Heart Rate Variability and Acute Musical Auditory Stimulation

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ABSTRACT

AIM: It was observed that auditory stimulation with music influences the cardiovascular system. In this study, we described the relationship between musical auditory stimulation and heart rate variability (HR).

METHOD: Searches were performed with the Medline, SciELO, Lilacs and Cochrane databases using the following keywords: "Music," “autonomic nervous system”, “sympathetic nervous system”, “parasympathetic nervous system”, “heart rate” and “ECG”.

RESULTS: Some studies showed that relaxant music acutely increase HRV through spectral analysis, while others reported that exciting music reduces global HRV.

CONCLUSION: Music present acute responses that may be different depending on the style.

Key words: Autonomic nervous system; Cardiovascular physiology; Hearing

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RESULTS

In the search strategy and electronic selection we located 826 titles. Among the articles we eliminated 480 repeated titles. After reading the remaining 347 articles we excluded 338 articles that met the exclusion criteria based on their titles and abstracts. At the end of seven articles they had their texts read full, excluding one article that did not present intervention, totaling 6 final articles.

Table 1 shows the 6 final articles resulting from the search and selection, describing the studies on the musical auditory stimulation on HRV, according to authors/year, population, analyzed variability indices and conclusions.

Iwanaga et al. analyzed the effects of repeated exposure to music on HRV in 13 healthy subjects between 19 and 27 years. The participants were divided into two groups: Group 1 (n = 21) who were exposed to classical baroque music, and Group 2 (n = 19) who were exposed to heavy metal. The results showed that the modification of HRV parameters were significantly reduced during heavy metal music in comparison with classical baroque music. The fast or meditative music induced an irritant effect, which was predominantly related to the pace. The slow or meditative music induced a relaxing effect, and this effect is particularly evident during a break. The music can generate concentration during the first faster rhythms then induce relaxation during pauses or slower rates, especially in musicians.

Orini et al. presented a method to characterize the effects induced by music on the dynamic modulation of heart rate. The study was composed of three steps: (1) the distribution analyzed "pseudo - Wigner Ville" which is performed to obtain a time-frequency representation of HRV; (2) A parametric decomposition used to robustly estimate the time course of spectral parameters; and (3) statistical analysis of the population to assess whether different dynamic stimuli elicit different responses. 75 healthy subjects were exposed to "nice " music, the Shepard sequences with the same time as the pleasant music has been applied and the songs considered" unpleasant " overlapped with the same sequences of Shepard tones. The results showed that the modification of HRV parameters are characterized by a rapid onset of transient phase (15-20 s), followed by an almost stationary phase. All types of stimuli caused significant changes in comparison with the rest condition, whereas during "pleasant" music heart rate and respiratory rate was higher (for more than 80% of the duration of the stimuli, p < 0.05), and the power of the HF modulation was low (for more than 70% of the duration of the stimuli, p < 0.05) compared with the unpleasant auditory stimulation.

Roque et al. evaluated the acute effects of baroque and heavy metal music on HRV in women. Healthy female students (n = 21, age: 25.2 ± 3 years) were exposed to auditory stimulation for 5 minutes for each style (baroque music and heavy metal). As inclusion criteria the volunteers could not present: cardiopulmonary, auditory, neurological and psychological changes; use medications that influence cardiac autonomic regulation; smoking and drinking.

The authors found that the low frequency (LF) component (ms²) was significantly reduced during heavy metal music in comparison with the control condition. On the other hand, no significant changes with regard to LF in normalized units (NU). Therefore, auditory stimulation with Baroque music did not influence the HRV in short term exposure; however, the acute exposure to heavy metal music affected the sympathetic modulation in healthy women.

Roque et al. evaluated the acute effects of different styles of music (baroque relaxing music versus heavy metal) in the geometric indices of the HRV. 21 healthy women aged 18-35 years old were divided into two groups: Group 1 (n = 21) who were exposed to heavy metal and classical baroque music; and Group 2 (n = 19) which were exposed to both styles of music and to white noise. Using headphones, the volunteers were exposed to every kind of music for five minutes (70-80 dB), and the interval between each exposure was 5 minutes. The triangular index and the standard deviation of the long-term indices of RR intervals reduced during exposure to both musical styles of the first group and tended to decrease in the second group, while the white noise decreased the high-frequency index. No change in the triangular interpolation, standard deviation of the instantaneous variability beat to beat and standard deviation in the RR interval ratio was observed. The authors suggested that Baroque and heavy metal music slightly decreases HRV due to the equivalent sound level.
Perez-Lloret et al[14] evaluated the effects on heart rate variability of exposure to different styles of relaxing music. 25 healthy subjects were exposed to silence or to different types of music as “new age” or romantic melodies in a random fashion. At the end of the study, the subjects were asked to select the melody that they would use to relax. The LH/HF ratio was significantly higher when the subjects were exposed to “new age” music when compared to the silence (3.4 ± 0.3 vs 2.6 ± 0.3, respectively, p < 0.02), while no differences were found with romantic “classic” or melodies’ songs (2.1 ± 0.4 and 2.2 ± 0.3). These results were correlated with a reduction of the high frequency (HF) band to the music ‘new age’ as compared to the silence (17.4 ± 1.9 vs 23.1 ± 1.1, respectively; p < 0.004). The authors found that the preferences of the participants by the type of music do not correlate with autonomic responses. The results suggested that “new age” music induced a change in HRV regardless of musical preference.

DISCUSSION

In general, analyzes of selected texts have shown controversial results. Some of the articles have shown that classical, baroque or slow pace music, increased relaxation, while heavy metal music with fast pace increased the excitement. Other products decreased HF with nice music, especially regarding the silence and decreased global HRV, due to the same noise presented by the music.

Iwanaga et al[13] and Bernardi et al[12] showed results that corroborate each other. The authors suggested that the slow pace and sedative music present relaxing effects on individuals, activating the parasympathetic component, but have the same effect with respect to any music. On the other hand, Roque et al[10] did not find influences of Baroque music on HRV in short period of exposure. However, acute exposure to heavy metal music affected the cardiac sympathetic regulation as well as the study of Iwanaga et al[13] and Bernardi et al[12].

Orini et al[15] found in their study that all styles of auditory stimulation modified the HRV parameters compared to the rest condition, while during the “nice” song the power of HF band was lower compared with the unpleasant auditory stimuli. Supporting the study of Orini et al[15] and Perez-Lloret et al[14] the LH/HF ration was significantly higher when the subjects were exposed to relaxing music, along with a reduction of HF component compared to the silence.

In the study of Roque et al[13], women were exposed to Baroque and relaxing music, as a result authors suggested that Baroque music and heavy metal slightly decreased HRV due to the noise levels equivalent. In another study, Amaral et al[17] used different intensities of the same musical styles of Roque et al, but found no significant differences in HRV.

An important point to be addressed is that no study showed that music repaired possible damage in the brain or in the heart.

In summary, it was shown that musical auditory stimulation induce controversial changes in autonomic modulation characterized by both increases, decreases of the indexes presented in relation to different musical styles and patterns. Others showed no difference in HRV. Finally, further studies needed it to become possible to use the musical auditory stimulation as a complementary therapy and alternative.

Table 1 Description of the studies on the musical auditory stimulation in the autonomic nervous system, according to authors year goals, population indices analyzed and conclusions

| Author and year | Objective | HRV indices | Conclusion |
|-----------------|-----------|-------------|------------|
| Iwanaga et al 2005[11] | To analyze the effects of repeated exposure to music on HRV. | LF, HF, LF/HF | The high frequency component of HRV during sedative music was higher than during excitatory music. These results suggest that the music decreased excitatory activation of the parasympathetic nervous system. |
| Bernardi et al 2006[12] | To investigate the responses to six kinds of music (with different rhythms, harmony, melody and structure) in musicians versus non-musicians. | LF, HF, LF/HF | Music induces an irritant effect, predominantly related to the rhythm. Slow music or meditation can induce a relaxing effect; relaxation is particularly evident during a break. Music, especially in trained subjects can focus attention during the first faster rhythms then induce relaxation during pauses or slower rhythms. |
| Orini et al 2010[13] | To present a method to characterize the effects induced by music on the dynamics of HR and HRV. | HF, LF, LF/HF | All stimuli caused significant changes in comparison with the rest condition, whereas during listening to pleasant music heart rate and respiratory rate were higher and HF was lower. Baroque music did not influence HRV in short period of exposure. |
| Roque et al 2013[14] | To assess the acute effects of Baroque and heavy metal music in HRV in women. | HF, LF, LF/HF | However, acute exposure to heavy metal affected the sympathetic component in healthy women. It was suggested that this style of music presents more significant acute effects compared to relaxing baroque music. |
| Roque et al 2013[15] | To assess the acute effects of baroque style and heavy metal on the geometric indexes of HRV in women. | RR, R, SD1, SD2, SD1/SD2, SDNN (ms), RMSSD (ms), pNN50 (%), LF (ms²), HF (ms²), LF (ms²), HF (ms²), LF/HF | Baroque (relaxing) and heavy metal (excitatory) slightly decrease the variability of the global heart rate due to the equivalent noise level. |
| Perez-Lloret et al 2014[16] | To evaluate the effects on HRV (HRV) of exposure to different styles of “relaxing” music. | SDNN, VLF, LF, HF, LF/HF | The results suggested that “new age” music induced a change in HRV from high to low frequencies, regardless of musical preference or listener. The “new era” style reduced HF compared with silence. |
CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

REFERENCES

1. Yinger OS, Gooding L. Music therapy and music medicine for children and adolescents. Child and Adolescent Psychiatric Clinics of North America 2014; 23(3): 535-553
2. Nizamie SH, Tikka SK. Psychiatry and music. Indian Journal of Psychiatry. 2014; 56(2): 128-140
3. Franco M, Bezerra AR. Music therapy in relief of pain in oncology patients. J. Einstein 2009; 7: 147-151
4. Johnsen EL, Tranel D, Lutgendorf S, Adolphs R. A Neuroanatomical Dissociation for Emotion Induced by Music. Int J Psychophysiol 2009; 72: 24-33
5. Porta A, Gneccchi-Ruscone T, Tobaldini E, Guzzetti S, Furlan R, Malliani A, et al. Symbolic Analysis of Short-Term Heart Period Variability during Graded Head-up Tilt. Rev Comun in cardio 2006; 93: 109-112
6. Zanini CRO, Jardim PCB, Salgado C, Nunes MC, Urzída FL, Carvalho MVC, et al. O Efeito da Musico terapia na qualidade de vida e na Pressão Arterial do Paciente Hipertenso. Arq Bras Cardiol 2009; 93: 534-540
7. Vanderlei LCM, Pastre CM, Hoshi RA, Carvalho TD, Godoy MF. Noções básicas de variabilidade da frequência cardíaca e sua aplicabilidade clínica. Rev Bras Cir Cardiovasc 2009; 24(2): 205-217
8. Thayer JF, Lane RD. The role of vagal function in the risk for cardiovascular disease and mortality. Biol Psychol 2007; 74: 224-242
9. Marlaes VR. Freqüência cardíaca e sua variabilidade: análises e aplicações. Rev Andal Med Deporte 2010; 3: 33-42
10. Bunsawat K, White DW, Kapurs RM, Baynard T. Caffeine delays autonomic recovery following acute exercise. Eur J Prev Cardiol 2014
11. Iwanaga M, Kobayashi A, Kawasaki C. Heart rate variability with repetitive exposure to music. Biol Psychol 2005; 70(1): 61-66
12. Bernardi L, Porta C, Sleight P. Cardiovascular, cerebrovascular, and respiratory changes induced by different types of music in musicians and non-musicians: the importance of silence. Heart 2006 Apr; 92(4): 445-52
13. Orini M, Bailon R, Enk R, Koelsch S, Mainardi L, Laguna P. A method for continuously assessing the autonomic response to music-induced emotions through HRV analysis. Med Biol Eng Comput 2010; 48(5): 423-33
14. Roque AL, Valenti VE, Guida HL, Campos MF, Knap A, Vanderlei LC, Ferreira C, de Abreu LC. The effects of different styles of musical auditory stimulation on cardiac autonomic regulation in healthy women. Noise Health 2013; 15(65): 281-287
15. Roque AL, Valenti VE, Guida HL, et al. The effects of auditory stimulation with music on heart rate variability in healthy women. Clinics 2013; 68(7): 960-967
16. Perez-Lloret S, Diez J, Domé MN, Delvenne AA, Braidot N, Cardinali DP, Vigo DE. Effects of different “relaxing” music styles on the autonomic nervous system. Noise Health 2014; 16(72): 279-284
17. do Amaral JA, Guida HL, Nogueira ML, Roque AL, de Abreu LC, Raimundo RD, et al. Musical auditory stimulation at different intensities and its effects on the geometric indices of heart-rate variability. Focus on Alternative and Complementary Therapies 2014; 19: 132-139

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