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Original Research Article

‘‘Short Term Effect of Raga Bhupali on Auditory Reaction Time of Healthy Adults.’’

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ABSTRACT

Aims & Objectives: In the present era, there might be no one who is untouched by music. There are various studies which show the effects of music on different aspects of cognitive processing. The physiological effects of music is still under scientific study and needs to be understood in a better way. The aim of our study is to study the effect of Raga Bhupali on Auditory Reaction Time of young adults.

Material and Methods: The study was conducted after obtaining approval from Institutional ethical committee. 75 healthy subjects of age group 18 to 25 years having normal hearing ability participated in the study. Informed consent was taken from all the subjects. The Auditory Reaction Time was assessed with the help of reaction time apparatus. Music used was instrumental (flute) Raga Bhupali by Pt. Hariprasad Chaurasia**.** Basal ART was taken before the subjects listened to music. Each type of stimulus i.e. low, medium and high pitched sounds was given 3 times and the lowest reaction time for each type of stimulus was considered as basal ART. Then the subject was asked to listen to instrumental music for 10 minutes with headphone and again ART was recorded. The data was compiled and analysed using SPSS - 20 (Software Package used for Statistical Analysis) software for statistical analysis

Result: The auditory reaction times decreased significantly (**p<0.001)** after listening to music of all the 3 frequencies of sound.

Conclusion – Instrumental Music has positive effects on auditory reaction time i.e. Auditory Reaction Time reduced after listening to **Instrumental** music. This indicates that music is not only soothing/or stress relieving factor, but it can also affect the cognitive and motor performance of an individual.

Keywords – auditory reaction time, instrumental music, raga bhupali

INTRODUCTION

Since ancient times, music has been an important part of our lives. Because of work overload and stressful life, people listen music to get relax. Apart from relaxing effect, music is known to have effect on the metabolic activities in the human body. It accelerates respiration, improves muscular activities, thus affecting the Central Nervous System and Circulatory System of the listener and the performer**.** [1]

The time taken by an individual to react to unwarranted or unexpected challenges is called as **reaction time** [RT] (Sternberg, 1966; Ganong, 2005) [2] “**So it is measured as the amount of time elapsed between the presentation of a stimulus and the onset of a response”.**[3] It indexes speed of stimulus processing and response programming.[4] **Auditory Reaction Time [ART]** is the speed with which a person can respond to an

auditory stimulus. [5] As reaction time involves speed & accuracy, it has provided a way to evaluate commonly used psychological tests for attention, concentration, and cognitive skills with well proven diagnostic and predictive validity (Welford, 1980). [2]

Factors Affecting RT

Because the reaction time involves a sensory as well as motor alertness, the factors affecting sensory as well as motor system can affect the reaction time. There are various factors which affect RT like- Age, gender, distractions, personality, alcohol, smoking, pranayama, yoga and exercise, pregnancy, menstrual cycle and music.

There are only few studies which show the effects of music on RT. Listening to music regularly helps keep the neurons and synapses more active. Neurological studies have identified that music is a valuable tool for evaluating the brain system. [6] There are various studies which shows that different parts of brain like the auditory cortex, frontal cortex, cerebral cortex and even the motor cortex are involved to process music.

Indian music, especially classical music, is considered to be one of the oldest musical traditions in the world. There are many "Ragas" in Indian classical music. Every Raga has its specific effect. For our study we have chosen **Raga Bhupali played on a flute.**

Raga Bhupali is a Raga in **Kalyan Thaat Bhupali**, also known as Bhoop, Bhopali or Bhupali. In south Indian music it is known as **Mohanam.** Raga Bhupali is being known to have awakening effect on someone who is in deep sleep. [7] The present study examined the effects of Indian Raga Bhupali on speed of cognitive-motor performance using auditory reaction time (ART) for different pitch sounds.

Medical Students and Reaction Time

Medical students or future's physician are one of the most important part of our community. A doctor is a person who is always ready to meet an emergency. Medical personnel always face stress which also affects their cognition. Besides acquiring medical knowledge, medical students or the future's doctors should also develop high order cognitive processing, knowledge and skills. And one of the most important factors for cognitive processing is motor coordination, and reaction time is one of the best test to determine motor coordination. It measures the motor response to visual and auditory stimuli.

AIMS AND OBJECTIVES

The primary objective of this study to evaluate the short-term effect of instrumental music Raga Bhupali on Audio Reaction time of **undergraduate medical students.**

The purpose of this study, is to test whether an outside force such as "music" will affect the reaction time. Whether music improve performance by affecting reaction time in medical students which are future's doctors to serve the society.

Hypothesis of the research

As Raga Bhupali is used to awaken someone out of deep sleep**.** So, we hypothesized that listening Raga Bhupali would reduce the speed of processing and thus shorten reaction time to auditory stimuli.

MATERIAL AND METHODS

The study was conducted after obtaining approval from Institutional ethical committee. Subjects were chosen using odd and even randomizing method. Informed consent was taken from all the subjects. The study group comprises of **300** under graduate medical students of age group 18 - 25 yrs., after applying sample size calculation **260** under graduate students were included in the study.

Study design: It is a cross sectional study

Inclusion criteria

- Individuals giving consent for test participation in the study.
- Age group 18 to 25 years.
- All the subjects were with no auditory or visual defects.

Exclusion criteria

- Individuals taking alcohol.
- Subjects who had inadequate sleep previous night.
- Subjects who were on any sedative or hypnotic or anti –allergic medication.

- Those have mental disorder or on related treatment
- Those who have musculoskeletal injuries or disorder.

Sample size: Sample size calculations
As population size of undergraduate medical students in our medical college as **800**
And Absolute precision of 5% at 95% confidence interval.

Using formula:
Sample size n = N* { z^2 * p (1-p) / e^2 / N – 1 [z^2 * p * (1 - p)] / e^2 }
Population size (N) = 800
Critical value of CI (Z) = 95% = 1.96
Sample proportion = 0.5
Margin of error = 5% = 0.05
Sample size comes out to be= 260

Statistical Analysis:
Data thus obtained were compiled, and tabulated by using Microsoft excel sheet. Then analysed, by using analytical tools **"Paired 't' test," "One sample 't' test"** with the help of **SPSS - 20** software (Software Package used for Statistical Analysis). The P value was calculated. It gives the probability of any observed difference having happened by chance. P value of 0.05 means that the probability of the difference having happened by chance is 0.05 in 1 i.e. 1 in 20. P value below 0.05 was considered to be statistically significant and P value below 0.01 was considered to be highly significant.

Apparatus used is Standardized Reaction time apparatus -**RTM608:** manufactured by Medicaid system Chandigarh. It is an electronic reaction time meter equipped with very sensitive quartz clock which has a resolutionof .001 sec accuracy of ±1 digit. The apparatus can record both auditory reaction time (ART) and visual reaction time (VRT). For recording ART It can produce high pitch, medium pitch and low pitch sounds as auditory stimuli.

Procedure: Each subject was made familiar with the apparatus and procedure was explained before doing the test. Subject had to react to three different frequencies of sound stimuli i.e. high, medium and low by pressing the respective key for the sound as soon as he hears the sound. When subject pressed the key as a response to auditory stimuli, the timer stopped. This time was directly taken as auditory reaction time. Three basal readings (before listening music) of response to auditory stimuli were taken and the best (i.e. the lowest) was taken as the **Basal auditory reaction time** of that subject. After taking Basal ART, an instrumental music - was played on laptop for 10 minutes with fixed volume, and subjects listened this music through headphones via laptop in a quiet room. After the music has stopped ART was recorded immediately. The music played is the instrumental melody Raga Bhupali (flute) by Pt. Hariprasad Chaurasia without the interference of the lyrics

OBSERVATION & RESULT
Basal Auditory Reaction Time

Table 1 Distribution of Auditory Reaction Time of study population

Parameters	Minimum	Maximum	Mean	Std. Deviation	95% Confidence Interval of the Difference	
					Lower	Upper
L ART	0.523	2.386	0.915	0.319	0.842	0.989
M ART	0.491	1.983	0.848	0.218	0.798	0.898
H ART	0.444	0.981	0.769	0.126	0.740	0.798

L ART = ART for low pitch sound stimulus M ART = ART for medium pitch sound stimulus
H ART = ART for high pitch sound stimulus

Basal Auditory Reaction Time
Table No.1 depicts mean, standard deviation and 95% confidence interval of reaction time parameters including auditory reaction time for low, medium, high pitch sound stimuli of the entire study population. The mean ART [Basal ART] is for low pitch sound stimulus is **0.915 sec.** (maximum) for medium pitch sound stimulus it is **0.848 sec.**and for high pitch sound stimulus it is **0.769 sec.** (minimum).

Table 2.1 Comparison between mean auditory reaction time before music, just after music

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
L ART1	260	.9156	.3200	.0369
L ART2	260	.7475	.1296	.0150
M ART1	260	.8486	.2185	.0252
M ART2	260	.7201	.1244	.0144
H ART1	260	.7692	.1263	.0146
H ART2	260	.6844	.1185	.0137

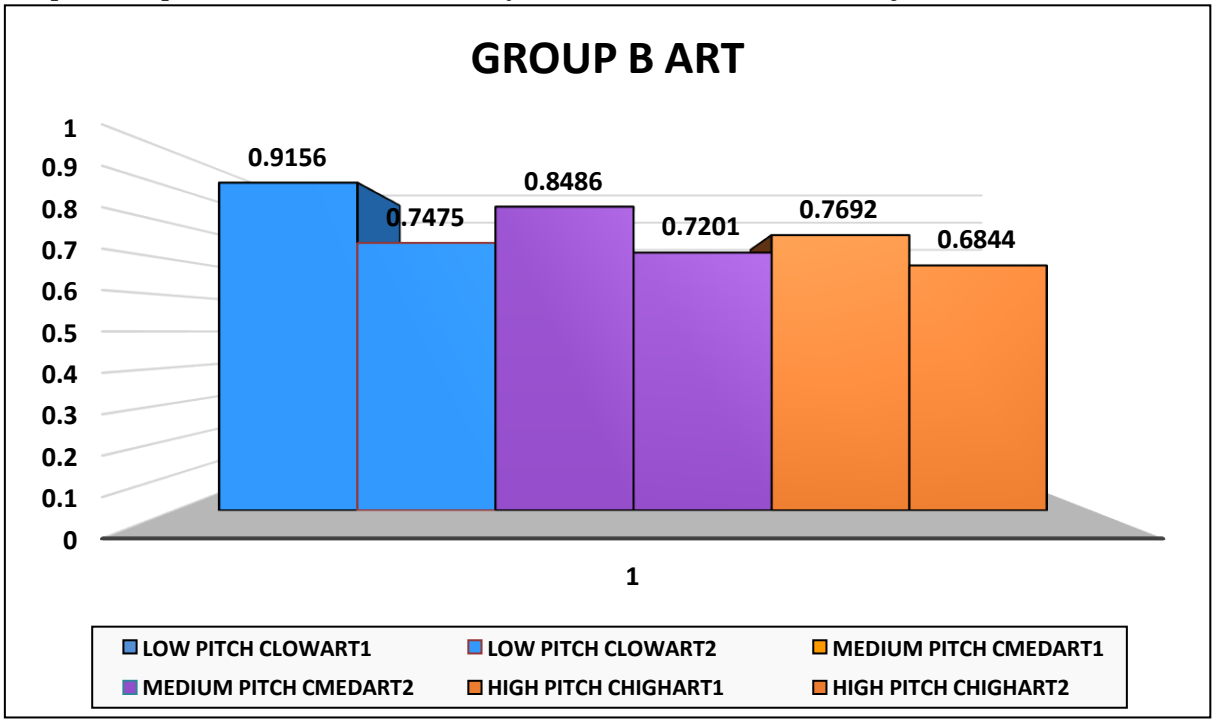
Table 2.2Comparison between mean auditory reaction time before music, just after music

One-Sample Test						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
L ART1	24.78	259	.000	.9156	.8420	.9893
L ART2	49.97	259	.000	.7475	.7177	.7774
M ART1	33.63	259	.000	.8486	.7983	.8989
M ART2	50.13	259	.000	.7201	.6915	.7487
H ART1	52.74	259	.000	.7692	.7401	.7982
H ART2	50.02	259	.000	.6844	.6572	.7117

L = Low pitch sound stimulus, M = Medium pitch sound stimulus H = High pitch sound stimulus, ART1 = ART before music, ART2 = ART after music

Table 2.1 and 2.2 depicts **One Samples Statistics** of **ART** for low, medium, and high pitch sound stimuli of **Study population before and after listening to music.** The mean ART for **low pitch** sound before listening music (basal) is **0.915±0.320 seconds.** After listening music, it is reduced to **0.747±0.129**. The mean ART for **medium pitch** sound before listening music (basal) is **0.848±0.218** After listening to music, it reduced to **0.720±0.124** The mean ART for **high pitch** sound before listening music (basal) is **0.769±0.126,** After listening to music , it reduced to **0.684± 0.118** .

Graph 1 Comparison between mean auditory reaction time before music, and just after music



Graph no 1 shows that **the mean ART has reduced after listening Indian classical instrumental music raga bhupali.**

Table 3.1 Comparison between mean ART of low, medium & high pitch sound stimulus of before music, just after music, through Paired sample t test

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	L ART1	.9156	260	.3200	.0369
	L ART2	.7475	260	.1296	.0150
Pair 2	M ART1	.8486	260	.2185	.0252
	M ART2	.7201	260	.1244	.0144
Pair 3	H ART1	.7692	260	.1263	.0146
	H ART2	.6844	260	.1185	.0137

L = Low pitch sound stimulus, M = Medium pitch sound stimulus H = High pitch sound stimulus , ART1 = ART before music , ART2 = ART after music

Table 3.2 Comparison between mean ART of low, medium & high pitch sound stimulus of before music, just after music, through Paired sample t test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	L ART1 - LART2	.1681	.2477	.0286	.1111	.2251	5.877	259	.000
Pair2	MART1 - MART2	.1285	.1581	.0183	.0921	.1648	7.039	259	.000
Pair3	H ART1 – H ART2	.0847	.0763	.0088	.0672	.1023	9.619	259	.000

L = Low pitch sound stimulus , M = Medium pitch sound stimulus H = High pitch sound stimulus , ART1 = ART before music , ART2 = ART after music

Table 3.1 and 3.2 shows the Comparison between mean ART of low, medium & high pitch sound stimulus before music, just after listening music, through Paired sample t test.For all the **pairs from 1 to 3 our** hypothesis has been accepted which says that there is a significant effect of Indian classical instrumental music raga Bhupali on ART (p=.000<.005). **The mean ART for low, medium, high, pitch sound decreases after listening the raga Bhupali.**

DISCUSSION

It is often seen that people listen music to improve their concentrating ability as usually seen among students, drivers or at work place. Some studies believe that music is distracter and deteriorate cognitive performance. But there are also some studies which show improvement in response time to various stimuli. So the effects of music are debatable**.** [8]

There are several studies which shows the effect of Indian classical music on brain functions. Ram K. Nawasalkar and Pradeep K. Booty study the effect of Indian classical music on human body using EEG**,** and find positive effect on brain on EEG signals. They conclude that Indian classical music can be used as a tool to relieve tension/ stress and to relax**.** [9] Indian Classical Music is the soul of every music. Classical Music greatly affect on brain activity. [9]

Karuna Nagarajan, and others studied the immediate effect of listening to Indian raga on attention and concentration. They concluded that Memory scores improved immediately after listening to Indian **Raga Bhupali.** [10] Raga Bhupali is a raga (feeling) of Bhakti (Devotion) and Shanti (Peace). It relaxes and re-settles the mind if someone feeling anxious or nervy. It is a great raga to bring us back to a calm state.

We choose Indian classical music as it is the heart and soul of Indian culture. From ancient time we know the magical power of Indian classical music. Indian raga also beneficial for human mood, emotion, and to cure many diseases. Extensive research was carried out to find out these effects.[12]

The study started with a proper evaluation of the participants related to how much they are connected to music in daily life. For it we give them some self-prepared questionnaire, question include, did they like music or not, did they listen music daily, what type of music they like, what is the mode of listening music. Most of the participants like music, and most of them listen music daily. The basal ART of our participants is for low pitch sound is 0.915 with SD of ± .319for medium pitch sound it is 0.8485 with SD of ± .218and for high pitch sound it is 0.769 with SD of ± .126. Thus the basal ART of our subjects is between **0.925 – 2.911. ms.**

The accepted figures for mean simple RTs for college-age 18 -25 yr individuals have been about 190 msfor light stimuli and about 160 ms for sound stimuli**.** [13] **So** the basal reaction time of our participants was not similar to above mention results. **[Table 1]** As the mention result for college age individuals was 30 -40 years back. In these 3-4 decades lots of things get changed in routine life of the youngsters like, stay up late at night, get up late in the morning, more use of mobiles and other gadgets like headphones, laptops, consumption of more junk food, increased cases of obesity, overall the lifestyle changes causes sluggish and lazy behavior of the young ones, and it may be the possible cause of longer reaction time of our participants. The mean ART has reduced after listening raga bhupali. [TABLE 3.1 and 3.2] We applied paired sample t-test as statistical tool for the purpose of hypothesis testing for the ART.

The statistical results reveal that null hypothesis H_0 has been rejected and alternate hypothesis $H_a$has been accepted which states that there is a significant effect of Indian classical raga on ART **(p=.000<.005). The mean ART has decreased after listening the Indian classical raga – bhupali.**

There are several studies which shows the effect of music on Reaction Time as study done by **Dr. Prasad BK** conclude decrease in reaction time with background music. He used verbal heavy metal of Bollywood music and instrumental – violin music as a background source. He concluded that there is improvement of ART and VRT with background music due to facilitation of processing of stimuli in somatosensory cortex**.** [8] Study by **Maja Meško[1], Vojko Strojnik[2]**, shows "the effect of techno music on visual reaction times and conclude techno music has the effect of shortening the reaction times of the participants. [14]

Another study by **Mohammed shah and Ranganath**was done on the effect of different genres of music listening on simple RT in young adults. They used rock and classical music on statistical analysis the result was insignificant with classical music. They got significant prolongation of RT on listening rock music.[15] The explanation for the prolongation of reaction time could be that they are taking RT along with the listening music, so while listening music the mind may be diverted from focusing on one particular task**.** [16] When carrying out two or more tasks at once one is merely juggling his/ her attention between each task. Hence any of the tasks becomes a distraction for the other one. Another possible reason for rock music prolonging reaction time may be due to their faster beats or tempo which may have a negative influence on reaction time.

The results of our study are in accordance with our original hypothesis. Studies have shown that the choice of the musical genre may influence cognitive performance.

Rauscher et al. showed that exposure to Mozart's Piano Sonata enhanced performance on an abstract/spatial reasoning task from the Stanford-Binet intelligence scale when compared with silence, a relaxation tape. [17] In 1995, they found that Mozart's Piano Sonata had a positive influence on the performance when comparedto a short story, minimalist music, or dance music. [18]

The possible mechanism is that the effect of listening to music helps to calm down the nervous system. One of the studies showed, music prior to a standardized stressor predominantly affected the autonomic nervous system in terms of a faster recovery**.** [19] Music influences how a listener feels, and feelings influence a wide range of stimulus including cognitive performance like that of thinking, logical analysis, problem-solving, originality, and mental flexibility**.** [20] Listening to classical relaxing music after exposure to a stressor resulted in considerable reductions in

anxiety, anger, and sympathetic nervous system arousal, and increased relaxation compared to no-music condition or listening to heavy metal music.[21]

The selected Indian classical raga Bhupali in our study is said to create pleasing effect on the internal environment due to the combination of notes. The improvement in memory scores could be due to the rasa or aesthetic mood induced by the raga. The consolidation and evocation of rasa represent the function of all fine arts. In the future, the study of Indian music may be extended to various Indian ragas and other dependent measures or cognitive tasks.
The advantage of our study design takes into consideration the immediate effect of music on RT. Hence, fixed covariates such as location, diet, and state of health are automatically controlled for within a proportional incidence framework.[22]

Mechanisms of Action
One proposed mechanism for the ability of music to regulate stress, arousal, and emotions is that it initiates reflexive brainstem responses. [23] Music modulates brainstem mediated measures, including heart rate, pulse, blood pressure, body temperature, skin conductance, and muscle tension.[24]
Brainstem neurons tend to fire synchronously with tempo.[25] Noradrenergic (norepinephrine) neurons in the brainstem and midbrain regulate the autonomic responses of heart rate, blood pressure, and respiration [26], along with cholinergic [27] and dopaminergic neurotransmission.[28]. Brainstem activation also mediates sensory and motor function through epinephrine, norepinephrine, and serotonin.[28]

CONCLUSION
Listening classical music raga Bhupali helps to improve reaction time. ART reduces after listening this raga due to facilitation of processing of stimuli in somatosensory cortex. Indian Classical Music can be used as a tool to relieve tension/ stress and to relax. Indian music, with its many Ragas, is known to be particularly of therapeutic value.
Reaction time is good indicator of quickness in our day today life. Fast reaction time, which measures how long it takes for your body to respond to external forces, is essential for leading a safe, healthy life. Having a fast reaction time means that your brain and spinal cord are quickly sending messages to your bones, muscles, and joints in order to make appropriate movements. Unfortunately, reaction time naturally decreases with age. This is primarily due to impaired or reduced cognitive functioning. Cognitive disorders, like Alzheimer's disease, Attention deficit disorder, Dementia, Epilepsy-related cognitive dysfunction all deals with slow Reaction time.
So Indian classical music can be used in disorder that is characterized by perception, information processing, or motor problems. Indian ragas could be a safe alternative for many medical interventions.

LIMITATION OF THE STUDY
Sample size itself is one of the measure limitation of the study, better results can be obtained by involving more participants.
We choose specific group (young medical students) for our study, so we cannot apply results of our study to general population.
We studied only immediate effects of music, study can be better if music will be listen for a longer duration, for example same music, at same time for at least 3-6 months.
The participants didn't have option for choice of music. So if they listen music of their own choice may be have better results.
We have to study others factors also influencing RT along with music.

Future scope - The results of this study have raised new questions to be answered in the future: e.g. the effects of different types of music, volume level, or a person's favorite music (as the results could be influenced by a person's emotions) on reaction time. For further research more participants should be involved and same music is listen for a longer duration.

Conflict of interest – none

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