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A Comparative Study of the Impact of Himalayan Singing Bowls and Supine Silence on Stress Index and Heart Rate Variability

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Abstract

Introduction: Sound vibrations have a profound impact on the body and the mind with evidence confirming reduced anxiety and increased wellbeing. The likely reason for driving the benefit is relaxation. The Himalayan Singing Bowls, used for therapeutic intervention to enhance the individual's emotional & physical wellbeing, may facilitate faster and deeper relaxation as compared to simple, supine relaxation.

Aim of the Study: The study aimed to validate the hypothesis that short 20 minutes sessions to relax with the help of the Himalayan Singing Bowl (HSB) could provide better depth of relaxation as compared to Supine Silence (SS) based on the objective assessment of physiology parameters i.e. Stress Index & Heart Rate Variability (HRV).

Methods: Seven metal Himalayan singing bowls were used in a particular sequence learned from an expert teacher for 16 subjects. The SS group consisted of 17 subjects. The HRV data was measured by the Emwave Pro device and analyzed using Kubios HRV Premium software. The analysis compared key HRV parameters within and between the groups.

Result: Overall, as expected, both groups achieved relaxation as measured by changes in HRV parameters. However, further analysis confirmed a more consistent relaxation, as measured by a statistically significant reduction in stress index and an increase in HRV, for HSB group. The HSB group achieved more consistent depth of relaxation during each subsequent 5 minutes interval throughout the session as compared to SS group.

Conclusion: The study confirms that singing bowls sessions can be leveraged as a tool for inducing good quality relaxation response (increased parasympathetic tone, reduced stress) to facilitate healing and energy recovery in just 20 minutes and achieve significant health benefits. More comprehensive studies must be conducted to further evaluate the findings with more sample size, different methods of relaxation and varied demographics.

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Keywords: Stress Index (SI), Heart Rate Variability (HRV), Himalayan Singing Bowls (HSB), Relaxation Response, Silence, Sound Healing

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Introduction

The scientific evidence has demonstrated a link between chronic stress and chronic disease through pathways that impact both the mind and the body [1, 2]. Chronic stress also has a significant impact on the immune system [3, 4]. Chronic stress impairs the autonomic nervous system by hyper-activation of the sympathetic nervous system also known as "fight or flight" mode. To manage the impact of stress on physiology, it is important to activate the "rest and digest" mode i.e., parasympathetic nervous system activity.

Research in meditation practices (specifically Mindfulness-Based Stress Relaxation), Yoga Nidra - Yogic relaxation and "Relaxation Response" has demonstrated enhanced well-being, reduced anxiety through improved physiological homeostasis [5, 6, 7, 8, 9, 10]. These studies confirm the impact of deep relaxation on the mind and the body, regardless of the types of methods involved [11]. Given the benefits of such practices, there is an opportunity to explore techniques that could lead to better and faster physiological relaxation response.

This study aimed to examine if sound vibrations from the Himalayan Singing Bowls could induce faster and deeper relaxation as compared to Supine Silence. Sound healing has been used for centuries in various forms across different cultures in religious rituals, festivals, social ceremonies and meditative practices using instruments such as singing bowls, gongs, bells, didgeridoo or using vocal sounds and chants [12, 13]. Scientific evidence confirms the impact of sound vibrations on physical and emotional health [14]. Sound healing or therapeutic interventions of sound, as compared to music therapy, involves a combination of different sounds without using any particular melody or rhythm. The resonance through sound vibrations impacts the physical body while the hearing process impacts the mind. Recent studies have confirmed the positive impact of singing bowls (its frequencies/partials) on the body and the mind (reduction in anxiety and mood) by measuring HRV (ECG-Electrocardiography), EEG (Electroencephalogram), Skin Conductance and various surveys. However, most of the studies have used a one-hour long session.

According to the authors' understanding based on the literature survey, no studies have explored the relaxation for a short duration intervention [9, 10]. This study aimed to test the hypothesis that HSB is likely to achieve much deeper relaxation even during a very short session of only 20 minutes as compared to SS based on objective physiological parameters (HRV).

Objectives

The study aimed to understand the impact of short duration i.e. 20 minutes' sessions with HSB on the subjects during supine relaxation. The primary objective was to assess the effectiveness of HSB sessions on the subjects as measured by the decrease in Stress Index through HRV data. The secondary objective was to understand if key HRV parameters also show the trend confirming the depth of relaxation resulting in increased parasympathetic nervous system activity.

The hypothesis is that only 20 minutes long HSB sessions are more effective in inducing deeper relaxation as compared to SS based on the assessment of objective HRV parameters.

Materials and Methods

Participants & Design

The study was conducted at a Wellness Center where the clients come to address quality of life challenges such as poor sleep, anxiety, relationship issue, etc. Each subject signed a written consent and confidential disclosure agreement. The ethics committee approval was not needed due to the non-invasive nature of the intervention consistent with an earlier study [12].

A room with good soundproof interiors was used while maintaining 25 Degree Centigrade temperature. This ensured the minimum impact of outside sound and a pleasant indoor temperature. The exclusion criteria included the presence of (a) chronic disease (b) epilepsy (c) pacemaker in the body and (d) metal parts due to any surgery inside the body or (e) inability for the subject to lie down on the floor in supine position. The demographics of subjects in both groups are captured in Table 1. Out of 21 individuals who participated in Himalayan Singing Bowls session, data of 5 individuals were rejected due to either artifact quality or disturbance in recording. For Supine silence, only 3

individuals' data was rejected out of 20. Table 1.

The Protocol

For Himalayan Singing Bowls sessions, the subjects were asked to lie down with eyes closed for 20 minutes. 7 Himalayan Singing Bowls (Full Moon Singing Bowls, Nepal) and a Tingsha were used (as shown in Figure 1). The bowls' diameter ranged from 18cm (for the smallest bowl) to 29.5 cm (for the largest bowl). The bowls were hit with a mallet (resembles the hammer with a soft, puffy end that is used for hitting) and the gap between the successive hits was minimum of 5 seconds. The sequence started with the bowl between the legs (furthest away from the head) and slowly moved towards the bowl nearer to the head while alternating on either side of the body. The sequence began with medium (about 50% of the maximum) intensity sound and each subsequent cycle of 7 hits of bowls and 1 hit of Tingsha reduced the intensity marginally (e.g. 50%, 40% and so on). Once the intensity was the lowest (10%) the subsequent cycles increased the intensity progressively towards 50% and this sequence was continued till 20 minutes were completed. Each cycle was followed by a sound of Tingsha. The subject remained supine with eyes closed throughout the practice, though the eyes were not covered during both the types of sessions. No guided instructions were used throughout the 20 minutes. This method is part of a more comprehensive method taught

Table 1. Demographics of the subjects

Intervention	Total Subjects	Number of Male subjects	Number of Female subjects	Average Age (years)
Himalayan Singing Bowls (HSB)	16	8	8	28
Supine Silence (SS)	17	7	10	25

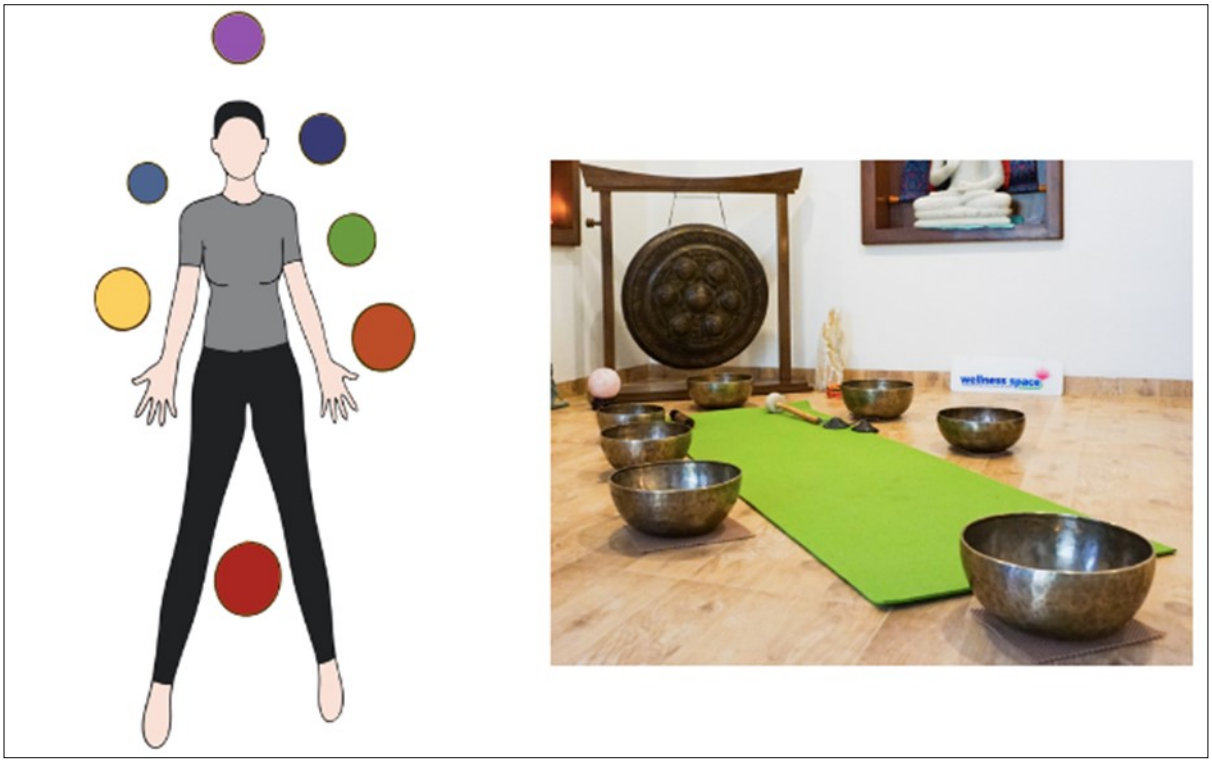


Figure 1. Arrangement of the Singing Bowls for Sound Bath Session (Left: Plan indicating the layout, Right: Actual photograph without the subject), reproduced with permission from Wellness Space, Ahmedabad, India.

by Master Shree Krishna Shahi (Nepal) to author Gunjan Y Trivedi in year 2016.

For Supine Silence, the exact same process was used (duration, position) and this was done in complete silence without any sound of singing bowls.

Data Analysis

Heart Rate Variability (HRV) & Stress Measurement

HRV is a physiological phenomenon denoting the variation in the time interval between heartbeats (also measured from beat-to-beat intervals i.e. R-R intervals. RR interval, measured via electrocardiogram signal, indicates the time intervals between consecutive heart beats. A low HRV, i.e., less variability in the heart beats as measured by the RR intervals, indicates that the body is under stress due to physiological reasons, exercise, disease condition or any other external stressor. High HRV denotes better emotional regulation [15]. HRV is also emerging as a marker of autonomic nervous system imbalance, stress, metabolic syndrome and chronic disease [16].

For the present study, we used Kubios Stress Index data and traditional HRV parameters such as Heart Rate (HR) and RMSSD (Root Mean Squared Standard Deviations of RR interval) [17]. The RMSSD reflects the beat-to-beat variance in heart rate and is the primary time-domain measure used to estimate the vagally mediated changes reflected in HRV. RMSSD also correlates with parasympathetic activity and hence used as a measure for this case study along with Stress Index (described in the next paragraph) [18]. Together, these three physiological measures provide a much better understanding of the relaxation process as compared to just a subjective survey or simple objective measurement such as heart rate alone.

HRV can also provide a physiological measure of stress levels experienced by an individual. There are several reasons to explore the physiological measurement of stress since it negatively impacts the quality of life. The stress has a trigger (cause) and it impacts the human body and the mind. Given the subjective nature of the trigger, it is difficult to measure stress and this gets further complicated due to each individual's subjective perceptions about stress. Thus, stress measurement is a complex process considering all the cause-effects factors such as (a) the environment or stimulus, usually happening outside the individual, (b) individual's own stress response mechanism which varies from person to person (c) perception or interpretation of the individual to the trigger and (d) finally, the biological impact on the physiology and cognitive functions (including sleep quality, memory, focus, etc.). Additional factors to consider in stress measurement include whether the stress is acute or chronic, an individual's coping mechanism, social support, etc. [19, 20].

Given these complexities, this study decided to use the HRV method based on Baevskey's calculation of Stress Index using the RR interval data [21]. This formula (1) uses a histogram based on the 50ms interval mapping of the RR intervals to calculate the stress levels. Kubios Premium HRV software, which was used to analyze the data, uses the square root of the Baevskey's stress index formula, shown below (and in Figure 2).

$$SI = \frac{AMo \times 100\%}{2Mo \times MxDMn} \quad \text{.....(1)}$$

Mo is the median of the RR interval in seconds. MxDMn is the width of the histogram showing the degree of variability in RR intervals. AMo is the height of the normalized RR interval histogram (bin width of 50ms). Figure 2

Emwave Pro device (HeartMath, LLC) was used to record the HRV signals using a PPG (photoplethysmogram) ear sensor during both types of sessions. The data was analyzed using Kubios HRV premium software (on a Windows PC). Features available in Kubios HRV Premium software (version 3.3.0) were used to export the parameters in a .txt file which included Stress Index, Heart Rate and RMSSD. Each .txt file was tabulated and analyzed using Microsoft Excel pivot table. The data was integrated for each of the 5 minutes during the 20 minutes long sessions. Microsoft Excel features, specifically function TTEST, were used to do statistical analysis of the data. The analysis used Paired T-test to compare the changes between various intervals for each method (details are captured in the results).

Results

Stress Index and HRV Trend

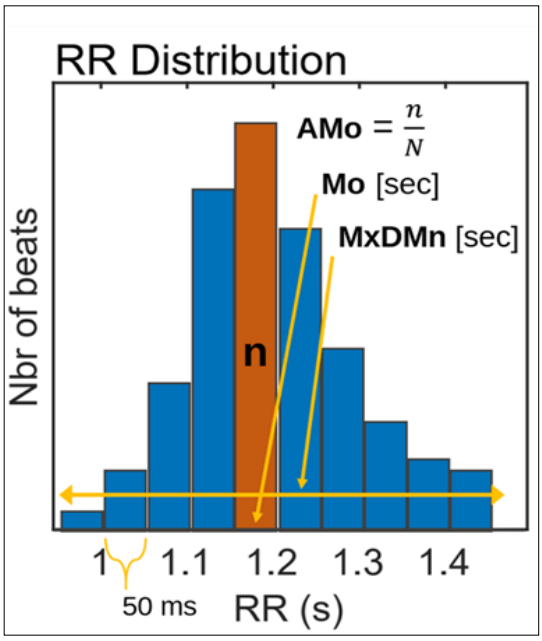


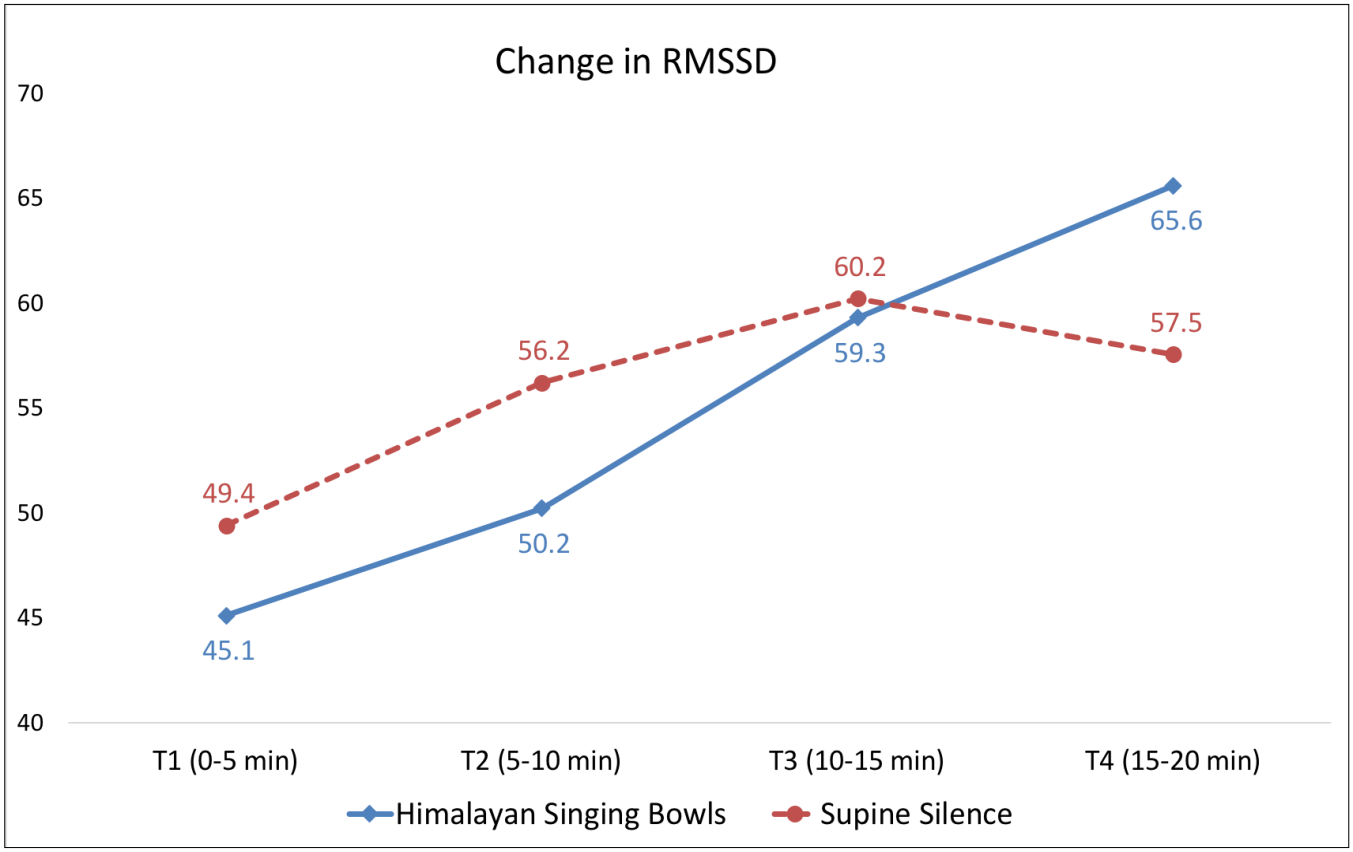
Figure 2. Stress Measurement using Baevskey's Stress Index
(Source: Kubios Website[21], reproduced with permission)

Table 2. Key HRV parameters for Himalayan Singing Bowls sessions (N=16)

Himalayan Singing Bowls (HSB)	Average of Stress index	Average of Mean HR	Average of RMSSD
T1 (0-5 min)	10.8	74.8	45.1
T2 (5-10 min)	9.7	73.5	50.2
T3 (10-15 min)	8.2	71.6	59.3
T4 (15-20 min)	7.4	71.3	65.6

Table 3. Key HRV parameters for Supine Silence sessions (N=17)

Supine Silence (SS)	Average of Stress index	Average of Mean HR	Average of RMSSD
T1 (0-5 min)	10.0	84.3	49.4
T2 (5-10 min)	9.0	81.2	56.2
T3 (10-15 min)	8.4	80.5	60.2
T4 (15-20 min)	8.8	79.3	57.5



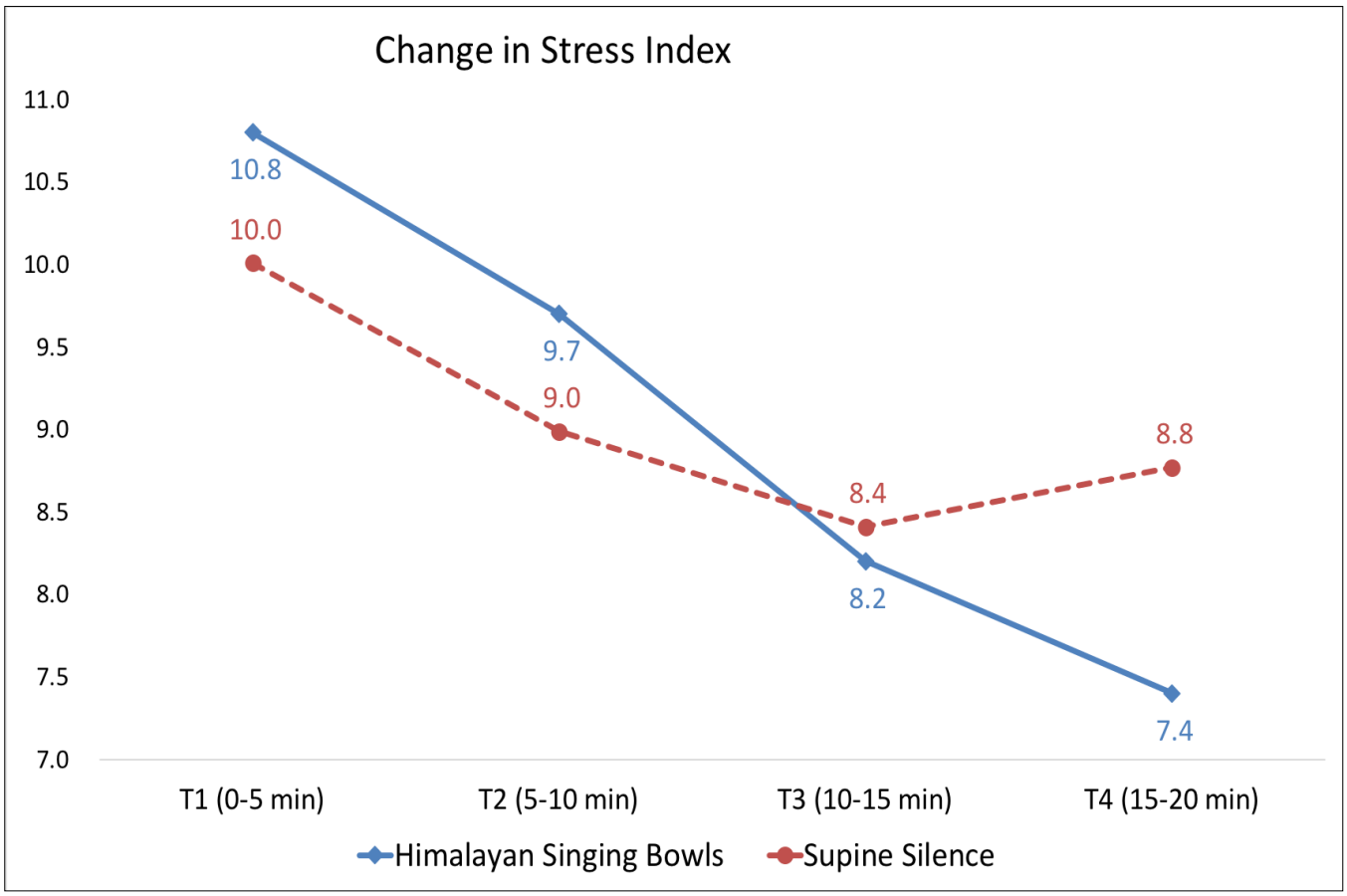


Figure 3. Changes in RMSSD and Stress Index during both interventions

The results of key parameters for HSB and SS groups are captured in Figure 3, Table 2 and Table 3 respectively.

Average Stress Index continued to decrease in the HSB group, however for the SS group the reduction was not consistent, i.e. during the last 5 minutes (T4 vs T3 in Table 3), there was an increase.

RMSSD and HR showed a consistent trend in HSB (decrease in HR every subsequent 5 minutes and increase in RMSSD also during every subsequent 5 minutes). For SS, during the last 5 minutes the RMSSD decreased.

To understand if there were statistically significant changes in HSB group for Stress Index, HR and RMSSD as compared to the SS group, the next section analyzes the data statistically.

Statistical Analysis

Tables 3 and 4 capture the Paired-T test results of SS and HSB groups respectively. The main objective was to confirm if the reduction in Stress Index is more significant in the HSB group as compared to the SS group. The secondary objective was to confirm if HR reduction and RMSSD increase is more consistent and significant in HSB as compared to SS group to validate the impact on the parasympathetic nervous system.

The analysis explored (a) how the parameters changed when each subsequent interval is compared with the first (starting) interval and (b) how parameters changed in each subsequent interval compared to the previous interval.

Reduction in Stress Index

When interval T4 is compared vs T1, both HSB and SS show statistically significant reduction (Table 3A and 4A). However, when we probe further by comparing each session with the previous session (i.e. T2 vs T1, T3 vs T2, T4 vs T3 in Table 3B and 4B), the stress index reduction is still statistically significant for each 5 minutes duration in HSB group ($p<.05$) and this is not the case for the SS group. This confirms the primary objective that HSB can significantly reduce stress as compared to SS throughout the short session of 20 minutes.

Changes in RMSSD and HR

Similar analysis for RMSSD and HR confirms that RMSSD reduction is not statistically significant when T4 is compared to T1 (Table 3A) for SS while HR reduction is statistically significant for T4 vs T1 in SS. In the HSB group (Table 4A), interval T4 vs T1 show a statistically significant increase in RMSSD and a statistically significant decrease in HR ($p <.05$). Further analysis (Table 3B and 4B) confirms that when each interval is compared with the previous interval, 2 out of 3 intervals show statistically significant changes in RMSSD and HR for HSB session whereas for SS, the RMSSD increase is not statistically significant in any of the intervals and HR decreases only in 1 out of the 3 intervals ($p<.05$).

To summarize, in the HSB group, there was a statistically significant stress index reduction as compared to SS during each subsequent 5 minutes interval confirming the primary objective. The reduction in HR and increase in RMSSD, in the HSB group is also more consistent as compared to SS. These changes indicate an enhancement of parasympathetic activity in the HSB group as compared to SS providing a confirmation of the depth of relaxation. Together, these results confirm the hypothesis that 20 minutes long supine session with HSB enables significantly more relaxation as compared to SS.

Discussions

This study highlighted that key HRV parameters (including Stress Index) show an improvement indicating good relaxation and activation of the parasympathetic nervous system. However, a more detailed statistical analysis provided new insights into the depth and quality of relaxation. When each group data was compared by breaking down the 20 minutes of each session into 4 intervals (T1 to T4), for HSB group, the final interval (when compared to the first interval), showed a statistically significant change in all the 3 parameters i.e. stress index, RMSSD, and Heart rate. However, for SS group, only 2 of the 3 parameters showed statistically significant reduction (i.e. RMSSD did not decrease in a statistically significant manner in T4 as compared to T1).

Based on this data, another analysis was conducted which compared each 5 minutes interval with the previous 5 minutes interval to understand if there are variations for both the methods. The analysis revealed that for the HSB group, 7 out of 9 intervals

Table 3 A & B. Supine Silence Group: Paired T-Test with comparison of various intervals (*NS indicates a p-value >0.05 i.e. not significant change, all other numbers indicate a statistically significant change i.e. p-value <=0.05)

A. Supine Silence: Comparison of each interval with the "first" interval (i.e. T1) to understand the trend					
Parameter and Intervals	T1 (Base)	T2 vs T1	T3 vs T1	T4 vs T1	How many intervals show statistically significant change?
Stress Index	Baseline	0.04	0.01	0.03	All 3
Heart Rate	Baseline	0.00	0.00	0.00	All 3
RMSSD	Baseline	0.07 (NS*)	0.05	0.11 (NS*)	1 of 3
B. Supine Silence: Comparison of each interval with the "previous" interval to understand the trend					
Parameter and Intervals	T1 (Base)	T2 vs T1	T3 vs T2	T4 vs T3	How many intervals show statistically significant change?
Stress Index	Baseline	0.04	0.10 (NS*)	0.23 (NS*)	1 of 3
Heart Rate	Baseline	0.00	0.17 (NS*)	0.05	2 of 3
RMSSD	Baseline	0.07 (NS*)	0.39 (NS*)	0.22 (NS*)	None

Table 4 A & B. Himalayan Singing Bowls Group: Paired T-Test with comparison of various intervals (*NS indicates a p-value >0.05 i.e. not significant change, all other numbers indicate a statistically significant change i.e. p-value <=0.05)

A. Himalayan Singing Bowls: Comparison of each interval with the "first" interval (i.e. T1) to understand the trend					
Parameter and Intervals	T1 (Base)	T2 vs T1	T3 vs T1	T4 vs T1	How many intervals show statistically significant change?
Stress Index	Baseline	0.02	0.00	0.00	All 3
Heart Rate	Baseline	0.06 (NS*)	0.01	.01	2 of 3
RMSSD	Baseline	0.00	0.00	0.00	All 3
B. Himalayan Singing Bowls: Comparison of each interval with the "previous" interval to understand the trend					
Parameter and Intervals	T1 (Base)	T2 vs T1	T3 vs T2	T4 vs T3	How many intervals show statistically significant change?
Stress Index	Baseline	0.02	0.00	0.02	All 3
Heart Rate	Baseline	0.06 (NS*)	0.04	0.05	2 of 3
RMSSD	Baseline	0.00	0.01	0.06 (NS*)	2 of 3

across the 3 measures provided statistically significant changes in the parameters (p-value <0.05). For 2 out of the 9 intervals, the p-value was 0.06 (which is not statistically significant however it is not very far from the cut-off compared to the data for SS). This denotes a very consistent reduction, session by session, for 16 participants during the Himalayan Singing Bowls session that lasted only 20 minutes! This was not the case for SS which provided statistically insignificant changes in various parameters when analyzed session by session (only 3 out of the 9 sessions across the total 3 parameters showed statistically significant reduction, p-value<0.05)

This finding is significant since the total duration of the session was only 20 minutes and despite that, the Himalayan Singing Bowls, as compared to Supine Silence, were able to achieve consistent enhancement in parasympathetic nervous system parameters. Consistent reduction in such a short duration is very encouraging as compared to earlier experiments where the session duration was longer (e.g. 1 hour). If we consider the p-value, for Himalayan Singing Bowls sessions the p-value >0.05 happened for only 2 measures and in those cases, the p-value was 0.06 (not very far from 0.05. In comparison, for Supine Silence, for most sessions with "not significant" reductions, the p-value was higher (usually > 0.2).

Future work in this area could explore (a) more sample size (b) understand this by demographics such as age, gender and also compare individuals who have insomnia versus individuals who usually sleep well and (c) explore additional methods such as Guided Imagery, Hypnosis script, Yoga Nidra with silence and singing bowls. The objective is to achieve deep relaxation in a relatively short amount of time – to calm the mind and the body and achieve the benefits similar to what is reported by other supine practices such as "Relaxation Response" or "Yoga Nidra". The findings from this study that only a 20 minutes long session with HSB can help in reducing stress and enhancing parasympathetic activity is significant and must be leveraged by health care professional. Some ideas for re-applications in health care centers are captured under "Recommendations".

Limitations of this Study

The sound vibrations often induce emotional responses that could be negative. Increased sample size and tracking of the mood before and after relaxation along with HRV parameters could provide a more detailed understanding of the variations in the relaxation depth for individuals who may have got triggered with negative emotions during the HSB sessions. This study involved healthy individuals (i.e. no chronic disease or ongoing medications) and hence the results could vary for individuals who have some chronic disease or conditions such as insomnia or anxiety. Finally, the use of 7 bowls could be a limiting factor if this approach is to be re-applied for patients who are confined to bed where the bowl arrangement may be a challenge. Future studies in this area should ideally randomize the same participants into two groups and include more subjects of varied demographics to get a more detailed understanding of the outcomes. A possible study idea is to explore the use of fewer bowls which could make it easy to bring the bowls to any location and also set them up in areas where space could be a constraint.

Conclusion

This study confirmed that Himalayan Singing Bowls can achieve deep relaxation in just 20 minutes and this relaxation is statistically significant compared to Supine Silence in-depth and consistency even when measured using physiology parameters related Stress Index and HRV. Specifically, the stress index continued to reduce in a statistically significant manner during each subsequent 5-minute interval for the sessions with Himalayan Singing Bowls.

Repeated practice of the Himalayan Singing Bowls session could improve autonomic nervous system balance and trigger relaxation response by a possible reduction in sympathetic tone and an increase in parasympathetic tone as measured by Stress Index & HRV. Further research in this area in the form of the randomized controlled experiment would validate the findings with more subjects with diverse demographics and methods.

Recommendations

The findings from the study can be incorporated broadly to induce deeper relaxation in a very short time.

HSB sessions can be used (a) for individuals who are facing sleep disruption by applying this methodology for few days at the same time in the

evening just before they sleep (b) for individuals to calm down and relax before a surgical intervention or an intervention such as chemotherapy (c) for general relaxation to reduce stress for anyone (d) for Sports where the ability to relax and rejuvenate could help in enhancing the performance.

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