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Effects of Pre-exercise Listening to Slow and Fast Rhythm Music on Supramaximal Cycle Performance and Selected Metabolic Variables

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Abstract

We examined the effect of listening to two different types of music (with slow and fast rhythm), prior to supramaximal cycle exercise, on performance, heart rate, the concentration of lactate and ammonia in blood, and the concentration of catecholamines in plasma. Six male students participated in this study. After listening to slow rhythm or fast rhythm music for 20 min, the subjects performed supramaximal exercise for 45 s using a cycle ergometer. Listening to slow and fast rhythm music prior to supramaximal exercise did not significantly affect the mean power output. The plasma norepinephrine concentration immediately before the end of listening to slow rhythm music was significantly lower than before listening ($p < 0.05$). The plasma epinephrine concentration immediately before the end of listening to fast rhythm music was significantly higher than before listening ($p < 0.05$). The type of music had no effect on blood lactate and ammonia levels or on plasma catecholamine levels following exercise. In conclusion, listening to slow rhythm music decreases the plasma norepinephrine level, and listening to fast rhythm music increases the plasma epinephrine level. The type of music has no impact on power output during exercise.

Keywords: Slow music, fast music, epinephrine, norepinephrine, dopamine, supramaximal exercise, power output, lactate, ammonia, heart rate.

Introduction

It is assumed that music significantly affects athletic performance and many athletes use it to increase both performance and motivation. Previous studies have demonstrated that listening to music with a soft and slow rhythm influenced physical performance more than music with a loud, fast rhythm (Becker et al., 1994; Copeland & Franks, 1991; Brownley et al., 1995). However, no significant difference was reported in the physical performance when listening to music with different rhythms (Schwartz et al., 1990; Coutts, 1961; Nelson & Finch, 1961; Nelson, 1963; Pujol & Langenfeld, 1999). Heart rate decreases when a person listens to classical music, popular music, and nontraditional music according to Guzzetta (1989). In contrast to this investigation, Coutts (1961) recognized that listening to fast music, slow music, or no music had no influence on the heart rate. Concerning the effect of music on blood lactate, Szmedra and Bacharach (1998) reported that blood lactate during submaximal exercise with music was significantly lowered. However, Schwartz et al. (1990) found no difference in individuals who listened to music during submaximal exercise when compared to those who didn't listen to music. Concerning the effect of music on plasma catecholamines, Möckel et al. (1994) demonstrated that meditative music helped decrease the plasma norepinephrine concentration when compared to waltz and modern classic music, but no significant difference was found in the plasma norepinephrine level with the music

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tests compared to using no music (Szmedra & Bacharach, 1998). These results therefore differ for each investigation. Moreover, these prior investigations on physical performance and blood metabolites during and after listening to music have been limited to endurance exercises, except for the investigations of Nelson and Finch (1961) and Nelson (1963).

Accordingly, we examined the effect of listening to two different types of music (with slow and fast rhythm), prior to doing supramaximal cycle exercises, on performance, heart rate, the concentration of lactate and ammonia in blood, and the concentration of catecholamines in plasma.

Materials and methods

Subjects

The subjects for this experiment were six male students. The purpose and protocol of the study and possible risks were fully explained to the subjects before each one signed an informed consent agreement. All subjects regularly participate in recreational sports such as swimming, soccer, volleyball, and resistance training at least three days a week. The mean and standard error (± SEM) of age, height, weight and body mass index (BMI) are 24.0 ± 4.1 years, 172.2 ± 2.6 cm, 70.2 ± 5.4 kg and 23.7 ± 0.7 kg/m^2, respectively.

Experimental protocol

All tests were conducted at the same time of day for each subject and were separated by 7 days. A cycle ergometer measured performance (Power max V, Combi Company, Tokyo, Japan). We chose classical music by Chopin, which has a slow rhythm, and music from American action movies (Rocky and Top Gun), which have a fast rhythm. The order the music was played was counterbalanced between the two different music types. The subjects listened to the music in a supine position for 20 min on closed portable headphones (Panasonic, RP-HT242, Tokyo, Japan). Then, immediately before the supramaximal test, they warmed up on the cycle at the same intensity of the supramaximal cycle ergometer test for three seconds. One minute after the warm-up, the supramaximal tests were performed for 45 s. The supramaximal exercise started after prompting, and the goal was to attain as many revolutions as possible. The load (kp; kilo pound) was 7.5 % of the weight (kg) of each subject. The mean load was 5.3 kp with a standard error of 0.2. After completion of the test each subject laid down on a bed in a supine position to enable blood samples to be taken. To obtain venous blood, a 21-gauge butterfly needle with a sampling vinyl tube was inserted into the antecubital vein. A series of 7-ml blood samples was obtained using disposable syringes at the beginning of the rest period, and 1.0, 2.5, 5.0, 7.5 and 10.0 min after exercise. Blood samples were immediately put into iced heparinized test tubes. Plasma was immediately separated at 2000 g for 10 min at 4°C. The plasma was stored at −80°C. Lactate and ammonia concentrations in the blood were measured within 5 min after collection.

Measurement of lactate, ammonia, catecholamines, and heart rate

The lactate concentration was measured using a lactate analyzer (Lactate Pro, Kyoto Daiichi Kagaku, Co., Ltd., Kyoto, Japan). The ammonia concentration was measured using an ammonia analyzer (Amicheck meter, Kyoto Daiichi Kagaku, Co., Ltd., Kyoto, Japan). The plasma epinephrine, norepinephrine and dopamine concentrations were measured before and after listening to the music and 1.0 min after exercising. The blood lactate and ammonia concentrations were measured before, immediately before the end of, and immediately after listening to the music and 1.0, 2.5, 5.0, 7.5, and 10.0 min after exercise. The catecholamines were measured by high-performance liquid chromatography (HPLC) using an electrochemical detector (ECD) as described by Lin et al. (1984). Heart rate was continuously recorded at 15-s or 1-min intervals using a Sports Tester Cardiotachometer (Accurex Plus, Polar Electro, Finland) when subjects were at rest, and during exercise and recovery.

Statistical analysis

Differences between the means were evaluated using two-way analysis of variance for repeated measurements. If this analysis showed significant differences, the means were compared post-hoc using Fischer's PLSD. Significant differences between 'before' and 'before the end of listening to music' were analyzed by the paired *t*-test. The level of significance was set at $p < 0.05$. All values are expressed as means ± standard error of the mean (SEM).

Results

Figure 1 shows the difference in power output during supramaximal cycling after listening to both slow and fast rhythm music. There was no significant difference in the power output during cycling. Table 1 shows the difference in heart rate when listening to slow and fast rhythm music, and in peak heart rate during exercise, and 1, 5, and 10 min after exercise. The slow and fast rhythm music did not affect the heart rate when resting, during exercise or during recovery. Table 2 shows the comparison of blood lactate and ammonia concentrations before, and immediately before the end of listening to slow and fast rhythm music and 1, 5, 7.5, and 10 min after exercising. No significant difference between slow and fast rhythm was found in blood lactate and ammonia concentrations. Table 3 shows the difference in the plasma epinephrine, norepinephrine and dopamine levels before, immediately before the end of listening to slow and fast rhythm music, and 1, 5, 7.5, and 10 min after exercising. Plasma epinephrine concentration immediately before the

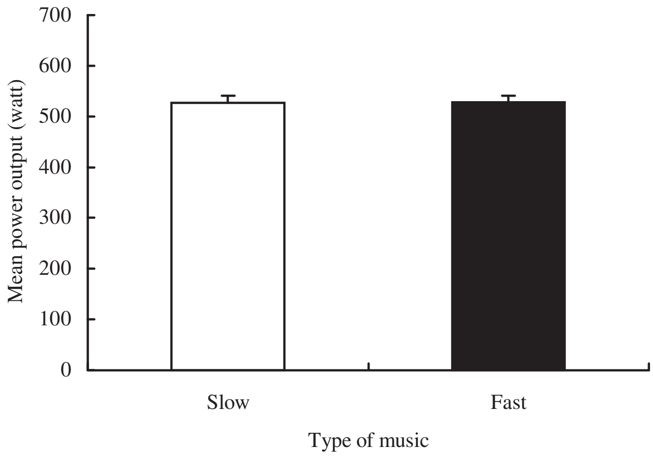

Fig. 1. Comparison of mean power output when listening to slow and fast music. The values are means ± SE.

Table 1. Comparison of heart rate when listening to slow and fast rhythm music.

Condition	Type of music: Slow music (beats/min)	Type of music: Fast music (beats/min)
0–20 min (listening to music)	65 ± 3	66 ± 3
30–45 s (peak, exercising)	174 ± 5***	176 ± 4^{+++}
0–1 min after exercising	147 ± 7***	145 ± 8^{+++}
4–5	101 ± 5***	103 ± 4^{+++}
9–10	98 ± 3***	100 ± 4^{+++}

The values are means ± SE.
*** $p < 0.001$ significant difference compared with listening to slow music.
$^{+++}$ $p < 0.001$ significant difference compared with listening to fast music.

Table 2. Comparison of blood lactate and ammonia concentrations when listening to slow and fast music.

(A) Blood lactate

Sampling time	Type of music: Slow music (mmol/l)	Type of music: Fast music (mmol/l)
Before	1.6 ± 0.20	1.4 ± 0.10
Listening to Music	1.5 ± 0.12	1.4 ± 0.10
1.0 min after exercising	13.5 ± 1.35***	11.7 ± 0.98^{+++}
2.5	14.4 ± 0.94***	12.8 ± 0.78^{+++}
5.0	14.1 ± 0.78***	13.7 ± 0.40^{+++}
7.5	13.5 ± 0.69***	13.5 ± 0.45^{+++}
10.0	13.2 ± 0.57***	14.0 ± 0.49^{+++}

(B) Blood ammonia

Sampling time	Type of music: Slow music (µmol/l)	Type of music: Fast music (µmol/l)
Before	60.3 ± 5.73	70.0 ± 19.91
Listening to music	65.4 ± 6.18	69.1 ± 14.95
1.0 min after exercising	198.4 ± 30.12***	180.4 ± 33.11^{+++}
2.5	243.4 ± 33.44***	237.7 ± 29.95^{+++}
5.0	304.9 ± 63.36***	290.6 ± 31.63^{+++}
7.5	320.1 ± 57.00***	297.7 ± 24.22^{+++}
10.0	283.3 ± 53.44***	269.9 ± 21.47^{+++}

The values are means ± SE.
*** $p < 0.001$ significant difference compared with listening to slow music.
$^{+++}$ $p < 0.001$ significant difference compared with listening to fast music.

end of listening to fast rhythm music was significantly higher than before listening to the music ($p < 0.05$). Plasma norepinephrine concentration immediately before the end of listening to slow rhythm music was significantly lower than before listening ($p < 0.05$). No significant difference was found in plasma dopamine concentration when listening to slow and fast rhythm music. No significant difference was found between slow and fast rhythm music conditions either plasma epinephrine, norepinephrine, or dopamine concentrations after exercise.

Discussion

The results of this investigation provide evidence that listening to slow rhythm music helps decrease the plasma norepinephrine concentration, and listening to fast rhythm music increases the plasma epinephrine. This finding coincides with the results of a previous study (Möckel et al., 1994), which demonstrated that meditative music led to a decrease in the plasma norepinephrine concentration. It is well known that plasma catecholamine concentration affects sympathoadrenergic activation (Frey et al., 1997), and also are a cause of stress-released hormones (Möckel et al., 1994). Our results, and the data of Möckel et al. (1994), suggest that slow rhythm and meditative music depress sympathetic activation, and this type of music has a stress lowering effect. In contrast, fast rhythm music led to an increase in adrenergic activation. However, music had no effect on plasma catecholamines concentrations after the exercise.

There was no significant difference in the mean power output during supramaximal cycling after listening to slow and fast rhythm music. This finding coincides with the results of a previous study (Nelson & Finch, 1961; Nelson, 1963), which reported no significant difference between fast and slow music conditions on 60–90 sec bicycle ergometer performance. Coutts (1961) and Szabo et al. (1999) also

Table 3. Comparison of plasma epinephrine (A), norepinephrine (B) and dopamine (C) concentrations when listening to slow and fast music.

(A) Plasma epinephrine

	Type of music	
Sampling time	Slow music (pg/ml)	Fast music (pg/ml)
Before music	36.6 ± 5.3	32.0 ± 6.5
After music	32.1 ± 5.2	48.6 ± 8.2*
1.0 min after exercising	1237.2 ± 321.1	895.6 ± 279.2

(B) Plasma norepinephrine

	Type of music	
Sampling time	Slow music (pg/ml)	Fast music (pg/ml)
Before music	153.0 ± 12.0	141.1 ± 24.9
After music	135.0 ± 13.4*	139.8 ± 26.5
1.0 min after exercising	5117.8 ± 753.9	3896.0 ± 534.6

(C) Plasma Dopamine

	Type of music	
Sampling time	Slow music (pg/ml)	Fast music (pg/ml)
Before music	8.0 ± 1.0	7.8 ± 0.6
After music	7.7 ± 1.0	6.5 ± 0.7
1.0 min after exercising	43.8 ± 4.7	35.1 ± 3.5

The values are means ± SE.
* $p < 0.05$: significant difference between Before and After music.

reported no significant difference on time-to-exhaustion for maximal bicycle exercise when comparing slow and fast music. The current results are consistent in finding that the type of music did not affect the power output during supramaximal exercise.

No significant differences in heart rate, blood lactate and ammonia concentrations immediately before the end of listening to music, and after supramaximal exercise subsequent to listening to slow and fast rhythm music were found. The type of music did not affect the heart rate, blood lactate, and ammonia concentrations.

In conclusion, listening to slow rhythm music decreases the plasma norepinephrine concentration, and listening to fast rhythm music increases plasma epinephrine. However, the type of music had no impact on mean power output during supramaximal exercise.

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