

Original article:

Blood pressure response to successive divided attention tests when performed with instrumental background music, comparing between different ethnic groups – a randomised controlled trial.

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Abstract:

Introduction: The entrainment effect of soothing music is well established. But studies on its effect in different ethnic groups in relation to task performance are sparse.

Objectives: To compare the effect of classical instrumental music on successive divided attention test and related blood pressure changes in Indian and Malaysian first year medical students.

Method: 60-Indian and 60-Malaysian 1styr medical students were randomised into equal numbers in music and control group, creating 4-subgroups. Three different forms of SDMT were tested as pre test, during music/control session and post test using total, correct and error score, for assessing divided attention. Simultaneously, multiple BP recordings were taken as pre test, during 1,5,15,25 minutes during music/control (+SDMT) and post test. (Statistically significant p value<0.05).

Results: Music group showed significant results for correct (p=0.02) and total (p=0.029) scores during post test while errors reduced (p=0.002). Malaysian music group performed the best. Indian music group showed decline in post test error scores (p=0.002). BP showed a drop in recording at 5minutes (p<0.001), a steep rise in values till 15minutes (p<0.001) (corresponds to SDMT) in music group. In the control group, BP changes were not significant. On comparing the subgroups, paired-t test values in the Malaysian music group were significant.

Conclusion: Classical instrumental music is beneficial to medical students and can alleviate instantaneous stress within a span of 5minutes. When used in the background, during task performance, can increase arousal which helps the students perform better. Performance improves with music irrespective of nationality, preference and with short duration of music.

Implications: Music can be used between lectures for a short time to relax the students and help them concentrate better for the subsequent classes, especially for last sessions.

Keywords: Ethnicity; 1st year MBBS; blood pressure; instrumental music; Symbol Digit Modality Test.

Abbreviations: SDMT - Symbol Digit Modality Test.

Introduction:

Medical students face high levels of stress and perceive the same stressor differently depending on

cultural background, mental stability and coping skills⁽¹⁾. With increasing international joint ventures for programmes of medical education⁽²⁾, Malaysian

students are coming to India for obtaining medical degree and may perceive higher stress due to added factors like environmental and food changes and lead to related decline in their performance.

Music acts as an efficient coping strategy as it is easily available, affordable and mobile⁽³⁾. Because of its entrainment effect⁽⁴⁾, soft instrumental music can cause physiological changes like drop in blood pressure, adrenaline and corticosteroids (all of which indicate decrease in stress)⁽⁵⁾ and may increase concentration ability which helps focus attention⁽⁶⁾, but this response varies at individual level and previous studies have shown mixed observations, some showing music having a negative influence during task performance⁽⁷⁾. Studies are also sparse regarding these findings in Indian and Malaysian students. Thus the objectives of this study is to assess the effects of classical instrumental music on physiological parameters of stress (blood pressure) while testing for divided attention (symbol digit modality test) in first year medical students belonging to different ethnic groups (Indian and Malaysian students). Also, to study the duration of use of music required to bring a change and if its effects vary with ethnicity

Objectives:

- To assess blood pressure response to instrumental background music and induced stress.
- To assess the effect of classical instrumental, background music on successive divided attention tests.
- To compare these affects in Indian and Malaysian first year medical students.

Materials and methods:

an RCT was conducted for a period of 1 year from May 2012-April 2013 in research laboratory of Department of Physiology J. N. Medical College, Belgaum, Karnataka, India, on 60 Indian (30 males + 30 females) and 60 Malaysian students (30 males + 30 females) studying in Phase-I MBBS. Permission to conduct the study was obtained from all the concerned authorities. Students with history of hearing impairments, history of drug abuse, smokers, alcoholics, suffering from cognitive disorders were excluded. Based on the pilot study conducted, the effect size was 20. Minimum of 30 students were selected with α error = 0.05 and β error = 0.2. Randomisation was done by opaque sealed sampling. Test/music Group: 60 medical students in music group which included 30 Indian (15 Indian girls+15 Indian boys) and 30 Malaysian students (15 Malaysian girls+15Malaysian boys). Control Group: same as test group, but without any music.

Table I: Various tests used during the entire protocol of the study.

Pre test	Blood Pressure; SDMT Form A	
Tests done during the time of induced stress with/ without music.	At 1min	Blood Pressure
	At 5min	Blood Pressure
	At 15min	Blood Pressure; Symbol Digit Modality Test (SDMT) Form B
	At 25min	Blood Pressure
Tests done post exposure	Blood Pressure; SDMT Form C	

Music used for intervention: Classical instrumental music consisting of flute, raga Malkauns, by Hariprasad Chaurasia from the album “Ragas” was used, CD being manufactured by Cynosure Infotech

New Delhi. Music was played for a period of 30 minutes selected for its meditative nature without strong rhythmic changes. Player used was Mitashi DVD player; model number TFD7607VERV1 along

with Zebronics over the ears headphones. The volume was kept at a comfortably constant level for all the subjects. The room was maintained at minimum noise.

Blood pressure recording: to assess quantitative physiological stress. A fall in the readings indicated relaxed state while a rise indicated increased arousal or stress (Mockel M 1994). “Omron BP Monitor Semi - Automatic Upper Arm (HEM-4030)” was used to measure blood pressure (Systolic BP and Diastolic BP). Readings were taken in sitting position at pre tests sessions, during the exposure at 1minute, 5 minutes, 15minutes, 25minutes and in post test sessions to compare pre, during and post test values, also to evaluate time taken for a response to occur.

Symbol digit modality testing (SDMT) (Figure-1)⁽⁸⁾: This test was used to assess concentration ability and divided attention along with visual scanning, tracking, and motor speed. Each sheet consists of 8 lines with 15 symbols in each line. A coding key is provided which consists of 9 abstract symbols each paired with a number from 1-9. The students were asked to scan the key and write down the number

corresponding to each symbol as many as possible within 90 seconds. Three different forms were used where the visual array of the test was maintained, but symbol pairs were varied in all the forms.

Form A – used during pre test in all subjects, performed without music; Form B – used during exposure to music/control; Form C – used during post test in all subjects, performed without music.

Interpretation: Scores were considered for three outcomes.

- CORRECT = indicates number of correctly marked digits. It indicates the accuracy with which the student performed the test i.e. without errors.
- ERROR = indicates number of mistakes or wrongly marked digits. A decline in error score points towards higher concentration and better performance.
- TOTAL = total digits marked that is correct + error. It indicates the speed with which student performed the test. This score is irrespective of the number of correctly marked digits or errors made.

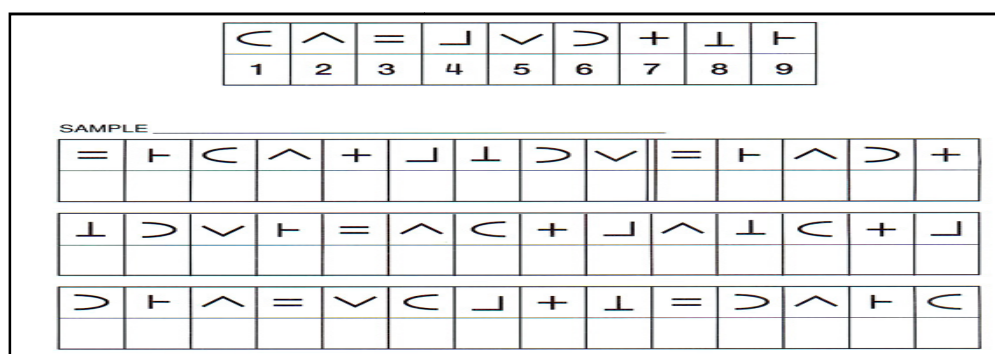


Figure-1: Sample of symbol digit modality test.

Results:

Students paired and unpaired t test was used to analyse the data. The data was tabulated in Microsoft excel 2007 and statistical analysis was carried out using SPSS software (version 20). p value < 0.05 was

taken as statistically significant. Following results were obtained.

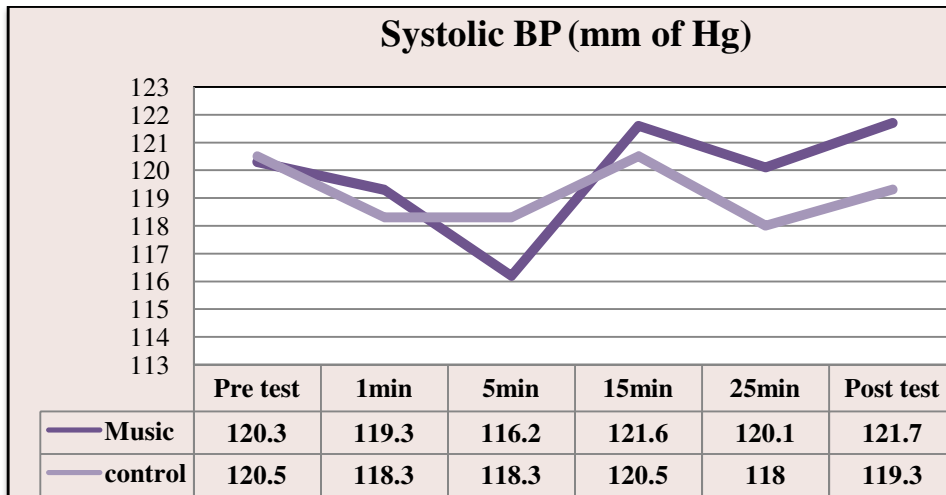
Blood pressure recording: (Graph I; Table II)

Systolic BP and diastolic BP showed similar response in music group that is, a drop in recording at 5minutes after music, showing relaxed state

($p < 0.001$, paired t test), a steep rise in values till 15minutes ($p < 0.001$, paired t test) (which corresponds to concentration task) and it remained elevated till post session. In the control group, BP recording show similar response with following variations: Drop at 5minutes after rest but the recordings are at higher levels than music group ($p > 0.05$ paired t test); There is a rise in values at

15minutes but the readings are lower levels than the corresponding music group; Systolic BP readings during post test are at lower levels compared to music group; Systolic and diastolic BP readings show similar response as described previously in both music groups but is more prominent in Malaysian students.

GRAPH-I: Systolic BP response comparing music and control group.



GRAPH-II: Diastolic BP response comparing music and control group.

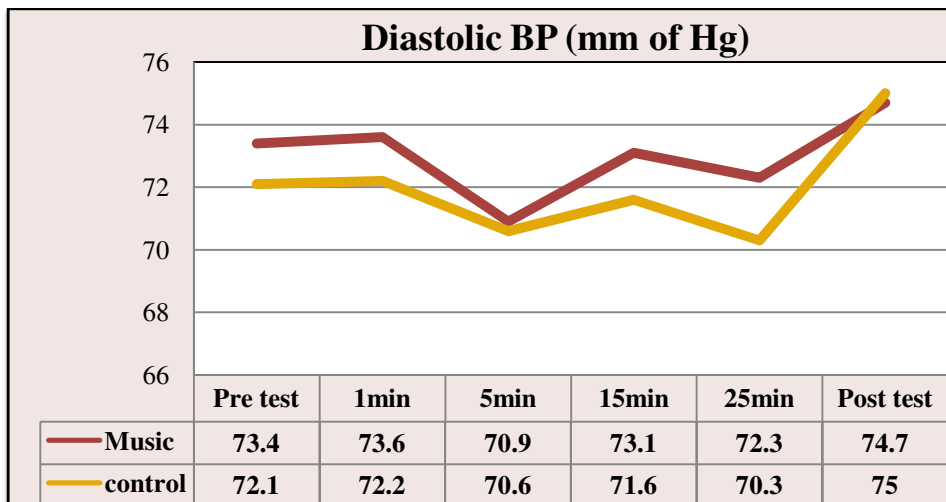


Table II: Comparison of Blood Pressure response by paired t test.

	Paired t test, p values			
	Comparing Pre test and 5min recordings		Comparing 5min and 15min recordings	
	SBP	DBP	SBP	DBP
Indian music group	<0.001	0.159	<0.001	0.17
Indian control group	<0.001	0.01	<0.001	0.06
Malaysian music group	0.004	<0.001	<0.001	0.003
Malaysian control group	0.33	0.31	0.39	0.40
Music group	<0.001	0.0002	<0.001	0.0099
Control group	0.06	0.08	0.2	0.27

Symbol digit modality test: (for divided attention)

There was no statistically significant difference between music and control group in pre test and during the exposure to music. Post test scores showed TOTAL scores (p=0.02) and CORRECT (p=0.029) scores being higher in music group compared to control group. (Table-III).

Table-III: Symbol Digit Modality test scores in Music and Control group:

	Test parameter	Music group	Control group	p-value
Pre test	Correct	56.5 ± 9.01	54.4 ± 7.68	0.156
	Error	0.95 ± 1.32	0.86 ± 1.08	0.706
	Total	57.5 ± 8.67	55.2 ± 7.55	0.129
During the exposure	Correct	59.4 ± 9.49	58.8 ± 7.04	0.703
	Error	0.75 ± 1.20	1.05 ± 1.89	0.302
	Total	60.2 ± 9.35	59.9 ± 7.07	0.843
Post test	Correct	66.1 ± 9.16	62.4 ± 7.91	0.020*
	Error	0.45 ± 0.72	0.75 ± 1.27	0.115
	Total	66.5 ± 8.96	63.1 ± 7.73	0.029*

When paired t test was applied to pre and post test scores of music and control groups, all the values were significant except the error scores of control group p = 0.264. There was significant decline in error in music group p = 0.002. (Table-IV).

Table-IV: Symbol Digit Modality test- comparison of PRE and POST test score in Music and Control group using paired t test.

	Music Group	Control Group
Pre test and post test	p-value	p-value
Correct	< 0.001*	< 0.001*
Error	0.002*	0.264
Total	< 0.001*	< 0.001*

On comparing results in subgroups, Malaysian students in music group showed highest “correct” score (63.9±7.17) and “Total” score (64.4 ± 7.26) compared to all other groups and was statistically significant. Highest error was seen in Malaysian control group 1.1 ± 2.12. (Table-V).

Table-V: Symbol Digit Modality Test scores recorded **DURING** music/rest in subgroups of Indian and Malaysian students.

(Mean ± SD)	Subgroup	Subgroup	p-value
	Indian music group	Indian control group	
Correct	54.9 ± 9.46	58.3 ± 7.54	0.129
Error	1.06 ± 1.5	1 ± 1.66	0.871
Total	56 ± 9.42	59.3 ± 8.06	0.150
	Malaysian music group	Malaysian control group	
Correct	63.9 ± 7.17	59.4 ± 6.59	0.013*
Error	0.43 ± 0.68	1.1 ± 2.12	0.107
Total	64.4 ± 7.26	60.5 ± 5.99	0.027*
	Indian music group	Malaysian music group	
Correct	54.9 ± 9.46	63.9 ± 7.17	< 0.001*
Error	1.06 ± 1.5	0.43 ± 0.68	0.040*
Total	56 ± 9.42	64.4 ± 7.26	< 0.001*
	Indian control group	Malaysian control group	
Correct	58.3 ± 7.54	59.4 ± 6.59	0.550
Error	1 ± 1.66	1.1 ± 2.12	0.840
Total	59.3 ± 8.06	60.5 ± 5.99	0.516

Malaysian music group performed the best compared to all the other three groups in respect to correct and total score in post test session. (Table-VI).

Table-VI: Symbol Digit Modality Test scores recorded **POST TEST** in subgroups of Indian and Malaysian students.

(Mean ± SD)	Subgroup	Subgroup	p-value
	Indian music group	Indian control group	
Correct	62.2 ± 9.82	61.4 ± 7.36	0.734
Error	0.43 ± 0.62	0.7 ± 1.11	0.261
Total	62.6 ± 9.52	62.1 ± 7.36	0.821
	Malaysian music group	Malaysian control group	
Correct	70 ± 6.53	63.4 ± 8.44	0.001*
Error	0.46 ± 0.81	0.80 ± 1.42	0.271
Total	70.4 ± 6.39	64.2 ± 8.08	0.002*
	Indian music group	Malaysian music group	
Correct	62.2 ± 9.82	70 ± 6.53	0.001*
Error	0.43 ± 0.62	0.46 ± 0.81	0.860
Total	62.6 ± 9.52	70.4 ± 6.39	<0.001*
	Indian control group	Malaysian control group	
Correct	61.4 ± 7.36	63.4 ± 8.44	0.340
Error	0.7 ± 1.11	0.80 ± 1.42	0.763
Total	62.1 ± 7.36	64.2 ± 8.08	0.305

When paired t test was applied to each of the subgroups, significant decline in error score was seen in Indian music group (p=0.002). (Table-VII).

Table-VII: Symbol Digit Modality test- comparison of PRE and POST test score in subgroups using paired t test.

Pre Test And Post Test	Indian Music Group	Indian Control Group	Malaysian Music Group	Malaysian Control Group
	p-value	p-value	p-value	p-value
Correct	< 0.001*	< 0.001*	< 0.001*	< 0.001*
Error	0.002*	0.132	0.132	0.398
Total	< 0.001*	< 0.001*	< 0.001*	< 0.001*

Analysing BP response and SDMT response together:

BP recordings indicate an increased relaxed state within 5minutes of music session. While with SDMT, performance improved with repetition or practicing the task (control group), the improvement was further enhanced by associating it with background instrumental music. Performance is best seen at the end of music session. Thus the rise in BP seen during the music session and in during post test, indicates more towards increased arousal than towards increased stress showing that, music can increase the required arousal to an optimal level and decrease fatigue. In Indian students, music decreases the number of errors while in Malaysian students, it increased their correct and total scores again corresponding to their BP response.

Discussion:

Blood Pressure was used as physiological indicators of stress or arousal⁽⁹⁾. The music group showed a peculiar response. Our findings are similar to those of Bernardi L et.al (2006)⁽¹⁰⁾. They suggest that cardiovascular system shows an entrainment effect to tempo and rhythm of music used. In our study, music used had a slow rhythm and hence the drop in Blood Pressure⁽¹¹⁾. An emotion response to music causes an increase in arousal. The adjusted body rhythm then spreads through proprioceptive feedback to the subcomponents of emotion such as cognitive, neurophysiological, motivational, expressive, and subjective feelings components⁽¹¹⁾. Also, music initiates reflexive brainstem responses, which via the

noradrenergic, cholinergic and dopaminergic neurons, modulates autonomic responses like pulse rate, blood pressure, which in turn modifies stress, arousal, and emotions. Brainstem neurons tend to fire synchronously with tempo to regulate these parameters⁽¹²⁾. Our study used a slow tempo classical music which had a very soothing rhythm and the autonomic system probably responded to it by toning down the sympathetic activity and catecholamine release thus causing a relaxed state⁽⁹⁾. Our study also confirms the other findings of Bernardi L et.al (2006)⁽¹⁰⁾ that even short duration of meditative music can induce measurable cardiovascular effects, in our study in duration of 5minutes. This effect is independent of a person’s preference or habituation to music, or ethnicity and is clearer when the rhythm of music used is simple.

When multiple complex tasks were given to the students along with background music, there was an abrupt rise in autonomic parameters over and above the control group, more evidently seen in Systolic BP. These remained elevated throughout the duration of task performance. Previous study done on surgeons, who also employed classical music, showed that their autonomic reactivity reduced and performance improved when music was played in background in the operation theatre⁽¹³⁾. In our study an increase in autonomic reactivity of the students in music group was seen along with improvement in their concentration. This points towards increased arousal with music. Our findings can be explained on

the basis of “Yerkes-Dodson law” which states that “Arousal level of individual increases performance up to an optimal level beyond which over-arousal leads to deterioration in performance”.⁽¹⁴⁾ In our study, student’s sympathetic activity increased when a challenging task was performed with background music. Music caused increased arousal and improvement in their neurocognitive performance. The autonomic parameters remained elevated even after the music was stopped (post test).

Successive Symbol digit modality test was used to assess concentration by visual scanning method. The baseline scores did not show any significant difference while, repetition of the test (done during and post exposure) showed improvement in scores in both the groups, and was significantly high in music group in post test sessions. These findings suggest that performance improves with repetition of a task or training and can be further improved when associated with soothing background music⁽⁵⁾. The number of errors committed by the music group were progressively lesser (and statistically significant) showing enhanced attention.

Music, as sound waves, not only activates the auditory cortex in the temporal lobe but, is said to activate at least 18 different areas of the brain when used while performing a specific task⁽¹⁵⁾. The results obtained in our study can be justified based on the “modality effect” which states that “Individuals who receive both auditory and visual information, both of which are processed in different parts of brain, learn better than those who use only resources involving visual system. Thus individual can perform two complex tasks with different modalities at the same time”⁽¹⁶⁾. Students in our study received both auditory and visual information, which increased their cognitive load and enhanced their performance. Our study contradicts the findings of Johnson MB

(2000)⁽¹⁷⁾ which recorded better results in the no-music conditions.

Indian music group showed a significant decline in error made compared to their pre test sessions, again upholding the concept of modality effect. Malaysian students in music group showed consistently better concentration ability throughout the protocol compared to all the other groups. Darrow et.al (2006)⁽¹⁸⁾ suggests that better concentration and the effect of music on concentration may be due to an acquired skill or a personality trait. The favorable outcome of music on concentration test may be a personality trait of Malaysian students.

Conclusions:

Thus classical instrumental music is beneficial to students and act as an “active coping” strategy as it can alleviate their stress within a very short period of time, in our study within a span of 5minutes. It has a specific effect on autonomic parameters i.e. it can decrease Blood Pressure and act as a relaxation technique while, when used in the background during task performance, can increase the readings of these parameters showing increased arousal which helps the students perform better. Performance improves with repetition or practicing a specified task, the improvement can be further enhanced by associating it with background instrumental music. Music can increase the required arousal to an optimal level and decrease fatigue. The specific effect produced by classical instrumental music on autonomic parameters and performance in divided attention test can be seen in all medical students irrespective of their nationality and preference. Thus music can entrain the cardiovascular rhythm to its own pace, and can act as a common language to bring all these students together.

Application of the study: soft music can be used between lectures for a short time to relax the

students, irrespective of their ethnicity and preference, and help them concentrate better for the subsequent classes. Classes taken at the end of the

day can use short meditative music to increase their arousal and retain some information which might help them understand better.

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