectively. These findings demonstrated the beneficial effect of music during warm-up on short-term supramaximal performances.

**Conclusions:** As it's a legal method and an additional aid, music may be used during warm-up before performing activities requiring powerful lower limbs' muscles contractions during short-term supramaximal exercises.

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## INTRODUCTION

While music has been used in several ways (e.g. therapy), it has only recently been used by athletes while warming up, exercising or cooling down to enhance performance [1]. During the last decade, there has been a sharp increase in the number of studies who examined the ergogenic effects of the combination of music and physical activity [2]. Karageorghis et al [3] indicated that music (i) can be used to alter psychomotor arousal and thus can act either as a stimulant or sedative, (ii) narrows a performer's attention and consequently diverts attention from sensations of fatigue and (iii) enhances the positive dimensions of mood (e.g. happiness, vigor) and tempers the negative dimensions (e.g. anger, depression, tension).

The majority of investigations on the effects of synchronous, asynchronous or out-of-phase (neutral in terms of motivational qualities) music tend to focus on aerobic rather than anaerobic exercise. Indeed, the efficacy of music in the context of submaximal aerobic performance has been well studied [2,4-8], and most findings reported positive effects of music on the athlete's perceived exertion and performance [4,9,10]. However, there has been a distinct lack of data into the effects of music on short-term supramaximal exercises (i.e. anaerobic exercises). Moreover, studies that have measured physiological responses to music on short-term supramaximal exercises have examined the effect of music while performing the task [1,11]. However, these latter findings are not applicable for athletes, since they cannot listen to music during competition. They can use music primarily during warm-up and/or

during recovery <sup>[12]</sup>. In adolescent volleyball players, Eliakim et al <sup>[12]</sup> found that peak power ( $P_{\text{peak}}$ ) during the Wingate test was significantly higher following a warm-up with music. However, they didn't find a significant music effect in the mean power ( $P_{\text{mean}}$ ) and the fatigue index. In physically active men, Chtourou et al <sup>[13]</sup> found that music during warm-up enhanced the  $P_{\text{peak}}$  and  $P_{\text{mean}}$  during the same exercise. Recently, in young sprinters, Chtourou et al <sup>[14]</sup> reported that listening to the music during warm-up increased the  $P_{\text{peak}}$  and  $P_{\text{mean}}$  during the subsequent Wingate test. However, the authors didn't show a music effect on the RPE and on the fatigue index. Although these studies support the hypothesis of the ergogenic effects of music on supramaximal performance, it is important to examine the music's effect with highly trained athletes. Indeed, research on the effects of music on supramaximal performance has yielded conflicting results, and it has been suggested that the timing and type of music, the type of exercise, and the fitness level of the athlete may all affect the performance response to music <sup>[15]</sup>.

In view of the above considerations along with the fact that the effect of music is reduced with the increased level of physical fitness, the purpose of this study was to determine the effect of music during warm-up on muscle power output, RPE and heart rate in highly trained athletes. In fact, in a world that one hundredth of a second could be the difference between fame and shame in one athlete's career, the search for legal methods and additional aids to improve athletic performances becomes very interesting.

## METHODS AND SUBJECTS

### Subjects:

Twelve male athletes ( $20.6 \pm 1.8$  yrs,  $177 \pm 4.4$  cm and  $72.3 \pm 5.3$  kg) volunteered to take part in this study. The criteria of the subject's inclusion was that they have a high physical fitness level (*i.e.* highly trained subjects). They belonged to the national and/or regional team of Tunisia and they were exercising at least four days per week for an average of 2-h on each day.

After receiving a thorough explanation of the possible risks and discomforts associated with the experimental procedures, they gave written informed consent. The experimental design of the study was approved by the university's ethics committee and meets the ethical standards of the Declaration of Helsinki.

### Procedures:

Following an initial familiarization session, participants attended the laboratory on two occasions separated by a minimum of 48 hours <sup>[16]</sup>. On each visit, they performed the Wingate test immediately after a 10 min warm-up either with (MWU) or without music (NMWU). During the warm-up, subjects pedaled at 60 rpm against a light load of one kilogram.

Heart rate (HR) was recorded during the warm-up (average) and immediately after the Wingate test, using a Polar heart rate monitor (Polar Electro Oy, T61-coded, Hungary). Rating of perceived exertion (RPE) was assessed using the 6–20 point Borg scale <sup>[17]</sup> after the warm-up and at the end of the Wingate test.

### Music protocol:

In order to mimic competitive conditions, music was played only during the warm-up. Due to the exercise type (high-intensity), high tempo music ( $> 120$  to 140bpm) was chosen for the study. The selection's criteria were based on the five recommendations of Karageorghis et al <sup>[2]</sup>. Music was played from recorded cassette tapes through personal headphones. In the no-music condition, headphones were worn but nothing was played. The music was switched off after the 10-min warm-up period.

### Wingate test:

As previously described by Chtourou et al <sup>[18-20]</sup>, the Wingate test was conducted on a friction-loaded cycle ergometer (Monark 894<sup>E</sup>, Stockholm, Sweden) interfaced with a microcomputer. This test consisted of a 30 s maximal sprint against a constant resistance related to body mass ( $0.087 \text{ kg} \cdot \text{kg}^{-1}$  body mass). The test began from a rolling start, at 60 rpm against minimal resistance (weight basket supported). When a constant pedal rate of 60 rpm was achieved, the start signal was given by the experimenter. During the 30 s, subjects were instructed to pedal as fast as they could.

The highest ( $P_{peak}$ ) and mean ( $P_{mean}$ ) powers during this test were recorded and stored for further analysis. The Fatigue Index (i.e. the percentage of decrease in power output) was calculated as follows [21,22]:

$$\text{Fatigue Index (\%)} = [(P_{peak} - P_{low})/P_{peak}] \times 100.$$

**Statistical analysis:**

All statistical tests were processed using STATISTICA Software (StatSoft, France). Data are displayed as the mean ± SD (standard deviation) within the text and tables. Data normality was assessed through Shapiro-Wilk *W*-test, and all variables showed normal distribution. Once the assumption of normality was confirmed, parametric tests were performed. HR and RPE data were analyzed using a two factors ANOVA (2 [music] × 2 [exercise] for RPE and 2 [music] × 3 [measure] for HR) with repeated measures on both factors. When ANOVAs revealed a significant difference, Post-hoc multiple comparisons using the LSD (least significant difference) Fischer test were conducted. The paired Student *t*-test was used for the Wingate test performance data to determine differences between non-music and music conditions. Test-retest reliability was assessed by intra-class correlation coefficients (ICCs) and standard error of measurement (SEM). For all statistical tests, the level of significance was set at  $P < 0.05$ .

**RESULTS**

**Heart rate (HR):**

HR values at the non-music and music experimental conditions are presented in Table 1. The main effect of

exercise ( $F_{(2,16)} = 777.1$ ;  $P < 0.001$ ) was significant with post-hoc tests showing that HR was significantly higher at end of the Wingate test in comparison with resting and post warm-up values in both non-music and music conditions ( $P < 0.001$ ). However, the music effect and the music × exercise interaction were not significant ( $P > 0.05$ ).

**Rate of perceived exertion (RPE):**

RPE scores recorded after the warm-up and at the end of the Wingate test in the two experimental conditions are shown in Table 1.

The two-way ANOVA (music × exercise) indicated that the main effect of exercise ( $F_{(1,8)} = 51.08$ ;  $P < 0.001$ ) was significant with post-hoc tests showing that RPE values recorded after warm-up were lower than those recorded at the end of the Wingate test in both non-music and music conditions ( $P < 0.001$ ). However, the music effect and the music × exercise interaction were not significant ( $P > 0.05$ ).

**Wingate test:**

Table 2 presents the values (mean± SD) of the Wingate test parameters recorded during the music and non-music conditions. ICC and SEM for  $P_{peak}$  and  $P_{mean}$  showed high reliability (ICC higher than 0.88 and absolute SEM lower than  $0.4 \text{ W}\cdot\text{kg}^{-1}$ ). Likewise, ICC and SEM for the fatigue index showed high reliability (ICC more than 0.78 and absolute SEM less than 16%).

There was a significant statistical difference in  $P_{peak}$  and  $P_{mean}$  between the non-music and the music experimental conditions ( $P < 0.05$ ).  $P_{peak}$  and  $P_{mean}$  were significantly higher after MWU than after NMWU ( $4.1 \pm 3.6$  and  $4.0 \pm 3.7 \text{ W}\cdot\text{kg}^{-1}$  for  $P_{peak}$  and  $P_{mean}$  respectively). However, there was no significant statistical difference in the fatigue index ( $P > 0.05$ ).

**Table 1:** Mean (SD) of heart rate and rate of perceived exertion scores at different time of test, in the music and the non-music protocols

Parameter		Without music	With music
Heart Rate	Rest	66.4 (3.1)	67.1 (3.8)
	Mean warm-up	104.8 (10.1)	106.2 (9.3)
	End of Wingate	181.8 (6.7)	180.1 (5.4)
Rate of perceived exertion scores	After warm-up	9.5 (2.1)	10.1 (2.4)
	End of Wingate	16.2 (2.0)	17.4 (1.4)

SD: Standard Deviation

**Table 2:** Mean (standard deviation) values for  $P_{\text{peak}}$ ,  $P_{\text{mean}}$  and fatigue index (n=9) measured in the music and the non-music protocols

Parameter	Without music	With music
$P_{\text{peak}}$ ( $\text{W} \cdot \text{kg}^{-1}$ )	11.1 (1.2)	11.6 (1.1)*
$P_{\text{mean}}$ ( $\text{W} \cdot \text{kg}^{-1}$ )	8.7 (0.5)	9.0 (0.6)*
Fatigue Index (%)	40.8 (8.3)	42 (7.9)

## DISCUSSION

The aim of this study was to examine the effect of warming-up while listening to music on athletes' short-term supramaximal performances during the Wingate test. The major result of our study was that music during warm-up increases  $P_{\text{peak}}$  and  $P_{\text{mean}}$  during the 30 s Wingate test. In fact, muscle power output was higher following MWU in comparison with NMWU. The present result suggests that the use of music while warming-up can enhance athletes' performance.

The present findings support those of previous researches which studied the music effect on long-duration exercise performance [2,4-6]. However, during short-duration supramaximal exercise, our results are at odds with those of Pujol and Langenfeld [11] and Yamamoto et al [23], who observed no music effect during the Wingate test.

Previous studies have demonstrated that the effect of music on performances decreased markedly with increasing subject's fitness levels [9,12]. Moreover, for music selections, research has demonstrated the efficacy of both asynchronous music [4] and synchronous music [5] in the context of long-duration exercise performances; however, there has been a distinct lack of research into the effects of music on short-duration exercise tasks. Since the present study examined the effect of music on short-duration supramaximal effort (the Wingate test), arousing music was selected.

Concerning the use of music while warming-up, previous studies have examined the effect of music during warm-up on short-term supramaximal exercise during the Wingate test in trained subjects [12,14]. The results of the present investigation are consistent with this previous study in highly trained adolescent volleyball players. In fact, the authors observed that warming-up with music increases the  $P_{\text{peak}}$

significantly ( $10.7 \pm 0.3$  vs  $11.1 \pm 0.3 \text{ W} \cdot \text{kg}^{-1}$ ). However, Eliakim et al [12] found that music had no effect on the  $P_{\text{mean}}$ . The discrepancies in the findings between our study and that's of Eliakim and co-workers in  $P_{\text{mean}}$  might be due to the sex of the subjects (males and females in the Eliakim et al [12] study and only males in the present study). In agreement with our findings, in physically active men, Chtourou et al [13] showed that  $P_{\text{peak}}$  and  $P_{\text{mean}}$  during the 30-s Wingate test increased after 10 min of warm-up with music. Likewise, in the context of short-term supramaximal exercises, several studies have demonstrated that pre-task music was associated with improved hand-grip strength [24], netball shooting performance [25], and faster choice reaction time [26].

The present study's findings and those of Eliakim et al [12] provide evidence for the importance of including music during warm-up before a major competition in order to reach higher performance. Several mechanisms may explain the ergogenic impact of music on short-term supramaximal exercise. It has been previously shown that music during warm-up [12] or during exercise [11,15] was used to motivate and to arouse athletes in order to perform supramaximal tasks with optimum efficiency. Other studies have suggested that power output during the Wingate test could be partly attributed to the subject's motivation level [27-29]. The music's motivational effects have also been linked to increases in individual perceptions of self-esteem and sense of confidence [11,15]. Moreover, music has been shown to be effective in reducing perceived levels of exertion [30], enhancing arousal levels [15] and facilitating motor coordination [1].

Following the warm-up, our results showed that the RPE scores were not significantly different between MWU and NMWU. The current data are at odds with those of Yamamoto et al? [23] where the subjects

underwent a submaximal exercise tasks, and those of Eliakim et al [12] during which participants performed the Wingate test. The disparity between these results is likely due to the relation between RPE values and the psychological status of the athlete (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 perception of exertion during exercise [31]. However, conclusions regarding this difference are probably negligible since the effort during the warm-up in both experimental conditions was perceived as very easy (mean RPE ~ 10). After the Wingate test, in line with the Eliakim and co-workers' findings, the RPE scores were unaffected by the music.

The Fatigue Index is currently computed even if its physiological basis is questionable [27,29]. In our study, the Fatigue Index during a sustained anaerobic cycling exercise is not affected by the music protocol. These results are consistent with those of Eliakim et al [12]. Moreover, it is likely that a music effect on the Fatigue Index would have been masked by its intrinsic (corresponding to the percentage of decrease between  $P_{peak}$  and the minimal power recorded during the test) variability [27,32].

## CONCLUSION

In light of these study findings, music may be considered as a legal *method* and additional aid for

young athletes during warm-up prior to playing competitive games. In fact,  $P_{peak}$  and  $P_{mean}$  during the Wingate test were higher after the music than the non-music conditions. This is an important point for coaches and it may benefit athletes involved in sports requiring powerful lower-extremity muscular contractions since it implies that all warm-ups prior to a competition must be performed with taking into consideration the effects of music. Thus, coaches and practitioners interested in short-term supramaximal performances may be well advised to incorporate arousing music during the warm-up duration in an attempt to augment subsequent power output. However, as the 30s supramaximal exercise was performed in experimental conditions it is important to examine the effect of music in another specific test to be applicable for real world such as athletic official competitions.

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**Conflict of interests:** None

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