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A study of the effect of relaxing music on heart rate recovery after exercise among healthy students

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A B S T R A C T

Background: Music has been employed in various clinical settings to reduce anxiety. However, meta-analysis has shown music to have little influence on haemodynamic parameters. This study aimed at investigating the effect of relaxing music on heart rate recovery after exercise.
Method: Twenty-three student volunteers underwent treadmill exercise and were assessed for heart rate recovery and saliva analysis; comparing exposure to sedative music with exposure to silence during the recovery period immediately following exercise.
Results: No differences were found between music and non-music exposure regarding: heart rate recovery, resting pulse rate, and salivary cortisol. Music was no different to silence in affecting these physiological measures, which are all associated with anxiety.
Conclusions: Relaxing music unaccompanied by meditation techniques or other such interventions may not have a major role in reducing anxiety in certain experimental settings.

1. Introduction

Therapeutic interventions involving music have been reported to be effective in reducing anxiety, improving quality of life as part of end-of-life care, and relieving pain through non-pharmacological means [1–7]. Therapeutic applications of music have been reported upon in diverse clinical conditions [8–16]. Recently this topic has been thoroughly and independently reviewed [17–22]. Meta-analysis has shown music to have merely a modest influence over blood pressure and heart rate for patients with coronary artery disease [23] and cancer [24]. This suggests that further research is still required regarding music therapies when evaluated using haemodynamic parameters. Although, blood pressure has been extensively investigated in several settings [25,26] the relationship between music exposure and a specific cardiovascular measure, heart rate recovery after exercise, has not been reported upon. The testing of heart rate recovery (HRR), in general populations, has been shown to be a strong predictor of mortality [27] and for healthy individuals HRR is an indicator of autonomic nervous system activity. This in turn is strongly influenced by anxiety and stress. HRR is defined as the speed at which heart rate decreases after cessation of moderate to heavy exercise [28] and it is considered to be the result of increased parasympathetic activity, coupled with sympathetic withdrawal [29,30].

The autonomic nervous system also has a major regulatory role in controlling salivary flow rates, and salivary solute composition. Sympathetic stimulation tends to produce protein rich, but low volume saliva [31]. Conversely, parasympathetic stimulation tends to produce protein poor, but high volume saliva [32]. Salivary cortisol levels have been reported to be a good indicator of responses to stress [33]. It has previously been demonstrated that salivary cortisol increases following psychological stress and reduce following exposure to relaxing music [34]. Thus, the monitoring of salivary flow rates, protein levels and cortisol levels may act as surrogate markers of autonomic activity and related anxiety and stress responses. These measures have the potential to detect the physiological effects of listening to sedative music. The aim of this study was to investigate the influence of exposure to relaxing music on HRR and salivary biomarkers among a group of healthy university student volunteers.

2. Methods

2.1. Study design

Participants were given a specific code number and randomly assigned to be exposed to silence or relaxing music on one of two occasions. Participants underwent a standardised physical exercise

Abbreviations: HRR, heart rate recovery; BPM, beats per minute.

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protocol on a treadmill on two separate occasions, within one week of each other. During the period immediately following exercise, the recovery period, participants were exposed to either music for one session, or silence for the other session. Which was first, and which was second (music or silence), was established through a simple randomisation process. Comparison of salivary biomarkers and haemodynamic measures were made between exposure to music and exposure to silence.

2.2. Setting and participants

Student volunteers were recruited through convenience sampling. Twenty-three undergraduate students (16 females and 7 males) completed the two treadmill exercise sessions. Participants were all first or second year medical students studying at University Brunei Darussalam. Recruitment took place during 2011. The inclusion criteria were: (1) students studying medicine, (2) able to run at 6.5 km/h for 2 min and (3) had a resting pulse rate of less 90 pbm. Participants were excluded from the study if they (1) had recent injury or surgical operations. All participants gave written informed consent before commencing the study. This investigation was approved by the Local Ethics and Research Committee. Enrollment and allocation procedures are summarised in Fig. 1.

2.3. Exercise protocol

Participants were briefed and familiarised with the procedures and equipment prior to the start of the data collection sessions. Participants were asked not to eat or drink anything for at least one hour before the experiment. At the time of the actual trial session participants were first asked to be seated for five minutes prior to exercise. The exercise procedure was performed individually in an isolated room along with the researcher. All haemodynamic measurements and specimen collections were also carried out in the same room. Participants were asked to use a treadmill for four minutes. Firstly, the participants were asked to walk for 1 min at 3.0 km/h. Then, it was adjusted to incremental grade of 13.0 with the same speed for another minute. Next, at the same inclination, the speed was increased from 3.0 km/h to 6.5 km/h for 1 min and 15 s. Lastly, the incremental grade was reduced to 0 and slowly decreased the speed to 0 km/h. Participants then performed a "cool-down" walk for 45 s before stopping the treadmill. Following exercise cessation participants were immediately seated. The 15 min following cessation of exercise was referred to the recovery period.

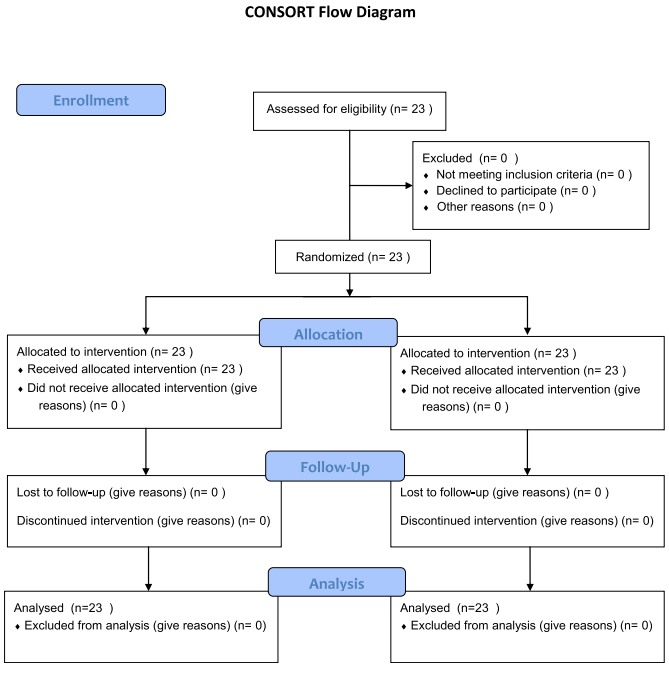

Fig. 1. CONSORT flow diagram.

2.4. Intervention

Their first or second trial was either; exposure to total silence or exposure to music, within the exercise recovery period. For the music exposure protocol "Canon in D" by Johann Pachelbel was played through stereo loud speakers. All participants were exposed to a constant volume level pre-selected by the researcher. This piece of relaxing music has been employed in previous studies related to inducing relaxation [25,35]. On completion of the music session, participants were asked to fill in a tick box questionnaire related to how they felt about the music based on sentiments ranging from annoying to relaxing.

2.5. Measurements

Resting pulse rate and blood pressure were measured in the sitting position before the start of exercise and 15 min after exercise. The participant's pulse rate was recorded continuously via a pulse transducer attached to the participant's thumb, Pulse Transducer which was connected to Powerlab 4/25T (AD-Instruments, ADInstruments S.E.Asia, Malaysia). Pulse rate was computed at 15 s intervals and reported as beats per minute (pbm). Heart rate recovery was defined as; maximum pulse rate − pulse rate at one minute (HRR-1) and two minutes after exercise (HRR-2) [28,36].

Passive drool was collected over three minutes [37], before exercise and again 15 min after exercise, i.e. on completion of recovery period. Saliva specimens were stored frozen prior to laboratory analysis. Volume of saliva collected over three minutes was recoded and reported as salivary flow rate (ml per minute). The volume of saliva was determined indirectly by weighing the specimen and converting the gravimetrical mass, in grams, to millilitres; assuming saliva has the same density as water. Salivary concentrations of total protein (Sigma–Aldrich, Poole, UK) and cortisol (Salimetrics LLC, PA, USA) were carried out using the Bradford and enzyme immunoassay respectively.

2.6. Data analysis

Descriptive data were expressed as median (inter quartile range; IQR) for all continuous variables. The effect of music exposure on HRR was analysed by comparison of medians using Friedman test. Similarly all other measures were compared using the Freidman test. Statistical significance was assessed using an alpha level of 0.05. The data were analysed using the Minitab version 14.0 software (Minitab Inc., PA, USA).

3. Results

Twenty-three participants were approached and assessed for eligibility for the study. All twenty-three met the inclusion criteria for the study. None refused to participate and all twenty-three completed the two treadmill exercise sessions.

All participants showed a greater than 20% increase in pulse rate in response to exercise. The median (IQR) percentage increase was 61 (49–81). Immediately after four minutes of exercise the median pulse rate (IQR) was 116 (108–141) bpm, which was significantly