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An exploration of heart rate response to differing music rhythm and tempos

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ABSTRACT

The aim of this study was to investigate acute cardiac response and heart rate variability (HRV) when listening to differing forms of music. Eleven healthy men aged between 18 and 25 years old were included in the study. HRV was recorded at rest for ten minutes with no music, then were asked to listen to classical baroque or heavy metal music for a period of 20 min. It was noted that heart rate variability did not affect HRV indices for time and frequency. In conclusion, music with different tempos does not influence cardiac autonomic regulation in men. However more studies are suggested to explore this topic in greater detail.

1. Introduction

Music as a therapeutic intervention [1] has been increasing in popularity there are growing number of studies demonstrating physiological changes in response to music, including blood pressure, heart rate, respiration, body temperature, biochemical parameters as well as affecting sensitivity to pain. This may modulate or influence trigger autonomic responses [3,4]. Affecting cardiovascular rate and rhythm and changes in respiration [2]. The autonomic nervous system (ANS) typically, adjusts heart rate and rhythm [5] whilst, heart rate variability (HRV) is a method for assessing cardiac autonomic control in humans. HRV describes fluctuations in intervals between consecutive heart beats (RR intervals). Whilst the detailed physiology relating to cardiac rates and HRV are not provided here, in the main, these factors are affected by the autonomic nervous system. Reduced HRV is an indicator of autonomic response to ANS [6].

Chuang et al. [7] studied the influence of music therapy on the nervous system in relation to fatigue, comfort and relaxation in cancer patients exposed to 2 h of music therapy for 6 months. They concluded that music causes an increase in parasympathetic and decrease in sympathetic modulation of the heart thus modulating heart rate resulting in a reduction of fatigue and enhanced relaxation and comfort [8]. Okada and Coworkers [9] have suggested the parasympathetic nervous system is affected by music since auditory stimulation resulted in reduced levels of plasma epinephrine and norepinephrine. They concluded that music could be beneficial in terms of improving the cardiovascular system of elderly patients with congestive heart failure, cerebrovascular disease and dementia. Other studies indicate that regular music therapy is useful for enhancing cardiac autonomic function [7–9]. Nevertheless, additional studies are required to explore this topic in greater depth. Additional studies on music therapy have focused on subjects pre and post surgery and whilst receiving pharmacological treatment. It would seem that few investigations have evaluated the acute effects of music on the cardiac autonomic regulation in healthy subjects.

When evaluating acute cardiovascular, cerebrovascular and respiratory changes induced by music [9], it was found that music with slow tempos, such as classical music, initiated a reduction in heart rate, blood pressure and respiratory rate, resulting in greater relaxation which subsequently benefitted cardio-respiratory responses [10]. In contrast, music with accelerated tempos, such as Heavy Metal music, was associated with physiological arousal leading to higher heart rate and rhythm [11]. To date though, there

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is limited literature comparing heart rate and variability when subjects are exposed to with slow and fast tempo musical styles.

Therefore, this study aimed to evaluate the effects of auditory stimulation with music comparing different tempos and their impact upon cardiac autonomic regulation.

2. Method

2.1. Study population

The study included eleven male students, aged between 18 and 25 years old with no known health issues. All volunteers were informed about the procedures and objectives of the study and signed informed consent. All study procedures were approved by the Ethics Committee in Research of the Faculty of Sciences of the Universidade Estadual Paulista, Campus of Marilia (Protocol Number CEP-2011-382) and followed the resolution 196/96 National Health 10/10/1996.

2.2. Exclusion criteria

Exclusion criteria included: cardiopulmonary, auditory, psychological, neurological disorders and other health related issues impairments reported by the volunteer that influence study outcomes. All subjects were screened to identify the use of prescribed or non-prescribed medications that could influence cardiac autonomic regulation. Subjects with previous experience of music therapy, and subject who regularly listened to heavy metal and baroque music styles were also excluded.

Subjects, age, gender, weight, height and body mass index (BMI) was recorded.

2.3. Measurement of the auditory stimulation

Measurements of equivalent sound levels for each subject were conducted in a soundproof room, using a SV 102 audio dosimeter (Svantek, Finland). Measurements were also taken during each session. These lasted for four minutes 50 s for the classical baroque music and five minutes 15 s for heavy metal music. An insert type microphone was placed inside the auditory canal of each subject and connected to a personal stereo.

Prior to each measurement, the microphones were calibrated with a calibrator acoustic CR: 514 model (Cirrus Research plc).

The Leq (A) was used during analysis. This is defined as the equivalent of a continuous sound which would contain the same sound energy as the time varying sound, i.e. Equivalent sound pressure levels. The frequency spectrum of the sound stimulation (octave band) [12,13] was also analyzed. Considering that most sounds are complex with, fluctuations in amplitude and frequency content, the interaction between sound energy level and frequency were required for meaningful analysis. Data recorded in this manner is referred to as a Sound Spectrum (Figs. 1 and 2).

2.4. HRV analysis

HRV behavior patterns were recorded beat-by-beat throughout the monitoring process at a sampling rate of 1000 Hz. During periods of higher signals, an interval of five minutes stability was selected and rates with more than 256 RR intervals only were used for analysis following digital filtering complemented with manual filtering for the elimination of premature ectopic beats and artifacts. Rates with more than 95% sinus rhythm were included in the study [14].

To analyze heart rate variability (HRV) low frequency (LF = 0.04–0.15 Hz) and high frequency (HF = 0.15–0.40 Hz) spectral components were used in absolute (ms^2) and normalized units. This provides value to each spectral component in relation to the total power minus the very low frequency (VLF) components. Thus the ratio between these two components (LF/HF) can be calculated using the Fast Fourier Transform algorithm [15].

Standard deviation of normal-to-normal R–R intervals (SDNN), the percentage of adjacent RR intervals with a duration greater than 50 ms (pNN50) and root-mean square differences (RMSSD) between adjacent normal RR intervals were monitored [16] The HRV analysis is a recognized method to explore cardiac autonomic regulation, HRV is used to identify mechanisms related to the ANS in individuals. Alterations in HRV provide a sensitive indicator of health or health impairment. Low HRV indicates inadequate adaptation of the ANS while high HRV indicates good adaptation [6].

For analysis of linear indexes in time and frequency, the software Kubios HRV was used [17].

2.5. Protocol

Data collection conducted in the same sound-proof room for all volunteers. Room temperature was controlled between 21 °C and 25 °C. With 50%–60% humidity. Subjects were instructed not to drink alcohol or take caffeine for 24 h prior to the study. Data were collected on an individual basis, between 18.00 h and 21.00 h in order to standardize the protocol. All data collection procedures were explained to each individual and the subjects were instructed to rest and avoid talking during data collection.

After the initial evaluation a heart monitor belt was placed around the thorax, aligned with the distal third of the sternum and a Polar RS800CX heart rate receiver (Polar Electro, Finland) placed on the wrist. Subjects were then seated and remained at for ten minutes with the earphones initially turned off.

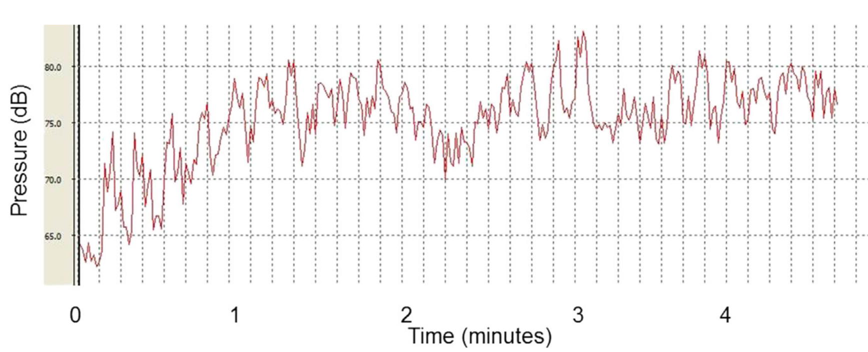

Fig. 1. Equivalent sound pressure of auditory musical stimulation of baroque style. dB: Decibel.