Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

The impact of music on choir singers' autonomic function

Sandeep Singh Chouhan, Sarita Kanojia, Ajay Kukreja, Avi Kukreja, Elina Singh

Professor, Department of Physiology, Lady Hardinge Medical College, New Delhi. Professor, Department of Physiology, ESIC Dental College, New Delhi

** Professor, Department of Physiology, Government Medical College, Bharatpur (Rajasthan)*

Undergraduate student, AIIMS Bilaspur

Undergraduate student, Christian Medical College, Ludhiana

Corresponding author: Ajay Kukreja

Abstract

Background and Objectives - The research paper investigates the impact of music on autonomic function in choir singers. The study aimed to understand how music influences various parameters related to autonomic function, including blood pressure, isometric exercise, cold pressor test responses, S:L ratio and parameters related to speed of cognitive processing including VRT, and ART.

Methods Subjects were asked to come to the Autonomic Laboratory in the Physiology department before music sessions/choir singing/practice sessions and after having regular sessions twice a week for 6 months. All tests were conducted in the LHMC & SSK Hospital, New Delhi with (AFT) lab of a reputed hospital of india. All the tests were carried out under thermo-neutral conditions and at the same time of day on all subjects, i.e., in the morning hours, to avoid response differences due to circadian changes. The subjects were instructed to abstain from stimulants such as tea, coffee, smoking, and alcoholic beverages prior to the day of the test and asked to have a light breakfast in the morning.

Results - The findings revealed that music led to notable alterations in autonomic function parameters among choir singers. Specifically, differences were observed in blood pressure, isometric exercise performance, cold pressor test responses, and autonomic ratios. The pre-music session exhibited an average S:L ratio of 1.72, which decreased to 1.12 in the post-music session. This reduction in S:L suggests autonomic modulation and it was statistically significant ($p<0.05$). Examining the isometric exercise responses, it becomes evident that music might influence the autonomic reactions of choir singers after choir singing & practice sessions. The baseline values for systolic blood pressure (SBP) during isometric exercise show that participants exhibited relatively consistent responses in the pre-music session, with an average SBP of 112.9 mmHg across the 6-month duration.

Conclusion- These results emphasize the potential effect of music on modulating autonomic function, highlighting the role of music in promoting physiological and psychological well-being. The implications of these findings for both the field of music and broader healthcare contexts are discussed, suggesting avenues for further research and applications.

Keywords: Music, autonomic function, blood pressure, isometric exercises, cold pressor test, reaction time.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Introduction:

The intricate relationship between human physiology and the arts has been a subject of intrigue for researchers across various disciplines. One such area of investigation is the effect of music on autonomic function, a fundamental aspect of the body's physiological regulation. Autonomic function, responsible for involuntary bodily processes such as heart rate, blood pressure, and breathing, plays a crucial role in maintaining homeostasis. [1]The potential for music to influence autonomic responses has led to burgeoning interest in its therapeutic applications, particularly within the context of choir singers. Music, a well-established discipline, employs music as a therapeutic medium to promote emotional, cognitive, and physiological well-being. [2] Choir singers, engaged in structured musical activities, provide a unique population for studying the potential impact of music on autonomic function. Their engagement in harmonious vocal expression and coordinated musical performance creates an environment where the interplay between music and physiological responses can be explored. As these singers undergo training and participation in musical activities, it becomes pertinent to delve into the question: How does music affect autonomic function in choir singers? To address this research question, a comprehensive investigation was conducted, encompassing various aspects of autonomic function and music effects. [3,4,5] The study involved the assessment of multiple parameters, including blood pressure, isometric exercise performance, cold pressor test responses, S:L ratio, VRT, and ART. To capture the effects of music interventions, pre- and post-music evaluations were conducted. This approach aimed to provide a holistic understanding of how music may influence autonomic function in the context of choir singers.

The background and significance of this research study are rooted in two fundamental aspects: the crucial role of autonomic function in maintaining health and well-being, and the emerging recognition of music as a potent intervention in enhancing various aspects of health. Autonomic function, governed by the sympathetic and parasympathetic nervous systems, plays an integral role in regulating bodily functions, including heart rate, blood pressure, and stress responses. By examining the potential effects of music on their autonomic function, we aim to uncover novel insights into the intricate interplay between music and physiological responses. The study's overview concisely describes the methods and parameters employed in this research endeavor. These encompass a range of measurements, including baseline blood pressure, isometric exercise response, the cold pressor test, the calculation of autonomic ratios, and the assessment of visual and auditory reaction times. By considering these parameters, we intend to comprehensively analyze the multifaceted impact of music on autonomic function among choir singers. The intricate relationship between human physiology and the arts has been a subject of intrigue for researchers across various disciplines. The effect of music on autonomic function, which is one of the fundamental aspects of the body's physiological regulation, is one area of investigation that is currently being investigated. Autonomic function, responsible for involuntary bodily processes such as heart rate, blood pressure, and breathing, plays a crucial role in maintaining homeostasis. [1] The potential for music to influence autonomic responses has led to burgeoning interest in its therapeutic applications, particularly within the context of choir singers. Music, a well-established discipline, employs music as a therapeutic medium to promote emotional, cognitive, and physiological well-being. [2] Choir singers, engaged in structured musical activities, provide a unique population for studying the potential impact of music on autonomic function. Their engagement in harmonious vocal expression and coordinated musical performance creates an environment where the interplay between music and physiological responses can be explored. As these singers undergo

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

training and participation in musical activities, it becomes pertinent to delve into the question: How does music affect autonomic function in choir singers? A comprehensive investigation was conducted to address this research question, encompassing various aspects of autonomic function and music effects. [3,4,5] The study involved the assessment of multiple parameters, including blood pressure, isometric exercise performance, cold pressor test responses, S:L ratio, VRT, and ART. To capture the effects of music interventions, pre- and post-musical evaluations were conducted. As a result of this work, we were able to provide a holistic understanding of how music may influence autonomic function in the context of choir singers by taking a holistic approach.

The background and significance of this research study are rooted in two fundamental aspects: the crucial role of autonomic function in maintaining health and well-being, and the emerging recognition of music as a potent intervention in enhancing various aspects of health. Autonomic function, governed by the sympathetic and parasympathetic nervous systems, is integral to regulating bodily functions, including heart rate, blood pressure, and stress responses. By examining the potential effects of music on their autonomic function, we aim to uncover novel insights into the intricate interplay between music and physiological responses. The study's overview concisely describes the methods and parameters employed in this research endeavor. These encompass a range of measurements, including baseline blood pressure, isometric exercise response, the cold pressor test, the calculation of autonomic ratios, and the assessment of visual and auditory reaction times. By considering these parameters, we intend to comprehensively analyze music's multifaceted impact on choir singers' autonomic function.

Materials and Methodology:

In this study, a prospective longitudinal design was used to investigate whether music can affect the autonomic function of choir singers in the long term. The study consisted of a pre-music assessment phase followed by a post-music assessment phase.

1. *Pre and Post-musical Assessments*- The study employed a longitudinal design, incorporating both pre- and post-music assessments to examine the effects of the intervention on autonomic function. By collecting baseline measurements before the initiation of music and subsequently comparing them to post-intervention measurements, the study aimed to capture changes in autonomic responses resulting from it.

2. *Subject Design*- A within-subject design was chosen to minimize individual variability and control for potential confounding variables. Each participant served as their own control, ensuring that any observed changes could be attributed to the music intervention rather than external factors.

Participant Selection and Recruitment: There were 30 choir singers that took part in this study. It was a group of church members who were regularly participating in choir singing in their church. Participants were 18-35 years of age, and they had at least 5 years of singing or were wholly self-taught.

Inclusion criteria:

Choir singers of either sex aged between 18 and 35 years with a history of singing for at least five years.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Exclusion criteria:

· Patients with the following criteria were excluded:

· Pregnancy

· Patients with a history of other neurological or psychiatric illnesses.

· Patients with a history of uncontrolled hypertension and diabetes.

· Patients with a history of cardiac disorders (heart failure, arrhythmias, congenitalheart disease and valvular heart disease).

· Patients with a history of any endocrine disease (hypo and hyperthyroidism, diabetes)

· Patients with any significant visual loss or hearing impairment.

Methodology

Demographic details like Age and Sex were recorded for the participants. All subjects were asked to come to the Autonomic Laboratory in the Physiology department before and after music sessions/choir singing twice. All tests were conducted in the LHMC & SSK Hospital, New Delhi with (AFT) lab of a reputed hospital of india.

All the tests were carried out under thermo-neutral conditions and at the same time of day on all subjects, i.e., in the morning hours, to avoid response differences due to circadian changes. The subjects were instructed to abstain from stimulants such as tea, coffee, smoking, and alcoholic beverages prior to the day of the test and asked to have a light breakfast in the morning.

The recording of blood pressure both (SBP and DBP) variability was done at Basal, 1 minute and 2 minutes undergoing isometric exercises and cold pressor test and the readings were recorded in a controlled ambient temperature of 23º C to 25°C

Music Administration: The music intervention consisted of a choir session that used to sing twice weekly for 2 hours. A total of 40 choir rehearsals and practice sessions took place over a period of six months.

Music intervention

1. ***Structure and Duration of Music Sessions***- During the music sessions, the choir sang sessions and each session was held for two hours. There are two sessions a week. Participants engage in a structured sequence of activities, including active music-making, guided relaxation exercises, and focused listening.

2. ***Techniques Used:*** Active Music-Making, Guided Relaxation and Focused Listening. Active music-making involves participants playing musical instruments or singing, fostering Engagement and self-expression. By using auditory cues and imagery, guided relaxation exercises were designed to induce relaxation responses. Focused listening sessions involved participants attentively listening to selected musical pieces chosen for their potential to evoke specific emotional states.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Measurements [5]

1. Baseline blood pressure measurements

Baseline blood pressure measurements were obtained from each participant using standardized procedures. These measurements served as a reference point for assessing changes in autonomic responses following the music intervention.

2. Iso-metric exercise response

Participants underwent an isometric exercise test, during which blood pressure and heart rate responses were recorded. The assessment provided insights into the physical and emotional responses to stress and exertion.

3. Cold Pressor Test

An autonomic response to a cold stimulus was evaluated by administering a cold pressor test. Blood pressure and heart rate changes during this test offered insights into sympathetic and parasympathetic reactions under stress.

4. Standing to Lying Ratio Calculation

The S:L ratio, reflecting the balance between sympathetic and parasympathetic activity, was calculated using established formulas based on heart rate variability. This ratio provided a quantitative measure of autonomic balance.

5. Visual and Auditory Reaction Times (VRT and ART).

Visual and auditory reaction times were assessed as indicators of neural processing speed. Participants' reaction times to specific stimuli were measured to understand potential changes resulting from the music intervention.

Data analysis:

Mean and standard deviation calculations were performed for each parameter. Paired t-tests were conducted to compare pre-music and post-music values. SPSS (V24.0) was used for analysis. A significant increase was observed in the SBP and DBP during the cold pressor test in the post-music session, with a smaller increase in the pre-music session. The S:L ratio showed a significant decrease post-music indicating potential autonomic balance shifts. Visual reaction time improved post-music, while auditory reaction time remained relatively stable.

Results:

Table 1-Comparison of S:L and 30:15 ratio in Pre and Post Music Sessions.

Variables	Pre-Music Sessions	Post-Music Sessions	p-value
Mean age	27.3±6.2		
Mean S:L ratio	1.72±0.192	1.12±0.20	0.01

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Mean 30:15 ratio	1.12±0.32	0.96±0.14	0.02

As per ***Table 1***, The pre-music session exhibited an average S:L ratio of 1.72, which decreased to 1.12 in the post-music session. This reduction in the S:L ratio suggests that autonomic modulation happened after music and it was statistically significant ($p<0.05$) Similarly the mean 30:15 ratio was also decreased in post music session and it was statistically significant.

Table 2- Comparison of Blood pressure between sessions in terms of Isometric exercises

Variables	Pre-Music Sessions			Post-Music Sessions			p-value
BP	Basal	1 min	2 min	Basal	1 min	2 min	
SBP	133.27±10.7	126±15	137.9±18.7	107.9±9.8	131±12.6	141.27±9	0.01
DBP	82±8.5	88±8.7	96±3.6	74.53±6.8	95.05±8.5	105.4±6.4	0.01

Based on ***Table 2***, which examines the autonomic responses of choir singers during isometric exercise, it appears that music can influence those responses. The baseline values for systolic blood pressure (SBP) during isometric exercise show that participants exhibited relatively consistent responses in the pre-music session, with an average SBP of 112.909 mmHg across the two durations. After participating in music sessions, the post-music displayed a lower average SBP of 108.5 mmHg during isometric exercise. This suggests that music might contribute to a more controlled autonomic response to physical. Systolic Blood Pressure (SBP) increased by an average of 0.36 mmHg during isometric exercise in the pre-music session, while it increased by 1.18 mmHg in the post-music session. Diastolic Blood Pressure (DBP) increased by 4.72 mmHg during isometric exercise in the pre-music session, while it increased by 12.90 mmHg in the post-music session.

Table 3- Comparison of Blood pressure between sessions in terms of Cold Pressor test

Variables	Pre-Music Sessions			Post- Music Sessions			p-value
BP	Basal	1 min	2 min	Basal	1 min	2 min	
SBP	112.54±14	123.8±12.9	131.1±13	109.4±9.8	123.2±9.8	129.6±11	0.01
DBP	81.8±8.8	92±7	98.1±5.8	75.45±5.8	92.72±6	94.4±6.8	0.01

Based on ***Table 3***, music can potentially affect stress-induced autonomic changes, as determined by its effects on cold pressor test responses. The pre-music session Systolic Blood Pressure displayed an average increase of 25.18 mmHg during the cold pressor test, while the post-music session Systolic Blood Pressure exhibited a smaller average increase of 21.682 mmHg. Similarly, the diastolic blood pressure (DBP) responses in the pre-music session showed an average increase of 7.81 mmHg, whereas the post-music session demonstrated a smaller average increase of 6.81 mmHg. These findings suggest that music might contribute to mitigating stress-induced autonomic responses, potentially enhancing the participants' ability to manage stressful situations.

Table 4- Comparison between Auditory and Visual reaction time in both sessions

Variables	Pre-Music ***Sessions***	Post-Music ***Sessions***	p-value
VRT	179.36±32.8	175.818±19.1	0.01
ART	203.18±32.5	199.09±22.5	0.01

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

As per ***Table 4*** reaction times provide further insights into the potential effects of music on autonomic balance and neural processing speed. In terms of reaction times, the post-music *sessions* displayed a shorter average visual reaction time (VRT) of 199.09 milliseconds compared to the pre-music sessions' average VRT of 203.18 milliseconds. This improvement in reaction time might indicate enhanced neural processing speed as a result of music interventions and it was statistically significant ($p<0.05$).

Discussion:

Overall, the pre-music session exhibited higher blood pressure responses during isometric exercise and the cold pressor test, whereas the post-music session showed more controlled responses. The slight decrease in the S:L ratio suggests a potential shift in the autonomic balance after music sessions. Visual reaction time improved post-music, while auditory reaction time remained stable. These findings indicate that music may have influenced autonomic function among choir singers, leading to potential improvements in stress responses and autonomic balance. It would be valuable to further explore these changes in order to gain a better understanding of the specific mechanisms underpinning the influence of music on the autonomic function of the body.

The data indicate that music may contribute to altered autonomic responses, evidenced by changes in blood pressure, autonomic ratios, and reaction times. The findings suggest potential physiological adaptations following music interventions, warranting further investigation into the underlying mechanisms and clinical implications of these changes. The discussion of the study's results provides a comprehensive understanding of the implications of the observed changes in autonomic function and their relationship to music.

Based on the results of this study, there may be a link between choir singing and autonomic function. The observed changes in response to isometric exercise and the cold pressor test indicate that music might modulate autonomic responses to stress. A decrease in the S:L ratio post-music suggests modulation of ANS, which could influence stress regulation and overall autonomic balance. Additionally, the improvement in visual reaction time post-music implies enhanced neural processing speed, possibly reflecting cognitive enhancements brought about by music interventions. Similar results were updated in a few studies done [6,7,8].

The findings of this study are in accordance with the existing literature which has highlighted the impact of music on autonomic function in the body. The results of previous studies have shown that engaging in music-related activities can lead to autonomic nervous system modulation. [9,10]. This aligns with the decrease in the S:L ratio observed in our study, indicating a potential shift towards parasympathetic dominance. Furthermore, the observed improvements in reaction time and stress responses corroborate with studies that emphasize the beneficial effects of music interventions on cognitive processing and stress management. [11,12,13]

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

There are significant physiological and psychological implications associated with the observed changes in autonomic function. Potential autonomic modulation after music sessions could result in improved stress responses and a more balanced autonomic nervous system, which may contribute to enhanced well-being as a result of the improvements in reaction time, it is possible that music interventions might have cognitive benefits, such as increasing individuals' ability to process information and respond to stimuli more efficiently as a result of the interventions.
According to these findings, choir singing can benefit from a greater understanding of how to manage stress and cognitive demands, since managing stress and cognitive demands is crucial to their performance as well as their overall experience, which is similar to a few studies that have been conducted. [14-20]

While the results provide valuable insights, the study has several limitations that warrant consideration. The sample size was relatively small, which might limit the generalizability of the findings. Additionally, the study design focused on choir singers, which could introduce bias due to their unique musical training. Because there was no non-musical session to serve as a control session, it is very difficult to isolate the change observed in the session solely as a result of music. Moreover, the study design did not address confounding factors such as participants' overall health status, lifestyle factors, or individual differences in responses to music.

Conclusion:

The present study illustrates the potential of music for influencing autonomic function and promoting overall well-being. In conclusion, this research study illuminates the transformative potential of music for autonomic function among choir singers. Having summarized the study's key findings and highlighted its significance, along with calling for continued exploration and practical applications, this section is a good way to summarize the study's broader implications as well as to set the stage for further research in the field of music and health.

Building on these findings, future research could explore larger and more diverse samples to strengthen the generalizability of the results. Incorporating a control session that takes part in alternative interventions or does not participate in any intervention would help clarify the specific effects of music on autonomic function in humans. Longitudinal studies could investigate the sustainability of the observed changes over extended periods. From a clinical standpoint, the findings suggest that music interventions could be utilized as a complementary approach to enhance autonomic regulation and cognitive performance, particularly for individuals in high-stress professions or those seeking cognitive improvements.

Choir singers' musical training may have an impact on autonomic function, according to this study. The observed changes in autonomic responses to stress, alterations in autonomic ratios, and improvements in reaction times collectively suggest that music interventions could contribute to physiological and psychological enhancements.

Conflict of Interest- None declared.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Source of Funding- None

References

1. Chafin, S., Roy, M., & Gerin, W. (2004). Cardiovascular and behavioral effects of the operatic performance. Psychosomatic Medicine, 66(4), 487-494.

2. Thoma, M. V., La Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M. (2013). The effect of music on the human stress response. PLoS ONE, 8(8), e70156.

3. Jespersen, K. V., Otto, B., Kringelbach, M. L., Vuust, P., & Aarts, P. (2015). Aesthetic chills: Knowledge-acquisition, meaning-making, and aesthetic emotions. Psychology of Aesthetics, Creativity, and the Arts, 9(4), 428-438.

4. Linnemann, A., Kappert, M. B., Fischer, S., & Doerr, J. M. (2019). Effects of music and nature sounds on cortisol levels and cortisol response to stress. Psychoneuroendocrinology, 105, 108-116.

5. Koelsch, S., Offermanns, K., & Franzke, P. (2010). Music in the treatment of affective disorders: An exploratory investigation of a new method for music-therapeutic research. Music Perception: An Interdisciplinary Journal, 27(5), 307-316.

6. Thoma, M. V., Ryf, S., Mohiyeddini, C., Ehlert, U., & Nater, U. M. (2013). Emotion regulation through listening to music in everyday situations. Cognition & Emotion, 27(3), 534-543.

7. Thoma, M. V., La Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M. (2013). The effect of music on the human stress response. PLoS ONE, 8(8), e70156.

8. Knight, W. E., & Rickard, N. S. (2001). Relaxing music prevents stress-induced increases in subjective anxiety, systolic blood pressure, and heart rate in healthy males and females. Journal of Music , 38(4), 254-272.

9. Saarikallio, S., & Erkkilä, J. (2007). The role of music in adolescents' mood regulation. Psychology of Music, 35(1), 88-109.

10. Miranda, D., & Claes, M. (2009). Music listening, coping, peer affiliation and depression in adolescence. Psychology of Music, 37(2), 215-233.

11. Koelsch, S., & Jancke, L. (2015). Music and the heart. European Heart Journal, 36(44), 3043-3049.

12. Bernardi, L., Porta, C., Sleight, P., & Spicuzza, L. (2005). Cardiovascular, cerebrovascular, and respiratory changes induced by different types of music in musicians and non-musicians: The importance of silence. Heart, 91(3), 445-450.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

13. Thoma, M. V., La Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M. (2013). The effect of music on the human stress response. PLoS ONE, 8(8), e70156.

14. Jespersen, K. V., Otto, B., Kringelbach, M. L., Vuust, P., & Aarts, P. (2015). Aesthetic chills: Knowledge-acquisition, meaning-making, and aesthetic emotions. Psychology of Aesthetics, Creativity, and the Arts, 9(4), 428-438.

15. Linnemann, A., Kappert, M. B., Fischer, S., & Doerr, J. M. (2019). Effects of music and nature sounds on cortisol levels and cortisol response to stress. Psychoneuroendocrinology, 105, 108-116.

16. Koelsch, S., Offermanns, K., & Franzke, P. (2010). Music in the treatment of affective disorders: An exploratory investigation of a new method for music-therapeutic research. Music Perception: An Interdisciplinary Journal, 27(5), 307-316.

17. Thoma, M. V., Ryf, S, Mohiyeddini, C., Ehlert, U., & Nater, U. M. (2013). Emotion regulation through listening to music in everyday situations. Cognition & Emotion, 27(3), 534-543.

18. Koelsch, S., & Jancke, L. (2015). Music and the heart. European Heart Journal, 36(44), 3043-3049.

19. Bernardi, L., Porta, C., Sleight, P., & Spicuzza, L. (2005). Cardiovascular, cerebrovascular, and respiratory changes induced by different types of music in musicians and non-musicians: The importance of silence. Heart, 91(3), 445-450.

20. Miranda, D., & Claes, M. (2009). Music listening, coping, peer affiliation and depression in adolescence. Psychology of Music, 37(2), 215-233.