Full-Length Article

Effects of Different Styles of Music on Human Cardiovascular Response: *A Prospective Controlled Trial*

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Abstract

Background The potential effects of classical music (CL) and heavy metal (HM) in comparison to silence (S [“controls CO]) or noise (N) on cardiovascular parameters (blood pressure [BP], heart rate [HR]) and cortisol levels (C) has not been studied before.
Objective To analyse the effect of different music styles (intervention group) on BP, HR and C compared to S (control group).
Methods 120 volunteers aged 25-75 years were studied. 60 volunteers were consecutively assigned in the intervention group (n=60). Sixty volunteers were matched according to age, sex, height and weight (control group). Interventional music styles were CL (Bach, Suite No. 3, BWV 1068); HM (Disturbed, Indestructible) or various daily sounds =“noise” [N]). Sound exposure of CL, HM, or N was 21 minutes.
Results In the intervention group systolic, diastolic BP (mm Hg) and HR (beats per min) decreased mostly when CL was played compared to HM, N or CO (p<0.001). Findings prior to and after sound exposure (CL, HM, N) or in CO:

	Prior	CL	Prior	HM	Prior	N	Prior	CO
BP_{syst} (mm Hg)	128.3	120.8	123.5	119.9	125.2	120.0	123.0	120.6
$BP_{días}$ (mm Hg)	81.9	77.0	79.7	77.0	77.7	76.8	77.4	75.4
HR (min-1)	75.3	67.8	72.5	66.6	72.6	66.9	70.4	64.6

Conclusions Music will influence cardiovascular parameters. Classical music (“Bach”) leads to decreased values of BP and HR. In HM, N or S we could not observe similar findings.

Keywords: ***Classical music, Heavy metal music, blood pressure Heart rate, cortisol.***

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Introduction

The effects of music on humans have been well documented for thousands of years. There are several individual reactions to music that are dependent on individual preferences, mood or emotions [1,2]. It has been reported that musical perception is associated with modulation in heart rate, heart rate variability, blood pressure, body temperature, perspiration, respiration and muscle tension [3-6]. Listening to classical music may provide a helpful mnemonic for verbal learning during early development and in educational settings [7]. Music’s effects on the brain’s electrophysiology have also been reported in a number of studies [8-12]. The music of many composers effectively improves quality of life and has been reported to improve health, particularly music by Bach and Italian composers [13,14]. Some reports are available that analyzed the effect of music under different circumstances [15-23]. However, it is still unclear whether different music styles will influence cardiovascular parameters [24]. The objective of our study was to analyze the effects of different music styles on cardiovascular parameters in a prospective controlled study in a large number of volunteers.

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Hans-Joachim Trappe, MD, FACC, FESC. Department of Cardiology and Angiology, University of Bochum, Hoelkeskampring 40, 44625 Herne, Germany. E-mail: hans-joachim.trappe@rub.de | COI statement: The authors declared that there was financial support by the German Heart Foundation, Frankfurt am Main, Germany. Trial registration German Clinical Trials Register (DRKS00009835). The authors have no conflict of interest to declare.

Methods

Trial design

This prospective controlled study was comprised a study population with healthy volunteers compared to controls. In studied volunteers, all were sequentially subjected to classical music (Johann Sebastian Bach: Suite Nr. 3 D major, BWV 1068) and heavy metal music (Disturbed: Indestructible). There were also subjected to an additional intervention, a variety of sounds (herein called "noise"). The groups with classical music, heavy metal or noise were compared to periods of silence (control group). The study was approved by the Ethics committee of the Ruhr-University Bochum according to the ICH-GCP guidelines. All volunteers provided written, informed consent to participate (Ruhr-University Bochum, Register-No.: 3898-11). The study was registered in the German Clinical Trials Register (DRKS 00009835).

Inclusion criteria

Inclusion criteria for the volunteers were a normal physical examination, an age between 25 to 75 years, no history of any cardiac disease, no hypertension and a normal 12 lead electrocardiogram. None of the volunteers had any kind of medication. Volunteers with systolic blood pressures of >140 mm Hg or diastolic blood pressures > 90 mm Hg at the physical examination prior to the study, were excluded. All participants were randomized to a sequential order of classical music, heavy metal music or silence.

Intervention with music

Classical music: The classical music component was the Suite No. 3, D-major, from Johann Sebastian Bach (BWV 1068). The Suite has five parts: Overture, Air, Gavotte, Bourée and Gigue. The duration of the suite in total is 21 min.

Heavy Metal: The heavy metal music component was "Indestructible", the fourth studio album by the American heavy_metal band Disturbed. Indestructible was recorded at Groovemaster Studios in Chicago, Illinois and released on June 3, 2008. The album was certified platinum by the Recording Industry Association of America in April 2009 for shipping over 1,000,000 copies in the United States. The single "Inside the Fire" was nominated for a 2009 Grammy award in the "Best Hard Rock Performance" category. The duration of heavy metal music application was 21 min.

Variety of sounds: An additional music component of the human study was comprised of a series of different sounds of daily living (here termed "noise"). These sounds were: a drill, a vacuum cleaner, a jackhammer, a hairdryer, a chainsaw, and a crying child. A soundtrack of these sounds, each of 3-4 minutes and in this sequence, totaled 21 min.

Measurements during music intervention

Studies were performed in all participants on consecutive days with each intervention starting every day at 10.00 a.m. in the same room during the study. All volunteers were instrumented with a 12-lead surface electrocardiogram (GE Marquette MAC 1200), a Holter recording (PhysioQuant, Fa. Envitec), and a continuous blood pressure recorder (Pathfinder-system, Fa. Spacelab Healthcare) or the Lifecard CF system, Fa. DelMar Reynolds GmbH. In all participants, after a baseline silence period of 30-45 min, study music was presented via stereo headphones (Fa. Philips, Eindhoven, The Netherlands) plugged into an mp3-player (Odays S-8 2 GB, S-15, Fa. Odys) at 10.00 a.m.. The duration of each of the classical music, heavy metal music and silence interventions was 21 min. The volume level of the music interventions was maintained at 60 db throughout. Over the course of the experiment, subjects were in a supine position. During the baseline period the subjects were asked to close their eyes and concentrate on the music. Room temperature was 23° C.

Participants

Participants (n=139) were screened for the study. Due to the inclusion criteria, 19 volunteers were excluded from the study. All of them were hypertensive and 9 of them received antihypertensive medication. In total, 120 healthy volunteers were enrolled in this prospective controlled trial (Fig. 1). All volunteers were between 25 to 75 years, with no history of cardiac disease, no hypertension and a normal 12 lead electrocardiogram. Volunteers were consecutively assigned to the interventional study group (n=60), 60 other volunteers were matched according to age, sex, height and weight. These volunteers served as control group und underwent a period of silence (Fig. 1).

Statistical analysis

The primary endpoint of the study were measurements of heart rate, blood pressure and cortisol prior to music and after music intervention. Paired sample t-tests were performed to evaluate differences between measurements taken before and after listening to music or silence. The Wilcoxon's test and Mann-Whitney-U test were applied to determine the differences before, during, and after listening to music or silence due to non-normally distributed data. Other tests used were the Shapiro-Wilk-test and the Bowkers test. All analyses were done with IBM-SPSS, Version 20 (IBM, Munich, Germany). P-values less than 0.05 were considered significant.

Flow Diagram

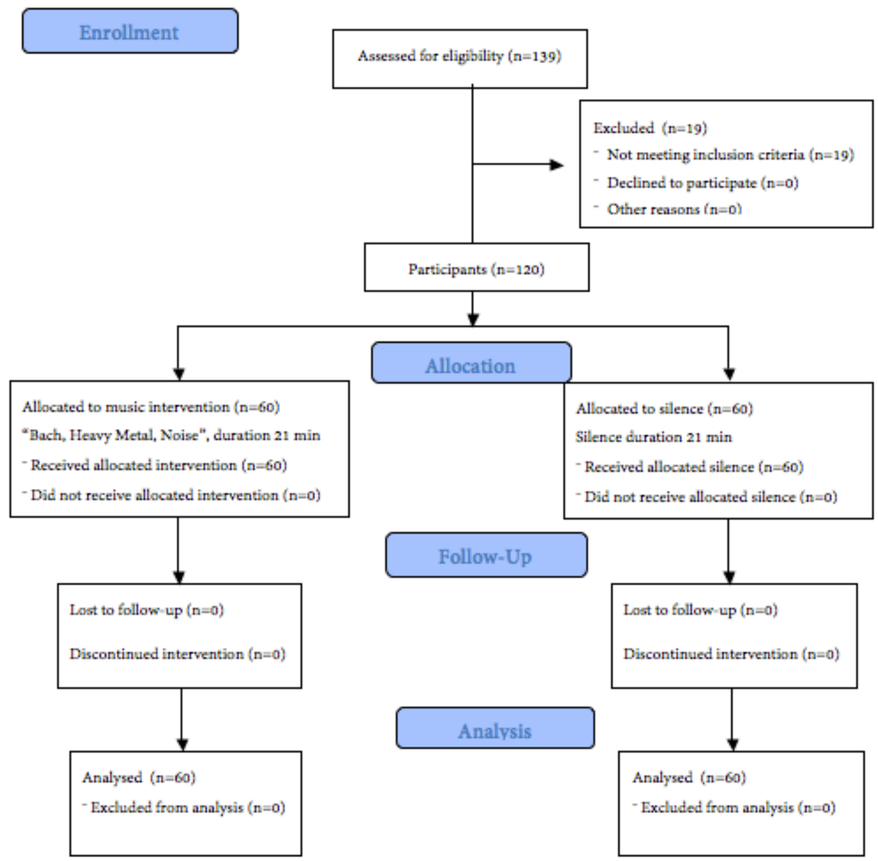

Fig. 1: Flow Diagram of the study

Results

Study population and Controls

60 healthy volunteers (30 males, 30 females) with a mean age of 46.1±12.6 years (range 25-75 years) were included in this prospective controlled study. These participants listened to three music interventions: classical, heavy metal and various daily sounds (noise). Sixty other volunteers (30 males, 30 females) with a mean age of 44.7±13.8 years (range 25-75 years) were matched to the study group and served as controls (Fig. 1). These participants were subjected to only one intervention of silence. There were no significant differences in the characteristics of the study group volunteers compared to those in the control group (*Table 1*). All participants were drug-free with normal values of blood pressure (RR <140/90 mm Hg), heart rate (60-100/min) according to the guidelines of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC)(25). All participants underwent the complete study protocol; none of them stopped the study previously. Adverse side effects of music were not observed in any of the volunteers. The study period was May 2011 to October 2012.

Study measurements

At 10.00 a.m., just prior to the music interventions, the volunteers underwent a blood test to measure their cortisol level to evaluate their stress level. 10 o'clock was chosen because, at this time, the circadian cortisol level is at its lowest. After the end of each music intervention, another blood test for cortisol measurement was performed. Just before and just after, participants were exposed to each music intervention, their blood pressure and heart rate were recorded under silence. Then, music starts and blood pressures and heart rates were recorded during 60 min after starting every five minutes. After one hour, measurements were done every 15 min until 1.00 p.m.

Results

Cortisol measurements

The cortisol level for the entire study population at baseline was 12.4±5.3 µg/ml (range 6.0-31.8 µg/ml) and was not different between males (13.1±5.1 µg/ml, range 6.0-24.9 µg/ml) and females (11.8±5.5 µg/ml, range 6.0-31.8 µg/ml). In addition no significant differences were observed between volunteers < 50 years (12.0±5.3 µg/ml, range 6.0-24.9 µg/ml) and those ≥ 50 years (12.9±5.4 µg/ml, range 6.0-31.8 µg/ml). Cortisol levels decreased significantly compared to baseline when listening to classical music (10.3±4.6 µg/ml, range 7.0-23.7 µg/ml, p<0.001), heavy metal music (10.6±4.4 µg/ml, range 7.6-26.1 µg/ml, p<0,001) and noise (10.7±4.5 µg/ml, range 7.5-24.3 µg/ml, p<0.001). Cortisol level also decreased significantly in the control population when exposed to silence (12.2±4.5 µg/ml, range 3.6-27.7 µg/ml, p<0.001). There were no significant differences in the cortisol levels between control group and volunteers who listened to classical music (p=0.583), heavy metal music (p=0.274) or noise (p=0.232)(Fig. 2).

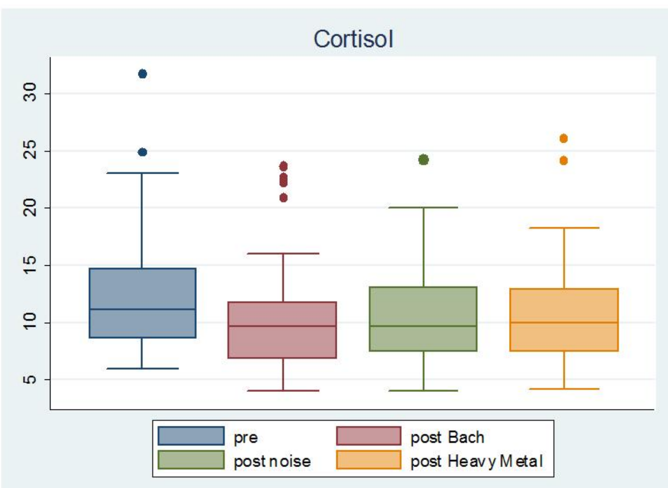

Fig. 2: Cortisol levels prior to the study and after listening to classical music, heavy metal music, noise and silence. Acoustic exposure=music intervention.

Blood pressures

We studied the systolic and diastolic blood pressures before music intervention, during music intervention and thereafter (Fig. 3,4).

Classical music

Upon the intervention of classical music, systolic blood pressure significantly reduced from 128.3±11.3 mm Hg, range 107-138 mm Hg, just before the music to 120.8±12.6 mm Hg, range 100-163 mm Hg, p<0,001, just after the music. After the

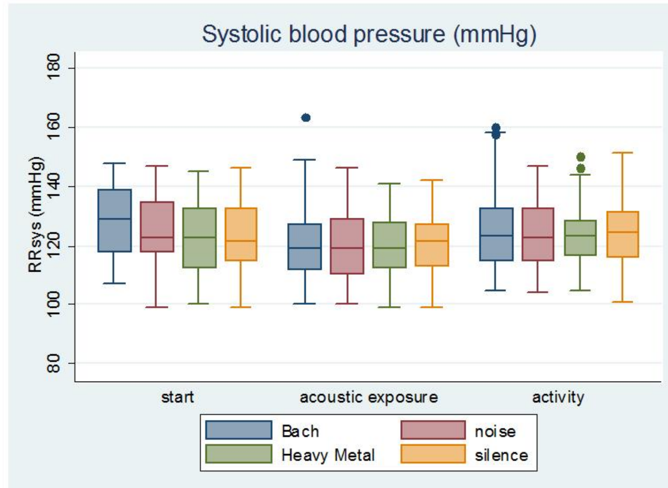

Fig. 3: Systolic blood pressure prior to the study and after listening to classical music, heavy metal, "noise" and silence.

end of classical music, systolic blood pressure increased significantly (mean 125.0±12.2 mm Hg, range 105-160 mm Hg, p<0,001). Likewise, significant reductions were noted in diastolic blood pressure immediately following classical music from 81.9±7.9 mm Hg, range 61-94 mm Hg just before the music to 77.0±9.0 mm Hg, range 55-101 mm Hg, p<0,001, just after the music. After the end of Bach's music the diastolic blood pressure was significantly higher (mean 82.7.0±8.4 mm Hg, range 58-102 mm Hg) compared to music application (p<0,001).

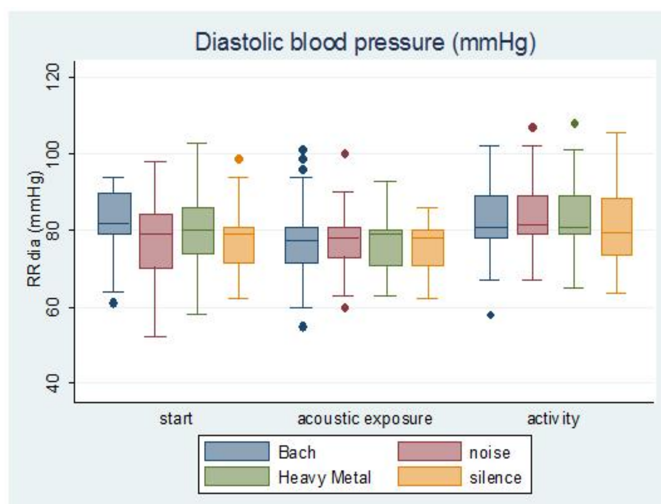

Fig. 4: Diastolic blood pressure prior to the study and after listening to classical music, heavy metal music, noise and silence. Acoustic exposure=music intervention.

Heart rate

Analogous changes in heart rate were observed due to the different music interventions (Fig. 5). Significant differences were noted in heart rate from the baseline period before the classical music intervention (heart rate 75.3±12.0 bpm, range 55-90 bpm) to following it (heart rate 67.8±8.4 bpm, range 53-86 bpm, p<0,001). After the end of Bach, heart rate increased significantly to 78.4±11.9 bpm, range 58-113 bpm, p<0.001). Analyzing the effect of the different components of Bach' suite, heart rate prior to its commencement was 75.3±12.0 bpm, range 55-99 bpm. From this, heart rate went to 69.8±11.2 bpm, range 48-105 (p<0,001) during "Ouverture", 68.4±9.4 bpm, range 53-88 bpm, p<0.001) during "Air" 68.4±9.4 bpm, range 53-88 bpm, p<0.001), during "Gavotte" 68.5±9.8 bpm, range 51-88 bpm, p<0.001), during "Bourée" 66.4±8.4 bpm, range 51-82 bpm, p<0.001) and during "Gigue" 68.1±9.2 bpm, range 52-85 bpm, p<0.001).

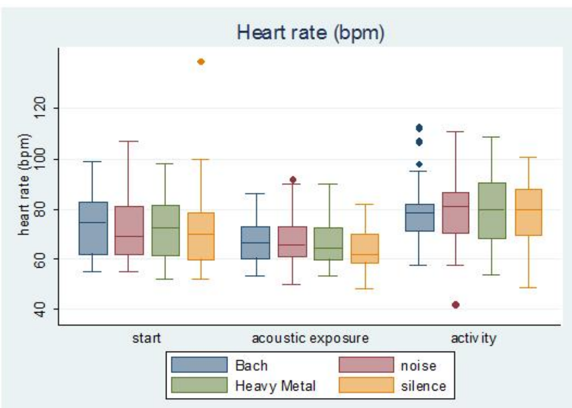

Fig. 5: Heart rate prior to the study and after listening to classical music, heavy metal music, noise and silence. Acoustic exposure=music intervention.

In volunteers undergoing heavy metal music heart rate decreased from 72.5±11.3 bpm (range 52-98 bpm) to 66.6±9.4 bpm (range 53-90 bpm, p<0.001). After heavy metal music intervention, heart rate increased significantly to 79.2±12.4 bpm, range 54-109 bpm, p<0.001. Interestingly, the noise intervention was associated with similar results: before the intervention the heart rate was 72.6±12.4 bpm (range 55-107 bpm) and decreased to 66.9±9.8 bpm, range 50-92 bpm; after discontinuation, heart rate increased to 79.0±12.7 bpm, range 42-111 bpm, p<0.001. Lastly, the control group exhibited similar changes with the silence intervention: heart rate was 70.4±14.0 bpm (range 52-139 bpm) at the beginning, 64.6±7.6 bpm, range 48-82 bpm, p<0.001) during silence and 78.8±11.9 bpm, range 49-101 bpm, p<0.001) after (Figure 4).

Baseline systolic blood pressures (128.3±11.3 mm Hg, range 107-148 mm Hg) decreased significantly following "Overture" (120.9±12.4 mm Hg, range 97-153 mm Hg, p<0.001), "Air" (121.1±12.4 mm Hg, range 98-162 mm Hg, p<0.001), "Gavotte" (120.9±12.6 mm Hg, range 102-164 mm Hg, p<0.001), "Bourée" (120.6±13.7 mm Hg, range 95-165 mm Hg, p<0.001) and "Gigue" (120.4±15.2 mm Hg, range 86-162 mm Hg, p<0.001). In addition, significant differences were observed in diastolic blood pressures: prior to classical music diastolic blood pressure was 81.9±7.9 mm Hg (range 61-94 mm Hg) and decreased significantly during "Overture" (76.9±8.8 mm Hg, range 50-100 mm Hg, p<0.001), "Air" (77.1±7.9 mm Hg, range 53-95 mm Hg, p<0.001), "Gavotte" (77.0±8.9 mm Hg, range 56-101 mm Hg, range 56-103 mm Hg)(p<0.001), "Bourée" (76.5±9.4 mm Hg, range 55-103 mm Hg, p<0.001) and "Gigue" (78.5±11.1 mm Hg, range 56-105 mm Hg, p<0.001).

Heavy metal music

Exposure to heavy metal music also caused a reduction in blood pressure, but to a lesser degree than classical music. Baseline systolic blood pressure before heavy metal music (123.5±11.6 mm Hg, range 100-145 mm Hg) was significantly reduced afterward (119.9±10.4 mm Hg, range 99-141 mm Hg, p<0.001). After the end of heavy metal music the systolic blood pressure increased significantly (124.0±9.8 mm Hg, range 105-150 mm Hg) compared to music application (p<0,001). In addition, significant differences were noted in diastolic blood pressure following heavy metal music (79.7±9.0 mm Hg, range 58-103 mm Hg) to 77.0±6.8 mm Hg, range 63-93 mm Hg when listening to heavy metal music, p=0.004. After the end of Disturbed's music the diastolic blood pressure was significantly higher (83.6.0±8.4 mm Hg, range 65-108 mm Hg) compared to music application (p<0,001).

Noise

Significant differences were noted in systolic blood pressure before and after listening to noise (125.2±11.4 mm Hg, range 99-147 mm Hg) before and 120.0±11.9 mm Hg, range 100-146 mm Hg, when listening to noise (p<0,001). After the end of various sound application the systolic blood pressure increased significantly (124.4±11.4 mm Hg, range 104-147 mm Hg) compared to music application (p<0,001). In addition, differences were noted in diastolic blood pressure before and after listening to noise (77.7±9.7 mm Hg, range 52-98 mm Hg) before and 76.8±7.4 mm Hg (range 60-100 mm Hg) when listening to noise (p=0.367). After the end of noise the diastolic blood pressure was significantly higher (83.5±8.4 mm Hg, range 67-107 mm Hg) compared to noise application (p<0,001).

Silence

We observed similar effects on blood pressures during interventions of silence: significant differences were noted in systolic blood pressure before to after silence (123.0±11.2 mm Hg, range 99-146 mm Hg) to 120.6±8.7 mm Hg, range 100-163 mm Hg, p=0.016. After the end of silence time the systolic blood pressure increased significantly (124.4±10.9 mm Hg, range 101-152 mm Hg, p<0,001). In addition, similar differences were noted in diastolic blood pressure before and during silence (77.4±7.9 mm Hg, range 62-99 mm Hg) before and 75.4±5.5 mm Hg, range 55-101 mm Hg) after (p=0.081). After the end of silence study time the diastolic blood pressure was significantly higher (81.3.0±9.7 mm Hg, range 64-106 mm Hg) compared to music application (p<0,001).

Discussion

To the best of our knowledge, this is the first prospective controlled study that analyzed the influence of different music styles on cardiovascular parameters in humans. The study investigated, whether music influenced the autonomic nervous system and/or cardiovascular parameters [26].

Effects of music on the cardiovascular system

Bernardi [6] studied 24 young, healthy subjects (12 chorists and 12 nonmusician control subjects) who listened in random order to music with vocal (Puccini's "Turandot") or orchestral (Beethoven's Ninth Symphony adagio) progressive crescendos, more uniform emphasis (Bach's cantata BWV 169 "Gott soll allein mein Herz haben"), 10-second period rhythmic phrases (Verdi's arias "Va pensiero" and "Libiam nei lieti calci") or silence while heart rate, respiration, blood pressure, middle cerebral artery flow velocity, and skin vasomotion were recorded. Vocal and orchestral crescendos produced significant correlations between cardiovascular or respiratory signals and musical profile, particularly skin vasoconstriction and blood pressures, proportional to crescendo, in contrast to uniform emphasis, which induced skin vasodilation and reduction in blood pressure. Correlations were significant both in individual and group-averaged signals. Phrases at 10-second intervals by Verdi entrained the cardiovascular autonomic variables. The extent of the responses appeared to be dependent on the specific pattern of the musical profile: when a sudden crescendo was spaced adequately, or the musical profile exhibited a regular or slow change, then the cardiovascular system tracked the musical profile, and skin vasomotion was evident. When the musical profile changed very rapidly, the overall effect was opposite. Skin vasomotion and a reduction in blood pressure by general relaxation were observed [6]. It has been shown in other studies by Nakahara [27] that music may have beneficial effects on heart rate, heart rate variability and anxiety levels in not only skilled pianists but also non-musicians both during the performance and listening of music. The findings of these different studies suggest that musical performance has a greater effect on emotion-related modulation in cardiac autonomic nerve activity than musical perception [28,29,30].

Fernell evaluated the effects of music on anxiety in the perioperative period [31]. Patients in the music group were given stereo headphones, a cassette player, and a choice of 22 types of music, including classical guitar music, chamber music, folk music and soft hits. Patients in the music group had lower heart rate and blood pressures than in the group not administered music both during and after surgery. In contrast to our study, Bernardi, Nakahara and Fernell had only short applications of music, which were selected by the participants [27,31]. In our study, different types of music were administered in random order. In addition, the other studies generally utilized subjective endpoints (participant's level of relaxation, mood and feeling) with no objective endpoints such as blood pressure, heart rate or cortisol levels. Therefore, it is difficult to compare our results with those of the other studies.

Bach and the cardiovascular system

Classical music can enhance cognitive functions, such as spatiotemporal reasoning, attention, and memory [32,33]. Music with slow rhythms and soft sounds seem to be beneficial [34,35]. A number of other studies have reported that listening to music with slow tempo, legato phrasing, minimal dynamic contrasts can lead to decreased heart rate, respiration rate, and blood pressure. However, these effects are inconstant [36]. In the present study, Bach's suite was selected to analyze the effects on blood pressure and heart rate. Analyzing the results from the five individual parts of the suite, significant differences were not demonstrated despite differences in the loudness and tempo of the different components. This is in contrast to prior observations which have concluded that the structure of a piece of music has a constant dynamic influence on cardiovascular and respiratory responses correlating with musical profile [6,37]. Specific musical phrases (frequently at a rhythm of 6 cycles/min in famous arias by Verdi) have been shown to synchronize inherent cardiovascular rhythms, thus modulating cardiovascular control. This occurred regardless of respiratory modulation, which suggests the possibility of direct entrainment of such rhythms and led to the speculation that some of the psychological and somatic effects of music could be mediated by modulation or entrainment of these rhythms [38]. These observations were made during 10- second periods. We utilized a novel study design and cannot support Bernardi's hypothesis that different music phrases have different influence on the cardiovascular system [6].

Role of various sounds on cardiovascular parameters

Noise is one of the most prevalent workplace hazards, which is not only prominent in factories, but also it is one of the hazards outside the workplace. Previous studies have identified significant adverse health effects due to industrial noise, including auditory and heart-related problems [39]. Van Kempten reported an association between both occupational and air traffic noise exposure and hypertension [40]. Virkunnen found significant increase in ischemic heart disease risk in their long-term follow-up of industrially employed men exposed to noise [41]. In addition, Lusk identified a significant association between blood pressure and heart rate with noise exposure [42]. In the present study, no significant differences on heart rate and blood pressures were found between the music and noise intervention modeled by a series of common household noises. A possible explanation for this might be that subjective perception of noise is not an important factor in the cardiovascular effects of noise exposure. This hypothesis is in agreement with Haralabidis [43]. He concluded that the cardiovascular system response appears to be independent of the noise amplitude and source. Surprisingly, our study showed that blood pressures decreased during noise exposure and returned to baseline after the cessation of the noise. Previous studies have not recorded a blood pressure decrement during noise exposure as significant as ours [44,45].

Influence of music on cortisol levels

Nielsson analyzed the follow-up of 58 patients following cardiac surgery [46]. These patients underwent 30 min music exposure one day after surgery compared to controls. Cortisol level, heart rate, ventilation rate, blood pressure, SaO_2, pain and anxiety indices were assessed. They found significantly lower cortisol levels in the music group patients compared to those without music. There were no significant differences in other parameters between both groups. Similar effects have been reported by Antonietti, in patients undergoing rehabilitation following surgery [47]. We demonstrated that cortisol levels decreased during music application. However, this was not specific to any particular type of music intervention, noise and silence.

Conclusions and interpretation

Music plays an increasing role in several disparate areas of everyday life and can reduce stress, improve athletic performance, and improve motor function in some neurologically impaired patients. Although there are many observations and explanations about the effects of music, most studies have not rigorously evaluated objective behaviors and cardiovascular response caused by different types of music. Various studies have suggested that this music not only makes people happy, but has significant effects on the cardiovascular system and influences significantly heart rate, heart rate variability and blood pressure as well. In the present study we demonstrated that multiple music styles, including also a variety of sounds and silence decreased blood pressures and heart rate. The classical music from Bach tended to exhibit the greatest effect.

Currently, there are no reported case studies that investigate the significance or organisation of song functioning in children with an acquired brain injury. Examining a developmentally significant musical function such as singing after injury in childhood is needed. Not only to inform our understanding of musical organisation in the developing brain, but also to inform clinical practices during MT interventions to maximise outcomes. Studying such phenomena in vivo with such a vulnerable patient population is difficult due a variety of heterogeneous factors including nature of injury, age at insult and levels of parental distress. Behavioral observations during standard clinical practice MT sessions provide a novel and non-invasive approach to study the nature and trajectory of recovery of musical functions after childhood brain injury. The following case represents a pivotal step toward understanding singing functioning in the developing brain and highlights the role that suitably trained music therapists might use in furthering our understanding of musical functioning in the presence of neurological damage.

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Biographical Statements

Hans-Joachim Trappe, born 1954, is a cardiologist, professor for internal medicine and cardiology at the Ruhr-University Bochum, Germany. Since 1996 he is director of the department of cardiology and angiology, Marien Hospital Herne, University Hospital of the Ruhr-University, Bochum, Germany. Beside his work in internal medicine and cardiology, he is an international organ player with many years of experience, with concerts in Cologne, Salzburg, Paris, Jerusalem, Berlin, etc. He has recorded 24 CDs as an organ player.

Irini Maria Breker has been working with Prof. Trappe for many years. She is a cardiologist in the department of cardiology and angiology at the Marien Hospital Herne, Ruhr-University of Bochum. She is continuously working the Topic "music and cardiovascular medicine".

Table 1 Demographics in the study population and controls

	Study group	Controls	p
No of volunteers	60	60	ns
Mean age (yrs)	46.1±12.6	44.7±13.8	ns
Mean height (cm)	173.6±10.8	173.1±9.7	ns
Weight (kg)	76.7±18.4	74.4±16.1	ns
BMI (kg/m^2)	25.2±4.5	24.6±3.8	ns
RR syst (mm Hg)	127.3±12.4	124.7±19.1	ns
RR diast (mm Hg)	78.8±10.2	79.9±6.3	ns
Heart rate (bpm)	68.9±13.5	68.6±10.1	ns
males			
No of volunteers	30	30	ns
Mean age (yrs)	45.4±13.3	45.5±13.7	ns
Mean height (cm)	181.7±8.2	180.4±6.9	ns
Weight (kg)	87.5±17.7	85.2±15.1	ns
BMI (kg/m^2)	26.4±4.7	26.2±4.1	ns
RR syst (mm Hg)	129.9±12.3	129.7±9.0	ns
RR diast (mm Hg)	79.4±7.4	80.3±6.3	ns
Heart rate (bpm)	71.9±12.9	68.6±10.8	ns
females			
No of volunteers	30	30	ns
Mean age (yrs)	46.7±12.0	43.9±14.0	ns
Mean hight (cm)	165.6±6.1	166.3±6.6	ns
Weight (kg)	65.8±11.6	64.4±9.1	ns
BMI (kg/m^2)	24.0±4.1	23.3±2.8	ns
RR syst (mm Hg)	124.7±12.3	120.1±14.4	ns
RR diast (mm Hg)	80.2±8.1	79.4±6.4	ns
Heart rate (bpm)	66.0±13.6	68.7±9.5	ns

Abbreviations:
BMI=body mass index, cm=centimeter, bpm=beats per minute, diast=diastolic, kg=kilogram mm=millimeter, syst=systolic, RR= blood pressure (Riva-Rocci), yrs=years