SHORT ARTICLE

Effect of Indian classical music and pop music on heart rate variability: A comparative study

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Abstract	Introduction	Methodology	Results	Conclusion	References	Citation	Tables / Figures

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Citation

Jain JK, Maheshwari R. Effect of Indian classical music and pop music on heart rate variability: A comparative study. Indian J Comm Health. 2019;31(4):556-560.

Source of Funding: Nil **Conflict of Interest:** None declared

Article Cycle

Received: 04/08/2019; **Revision:** 08/11/2019; **Accepted:** 19/12/2019; **Published:** 31/12/2019

Abstract

Background: Indian Classical Music (ICM) has a structured and combinational classification basis. It has a time tasted philosophy of different notes for different time and mood called, 'Raaga'. Each 'Raaga' has unique combinational rules of notes, and it is associated with different essence, feeling, and emotions. **Aim & Objective**: The aim of the present study is to explore the effect of one popular ICM Raaga 'Bhairavi' on heart rate variability (HRV) as compared to the results with pop music of their choice. **Settings & Design**: HRV analysis was carried out in three cases; in silent environment, with classical music and with pop music for each subject on same time but different days. **Methods & Material**: Fifty three young adults participated in the non-invasive and benign study. Electrocardiogram (ECG) was recorded in silent environment and with classical and pop music and HRV parameters were extracted. **Statistical analysis used**: Student paired t test was used to compare the difference between HRV parameters during silent and music states. **Results**: The parasympathetic activity was increased whereas sympathetic activity decreased with classical music. **Conclusions**: Raaga 'Bhairavi' has been long considered as soft and soothing composition and thereby reducing stress, better compared to other popular music, like pop. The same study can be extended with other 'Raagas' using HRV parameters.

Keywords

Music; Heart rate; Autonomic Nervous System

Introduction

Music is composed of frequency, tone, rhythm, beat, loudness, lyrics and aesthetics. Therefore, it is a complex signal which stimulates the human body at multiple levels. Such signals may cause emotional changes which results into increase or decrease of sympathetic and parasympathetic activity of the cardiac autonomic nervous system (ANS).(1) The heart rate variability (HRV) analysis is used as a popular non-invasive tool for assessing the activities of the ANS.(2) Hence the effect of music on ANS can be observed by HRV analysis.

The music has been reported to decrease blood pressure, heart rate (HR), respiration rate, anxiety and pain with improved quality of sleep, pre competition stress in athletes etc. in many research studies.(3,4) Its therapeutic effects can be used

under various psychiatric disorders.(5) Further, the genre of music has been reported to have different effect on ANS e.g. 'popular or pop' music has excitatory effect on ANS whereas 'classical' or 'romantic' melodies have relaxing effects on ANS.(6) Tanaka Y et al. further reported that the Japanese music was more effective for Japanese dementia patients than western classical music.(7) This was based on the assumption that familiarity in music is highly contextual.

India has great diversity in religions, languages, music, dance, customs, climate, food etc. In context to music, Indian classical music (ICM) has two major traditions; North Indian classical music called 'Hindustani' while south Indian stream is known as 'Carnatic'. The fundamental element of the ICM is the 'Raaga' which forms the fabric of a melodic structure. 'Raaga's are grouped into broader families called 'Thaat'. Each 'Raaga' is associated with a distinct essence, feeling (Rasa) and emotional content (Bhava).(8) Some studies have used various 'Raaga's for the improvement of various physiological and psychological parameters. For example, 'Raag Darbari' has been reported to affect cognitive system and hence improved brain efficiency.(9) In another study, 'Raaga Bhupali' has been reported to reduce anxiety with reduced sympathetic activity and increased vagal activity.(10) Still the scientific investigation of ICM is in infancy as reported by Hegde S et al.(11) Thus there is a need to explore the physiological and psychological effects of 'Raaga's using quantitative methods.

In this study, effects of 'Raaga Bhairavi' on HRV are being presented. 'Bhairavi' is the main 'Raaga' in 'Bhairavi Thaat'. It has all the seven notes and so it is called 'Sampoorn' (Complete) 'Raaga'. Although it's time is classically defined as early morning, but often, it is preferred to play at the climax or at the end of any musical performance .(12)

Aims & Objectives

To evaluate and compare the effects of 'Raaga Bhairavi' based classical music and choice based pop music on HRV.

Material & Methods

Study type: A cross sectional study of undergraduate young students and staff members. Study area: The present cross-sectional study was conducted at the institute situated in North India. Inclusion criteria: A number of college students and staff members were invited voluntarily to take part in the study. Exclusion criteria: Subjects were excluded from the study based on the following criteria

I. Subject having blood pressure in the hypertension range or higher
II. History/treatment of any cardiovascular diseases, any form of neurological disease or deafness as reported by individuals.
III. Subjects identified with diabetes.
IV. Subject who had any kind of drugs taken within 12 hours prior.

Study population: Based on the inclusion and strict exclusion criteria, fifty three subjects in the age group of 18 to 47 years participated in the study. Study duration: 4 months, from August 2018 to November 2018. Consent: Details of the study, procedure and objectives were given to the subjects and written consent was obtained, prior to the data acquisition. Ethical clearance: The study was approved by institutional ethical committee on dated 03-02-2018 (Ref. no. F1B(93)/Estt/ECB/226/2007/207). Study instrument: PowerLab26® (bio amplifier) LabChart8.0® software (AD Instruments, Australia) was used as data acquisition system. Sphygmomanometer (MLT1100/A) for measurement of blood pressure, disposable alcohol swabs (MLA1094) for cleaning the skin before placement of electrodes and electrode cream (MLA1090) was used to ensure good contact between electrodes (MLA700) and skin. Strategy for data collection: The subjects were asked to sit in relaxed position for 15 minutes. Blood pressure was measured using Sphygmomanometer, PowerLab26® and LabChart8.0® software. The subjects were asked to lie on their back and ECG lead II was recorded in supine position with normal breathing. Five minutes of ECG duration was recorded as per the guidelines issued by task force.(13) In order to remove the bias, the ECG recording was performed on three consecutive days at the same time for each subjects with all other conditions unchanged except,

Case 1: Silent state (SS) – ECG was recorded for five minutes in silent environment. This was to acquire baseline HRV of the participant.

Case 2: Classical music (CM) – The song based on 'Raaga Bhairavi' was played for ten minutes. After initial five minutes of play, ECG recording began and continued for next five minutes with music.

Case 3: Pop music (PM) – Pop music of individual's choice was played for ten minutes. After five minutes of pop music play, ECG recording began and continued for next five minutes with pop music.

The HRV module of the LabChart8.0® software detected beats by detecting R waves in the ECG signal. The beats were classified as normal or ectopic beat based on preset limits. The ectopic beats were identified if the inter-beat interval (IBI) differs more than ±30% from mean.(14) The cubic spline interpolation method was used to replace the ectopic beats with interpolated values based on weighted average of nearby accepted values. Thus, ectopic-beat-free RR interval was obtained which was termed as NN (normal to normal) intervals.

Following time domain HRV indices were obtained from HRV module of the LabChart8.0® software (i) Standard deviation of normal RR intervals (SDNN) (ii) Root mean squared differences of normal RR intervals (RMSSD) (iii) Number of adjacent RR intervals differ by more than 50 ms (pNN50 count). Commonly used frequency domain HRV measures e.g. low frequency (LF) power, high frequency (HF) power, LF power in normalized unit (LFnu), HF power in normalized unit (HFnu), total power (TP) and sympathovagal balance (LF/HF ratio) were obtained by a Fast Fourier Transformation technique.(15)

Statistical analysis: The parameters were expressed as mean±SD. Student paired t test was used to compare the difference between HRV parameters during silent state and music states. Differences were considered significant at the level $p<0.05$.

Results

The time and frequency domain HRV indices were obtained with LabChart8.0® software. The mean values of HRV measures for silent state (SS), classical music (CM) and pop music (PM) are presented in (Table 1).

The students paired t test was carried out to test the significance of music stimuli. The mean RR interval was increased with both types of music stimuli, but the effect was statistically significant (P=0.0123) with 'Bhairavi'. Since HR is inverse of the RR interval therefore it decreased with both type of music stimuli, but significantly (P=0.0031) with 'Bhairavi' only.

The SDNN decreased significantly (P=0.0145, P=0.0152) with both types of music stimuli. However, the parasympathetic nervous system activity indicator, RMSSD increased significantly (P=0.0106) with 'Bhairavi' while insignificant (P=0.0861) variations were observed with PM.

The music stimuli also had significant impact on frequency domain HRV indices. The LF(nu) power was decreased (P=0.0010) while HF(nu) power was increased significantly (P=0.0006) with 'Bhairavi' whereas insignificant variations were observed with PM. The LF/HF ratio decreased significantly (P=0.0009 & 0.0153 respectively) with both types of music stimuli. The box plot for variations in LF(nu) and HF(nu) of all the three cases is shown in (Figure 1). The line in the box represents the median value while '+' sign indicates the mean value of the variable. The 25th and 75th quartiles are represented by the lower and upper lines of the box. The line extending the box represents the lower and upper range of the variable.

Discussion

In this study, the decreased HR was observed with 'Raaga Bhairavi' as it had relaxing effect for most individuals on autonomic nervous system thereby increasing parasympathetic activity and thus reducing heart rate. Kar SK et al. also reported reduced intra operative stress as measured with reduced level of cortisol with Indian classical music therapy suggesting increased parasympathetic activity with classical music.(16) On the other hand, some researchers identified that the pop music may enhance sympathetic nervous system activity by increasing the level of stress hormones such as cortisol, norepinephrine and adrenocorticotropic etc.(17,18)

The reduction of LFnu with music demonstrates the decrement of sympathetic nervous system activity while increased HFnu is an indication of increased parasympathetic activity. However, the significance level was obtained for 'Bhairavi' only. The decrement in LF/HF ratio indicates a shift of sympathovagal balance towards parasympathetic dominance. The SDNN and total power was reduced with music stimuli. This may be attributed to the reduction of sympathetic activity with music as these two parameters represent overall variability. The RMSSD increased with 'Bhairavi' as it represents the parasympathetic activity.

Conclusion

The study outcomes suggested that the composition in 'Raaga Bhairavi' significantly affected the HRV, suggesting a relaxing state and thereby reducing stress, which was found to have higher degree of significance over the choicest pop music. Similar studies can be conducted with other 'Raaga's and other types of music.

Recommendation

The characteristic of the Indian classical music based on 'Raaga Bhairavi' is found relaxing effect for most individuals. Therefore, it may be incorporated into stress management programs to improve public mental health. Also, it may be used as a supportive medicine.

Limitation of the study

The current study was conducted in a late adolescence to middle aged group; therefore, the study findings cannot be generalized. Future research studies may be carried out on larger population including younger and elderly subjects.

Relevance of the study

Stress has become a global health problem. In this situation, music may be helpful in improving physical as well as mental health. The current study suggests that the Indian classical music may be used to reduce the effect of stress thereby improving public health.

Authors Contribution

JKJ: Substantial contribution to concept and design of the study, data acquisition and analysis, drafting of the manuscript. RM: Substantial contribution concept and design of the study, data interpretation, revising the manuscript for intellectual content.

Acknowledgement

The authors are indebted to all the volunteers who participated in the study. The institutional ethical committee of Government Engineering College Bikaner, Rajasthan is acknowledged for providing guidance and ethical clearance. The authors are also indebted to their respective organizations for their patronage and support.

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Tables

TABLE 1 HRV MEASURES DURING SILENT AND MUSIC STATES

Parameters	Music states			SS v/s CM		SS v/s PM	
	Silent State (SS)	Classical Music (CM)	Pop Music (PM)	t stat	p value	t stat	p value
RR (ms)	810.93±97.95	819.82±97.56	816.04±93.41	2.31	<0.05*	1.15	0.26
HR (BPM)	75.36±8.87	74.44±8.55	74.72±8.34	2.85	<0.05*	1.51	0.14
SDNN (ms)	52.03±21.92	47.68±17.07	47.98±17.28	2.25	<0.05*	2.23	<0.05*
RMSSD (ms)	39.53±19.26	42.39±21.40	40.99±20.44	2.38	<0.05*	1.38	0.17
pNN50 (%)	19.56±16.91	19±16.97	18.56±16.73	0.52	0.61	0.93	0.36
LF (ms^2)	1055.42±940.54	715.98±517.14	823.99±608.38	3.29	<0.05*	2.54	<0.05*
HF (ms^2)	956.17±1386.12	863.9±1029.95	774.62±747.43	0.85	0.39	1.52	0.13
LF (n.u.)	54.45±16.14	49.11±16.61	52.15±13.54	3.25	<0.05*	1.31	0.19
HF (n.u.)	41.02±15.17	46.53±16.48	43.73±13.23	3.4	<0.05*	1.6	0.12
TP (ms^2)	2984.96±2907.5	2481.75±1911.7	2517.88±1860.9	2.04	<0.05*	1.82	0.07
LF/HF	1.65±0.96	1.33±0.87	1.41±0.78	3.27	<0.05*	2.22	<0.05*

Values are shown as mean ± SD, *statistically significant at p<0.05; ***Abbreviations****: t stat, student t test statistics; RR, R to R interval; HR, heart rate; SDNN, standard deviation of NN intervals; RMSSD, root mean square of differences of successive RR intervals; pNN50, percentage of RR intervals greater than 50 ms; LF (ms2), low frequency power in absolute unit; HF (ms2), high frequency power in absolute unit; LF (nu), low frequency power in normalized units; HF(nu), high frequency power in normalized units; TP, total power; SD1, Poincare plot (long term variability); SD2,Poincare plot (short term variability)*

Figures

FIGURE 1 BOX PLOT FOR NORMALIZED LF AND HF POWER DURING SILENT AND MUSIC STATES