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Distinctive outcomes of successive divided attention as weighed against working memory when analysed with instrumental background music – randomised control trial

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ABSTRACT

Introduction: Music used by students during studying should help them.
Objectives: To assess the effect of instrumental, background music on concentration and working memory in 1^{st}-year medical students.
Materials and Methods: 60-girls and 60-boys of 1^{st}-year MBBS, were randomised into music and control groups equally. Concentration was assessed using 3 different forms of SDMT as pre-test, during music/control session and post-test using total, correct and error score. For assessing working memory, Rey-Ostherrieth-complex-figure-test was used. (significant p value<0.05).
Results: Music group showed significant improvement in correct (p=0.02) and total (p=0.029) scores during post-test while errors reduced (p=0.002). For ROCF, recall was better in music group compared to controls but the values were not statistically significant (p=0.223).
Conclusion: Performance improves with repetition of a specified task; the improvement can be enhanced by associating it with background instrumental music. Performance is best seen at the end of music session showing that, music can increase the required arousal to an optimal level. Instrumental music does not seem to have an influence on working memory, it does not hamper it. Students can be advised to use instrumental music, preferably of raga Malkauns, in background while studying which will help them concentrate better and will not hamper their retention.

1. Introduction

Researchers have found high anxiety levels in medical students which are related either to academic or psychosocial factors. In fact, levels of stress are much higher among 1st year medical students compared to other years. Some amount of stress is needed for learning, called "favourable stress," but too much or chronic stress can affect mental and physical health causing poor academic and clinical performances.[1] A stroll around the college library, and we can see many students with earplugs in their ear while studying, probably to cope with stress. Music can act as an efficient coping strategy as it is easily available, affordable and mobile. But how much it actually helps them to relax and to concentrate varies at individual level. Previous studies have shown mixed observations.[2,3]

The mixed observations are probably because the type of Music used in different studies are variable either in type, rhythm, tempo, being vocal or only instrumental, self-chosen, etc. Also, its use in "visual-spatial constructional ability" is sparse. Previous research shows slow paced rhythms and tempos, like that of classical music can lead

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to diverting the thoughts in a more positive direction similar to the actions of yoga or meditation.[4] Also vocal component of music was seen to be more disrupting than pure instrumental.[5] Hence we used classical instrumental music of raga Malkauns. This raga is believed to have been created by goddess Parvati (the wife of Shiva) to calm Shiva's Tandav. Malkauns is a serious, meditative raga, and is developed mostly in the lower octave (mandra saptak) and in a slow tempo (vilambit laya).

Thus, the objective of this study was to assess the effect of classical instrumental, background music on concentration and working memory in first year medical students, both of which are required for generating good long term memory.

2. Materials and Methods

Ethical clearance was obtained from all concerned authorities and written informed consent was taken from all students before conducting the study. Using opaque sealed sampling, an RCT was conducted for 1 year in research laboratory of the Department of Physiology, J. N. Medical College, Belgaum, Karnataka, India, on 120 students studying in Phase-I MBBS. Study was conducted during working days (except Saturdays and Sundays) between 4pm to 6pm.

2.1. Exclusion criteria

Students with a history of headaches, migraine, hearing impairments, history of drug abuse, smokers, alcoholics, and suffering from cognitive disorders were excluded from the study.

2.2. Sample size

Based on the pilot study conducted, the effect size was 20. Minimum of 30 students were selected with $\acute{\alpha}$ error = 0.05 and β error = 0.2.

2.3. Test/music group

60 medical students in music group with equal number of girls and boys.

2.4. Control group

60 medical students in control group with equal number of girls and boys.

2.4.1. Music used for intervention

Classical instrumental music consisting of flute, raga Malkauns, by Hariprasad Chaurasia from the album "Ragas" was used. Music was played for 30 min. Player used was Mitashi DVD player, 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.

2.4.2. Test used to assess concentration: Symbol digit modality testing (SDMT)[6]

This test is used to assess concentration ability by divided attention, visual scanning, tracking, and motor speed. Each sheet consists of 8 lines with 15 symbols in each line and contains a box below each symbol to fill in the corresponding number. A "coding key" is provided at the top of the page which consists of "9 abstract symbols" each paired with a number from 1-9. The student is asked to scan the key and write down the number corresponding to each symbol, as rapidly as possible. Once the test form was placed before the student, 90 seconds were allowed to complete the trial.

Three forms different from each other in symbols were used

1. Form A – used during pre-test for both groups.
2. Form B – used during exposure to music/control.
3. Form C – used during post-test for both groups.

Interpretation of SDMT: Scores are considered for three outcomes. i.e CORRECT score, ERROR score and TOTAL score.

2.4.3. Test used to assess working memory: Rey-Osterrieth complex figure test (ROCF)[7,8]

The purpose of this test is to assess working memory by visual-spatial constructional ability and visual memory. The materials consist of blank pieces of paper and the Rey-Osterrieth figure. The measures of performance derived are

1. A copy score (which reflects the accuracy of the original).
2. A recall score (accuracy of figure recalled to that of original).

The task is essentially an incidental learning test. There is no warning of the memory component until the subject is asked to recall the figure from memory. There are no significant differences between dominant and non-dominant hand performance on the copy portion of the task.

1. Copy: Subjects were allowed to copy within maximum of 5 min. After the drawing is completed, it is removed from sight along with the stimulus card.
2. Recall**:** After a delay filled with other task (in our study, a concentration test was given: SDMT form B), a clean sheet of paper was provided and the students were told to recall the figure.
3. Scoring: The figure is broken down into 18 elements and scored in the range of 0.5 and 2.0 points are awarded for each element, depending on the

accuracy, distortion, and location of its reproduction. Thus, maximum score can be 36 indicating the best performance.

2.5. Study design

Table 1: Showing study protocol

Pre-test	Symbol Digit Modality Test (SDMT) Form A	
Tests done with music/in controls	After 5min	Rey Osterrieth Complex Figure Test (ROCF) - Copy
	After 15min	Symbol Digit Modality Test (SDMT) Form B
	After 25min	Rey Osterrieth Complex Figure Test (ROCF) - Recall
Post-test	Symbol Digit Modality Test (SDMT) Form C	

Table 1 shows study protocol. Pre-test done in all 120 subjects, during music / non-music sessions, SDMT was used for concentration and ROCF for working memory. Post-test was done in all 120 subjects without music.

Pre-test and post-test was done without music in both groups, while memory test (ROCF) and SDMT form B was done with background music in music group and with no music in control group. ROCF-copy was done 5 minutes of playing music/rest, SDMT after 15minutes of music/rest and ROCF-recall after 25 minutes/rest.

3. Results

Results of SDMT test used for divided attention.

Table 2: DMT 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
With music / rest	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*

* Statistically significant p-value. (< 0.05); Results of concentration

Illustrates mean + SD of SDMT concentration test in all 120 subjects during pre-test, music/non-music session and post-test. Values are determined as correct, error and total scores for each session. Unpaired students t test is used to assess statistical significance.

Table 3 illustrates mean + SD of SDMT in music and control group separately. Paired t test was used to assess changes in values in pre and post SDMT test. Correct, error and total scores were compared.

Table 3: SDMT- comparison of PRE and post test score in Music and control group

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

* Statistically significant p-value. (< 0.05)

Table 2 SDMT score was not statistically different between music and control group in pre-test. Correct and Total scores were better while errors reduced in music group but were not statistically significant. In Post-test, Total scores and Correct scores being higher in music group (66.1 ± 9.16 and 66.5 ± 8.96 respectively) compared to control group (62.4 ± 7.91 and 63.1 ± 7.73 respectively). Values were statistically significant (p-value for Correct = 0.020*; Total = 0.029).

Table 3 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.

3.1. Results for ROCF test to assess working memory

Table 4: ROCF scores in Music and Control group (max score = 36)

	Figure copy	Figure recall
Music group	33.9 ± 2.69	24.5 ± 5.07
Control group	33.9 ± 2.36	23.3 ± 5.06
p-value	0.986	0.223

Table 4 determines copy score and recall score separately in music and control group.

Table 4 there was no statistical difference between the score for copying the figure in music and control group (p=0.986). Figure recall was better in music group compared to control group but the values were not statistically significant (p=0.223).

4. Discussion

4.1. Concentration

SDMT was used to assess concentration by visual scanning method. The baseline scores did not show any significant difference between music and control groups 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. These

findings correspond to that of Savan A (1999).[9] Also the number of errors committed by the music group on repeated tests were progressively lesser (and statistically significant) compared to control group showing enhanced attention on the concentration task performed.

Soothing music not only facilitates positive mood enhancement, but also activates auditory cortex in the temporal lobe and, can activate 18 different areas of the brain when used while performing a specific task.[10] The explanation they give is based on the working memory model of Baddeley (1992)[11] called "modality effect" or"modality principle". In his model, working memory has two modality-specific slave systems: one for processing visual and spatial information and one for acoustic information. When information is presented in two sensory modalities (visual and auditory) rather than one, both slave systems are addressed and total working memory capacity is increased. In other words "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". 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 et al (2000)[3] which recorded better results in the no-music conditions probably because of difference in the age group of the subjects used.

4.2. Working memory

ROCF was used to assess visual working memory. Test scores showed no significant difference between music and control group. Salame P and Baddeley (1989),[12] in their study showed that participants performed better in working memory test when there was no music present rather than with instrumental music. Banbury et.al (2001)[13] suggested that any type of background music or auditory distractions hamper memory, especially short term memory, called the "irrelevant sound effect" (ISE).[14]

ISE is explained on the basis "phonological loop model". They explain that irrelevant sounds either interfere with the passive store, holding verbal information in a phonological code or weaken the associations between adjacent items in the memory list.[15] Previous studies have reported vocal music to be more disruptive and instrumental music to be beneficial (over silence) on recall of visually presented verbal items such as digits, syllables, or words tasks.[5,12,16] Steady state sounds have a minor effect or no effect at all.[14] Our study supports the ISE and has shown that instrumental music, which is continuous and rhythmic, has a minor effect on memory component.[15] Our study partly corresponds to the reviews of Salame P and Baddeley[12] but does not support the finding that no-music group does better.

5. Conclusion

Thus, classical instrumental music is beneficial to students as it can improve their concentration capacity (although no beneficial effect is seen on recall capacity). Performance improves with repetition or practicing a specified task, the improvement can be further enhanced by associating it with background instrumental music. Performance is best seen at the end of music session showing that, music can increase the required arousal to an optimal level. Though instrumental soothing music does not seem to have an influence on recall or working memory, it does not hamper memory and, can be safely used in background while solving memory tasks. Students, who use music while studying, can be advised to use instrumental music in background which can help them relieve their anxiety, concentrate better and perform better. Also, it can be constructively used between lectures to delay mental fatigue in students.

6. Informed Consent

Written and well-informed consent was obtained from all subjects at the beginning of the study.

6.1. Compliance with Ethical Standards

All experiments were conducted in accordance with the guidelines for human ethics defined by Medical council of India and were approved by the Ethical Committee for human research by the institute of KLEs JNMC Belgaum.

7. Source of Funding

No funding obtained to declare.

8. Conflict of Interest

The authors declare that they have no conflict of interest.

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