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Original Research Article

Comparing and analysing working memory and its adjustments with classical instrumental background music in adolescents of diverse ethical origin – An RCT

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ABSTRACT

Introduction and Objectives: Students use variety of music while studying. The aim was to analyse effect of instrumental, background music on working memory in medical students of Indian and Malaysian origin.

Materials and Methods: Age and gender matched 120 1st-year MBBS students (60 Indian and 60 Malaysian), were randomised into music and control groups equally. Music used was non vocal flute, raga malkauns. After 5 min of music/rest, working memory was assessed using Rey-Ostherrieth-complex-figure-test (ROCF). After another concentration task(SDMT) and a gap of 25min, recall of figure was assessed. Copy and recall figures were scored for 36 points.(significant p value<0.05).

Results: There was no statistical difference between copy and recall score of ROCF when compared between music and control group of both ethnicities (p=0.223). Malaysian students performed significantly better in copy and recall score compared to Indian students.

Conclusion: Instrumental music does not seem to influence working memory, but it does not hamper it too. As a diverse population, Malaysian students are bestowed with efficient working memory than Indian students. Music has no differential influence on the working memory of the two ethnic groups. Students can be advised to use instrumental music, preferably of raga Malkauns, in background while studying which will not hamper their retention.

1. Introduction

Researchers have found high levels of stress in medical students related to their academics, psychosocial aspects and the requirement to develop strong interpersonal skills and self-confidence, all this in order to be “fully”-qualified doctor (Misra 2000).[1] International medical education is an increasingly active component which imbibes variety of strategies like increase in core competency and curriculum development, increase manpower, topic/disease information exchange, cooperative arrangements, newer technologies etc. (Bury G 2003).[2] With increasing joint ventures, Indian medical schools, for many years, have offered opportunities to Malaysian students to obtain medical education in India. During their study Malaysian students receive the same study materials for equal duration as their Indian counterparts. These students may not only perceive the above said stressors but also additional ones like being very far from home, environmental factors, food change etc (Herlekar SH 2017).[3]

A stroll around the college library, and we can see many students with earplugs in their ear while studying, probably to cope with stress. An efficient coping strategy has to be such that it is easily available, affordable and mobile, bring a change within short time, help relieve anxiety and increases task performance (Furnham 2003).[4] Music can act as an

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efficient coping strategy. But how much it actually helps them to relax and to concentrate varies at individual level. Previous studies have shown mixed observations (Burleson SJ 1989; Johnson MB 1990).[5,6] 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 to diverting the thoughts in a more positive direction similar to the actions of yoga or meditation (Sairam TV 2006).[7] Also vocal component of music was seen to be more disrupting than pure instrumental (Furnham A 1999).[8] 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).

2. Objectives

1. To compare working memory of Indian and Malaysian first year medical students.
2. To assess the effect of classical instrumental background music on working memory in Indian and Malaysian first year medical students.

3. Materials and Methods

Ethical clearance was obtained from all concerned authorities and written informed consent was taken from all students before conducting the study. An RCT was conducted for 1 year in research laboratory of the Department of Physiology, J. N. Medical College, Belgaum, Karnataka, India. Permissions were also obtained from KLEs USML medical college for recruitment of Malaysian medical students. 120 students: 60 Indian students (30 males + 30 females) and 60 Malaysian students (30 males + 30 females) studying in Phase-I MBBS were the subjects. Study was conducted during working days (except Saturdays and Sundays) between 4pm to 6pm. Sample size calculated with $\acute{\alpha}$ error = 0.05, β error = 0.2 and effect size 20.

3.1. 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.

Randomisation: was done by opaque sealed sampling.

Participant's information: A structured Performa was used to collect socio-demographic and nationality information from all study participants.

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+15 Malaysian boys). Control Group: same as test group, but without any music.

Total of 8 subgroups created (n=15 in each subgroup)

Music Group	**Control Group**
1. Indian girls	5. Indian girls
2. Indian boys	6. Indian boys
3. Malaysian girls	Malaysian girls
4. Malaysian boys	8. Malaysian boys

3.2. Music used

Instrumental music of raga Malkauns, by Hariprasad Chaurasia from the album "Ragas" on flute was used for its meditative nature, CD was by Cynosure Infotech New Delhi. Music was played for 30 minutes. Mitashi DVD player was used; along with Zebronics over the ears headphones. The volume was at a comfortably constant level for all the subjects. The room was maintained at minimum noise.

Test used to assess working memory: Rey-Osterrieth Complex Figure Test (ROCF).[9,10]

The ROCF is one of the most commonly used tests in the field, ranking among the top 10 tests used by neuropsychologists. 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. The length of delay chosen (15, 30, 45, or 60 min) does not affect overall recall performance, provided the delay is no longer than 1 hour. After 5minutes of music/rest session,

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 called Symbol digit modality test, SDMT), 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.

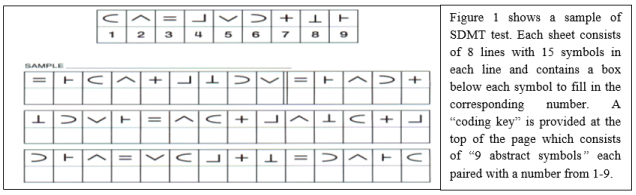

Figure 1 shows a sample of SDMT test. Each sheet consists of 8 lines with 15 symbols in each line and contains a box below each symbol to fill in the corresponding number. A "coding key" is provided at the top of the page which consists of "9 abstract symbols" each paired with a number from 1-9.

Fig. 1: Sample of symbol digit modality test used for concentration[3]

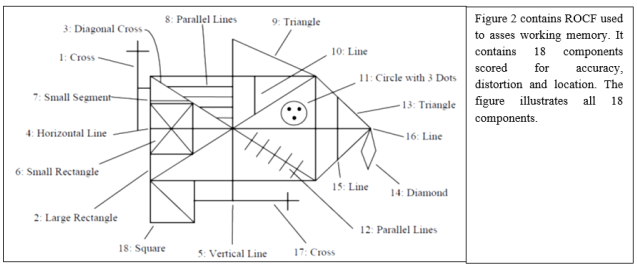

Figure 2 contains ROCF used to asses working memory. It contains 18 components scored for accuracy, distortion and location. The figure illustrates all 18 components.

Fig. 2: ROCF figure with 18 components that were scored

Table 1: Showing study protocol

Tests done with music/ controls	After 5min	Rey Osterrieth Complex Figure Test (ROCF) - Copy
	After 15min	Symbol Digit Modality Test (SDMT)
	After 25min	Rey Osterrieth Complex Figure Test (ROCF) - Recall

Memory test (ROCF) was done with background music in music group and with no music in control group. ROCF-copy was done 5minutes of playing music/rest, and ROCF-recall after 25 minutes/rest.

4. Results

Table 2: Rey osterrieth complex figure test scores in music and control group

(Mean ± SD)	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

1. There was no statistical difference between the score for copying the figure in music and control group (p=0.986). (Table 2)
2. Figure recall was better in music group compared to control group showing better memory retention with music but the values were not statistically significant (p=0.223). (Table 2)
3. Figure copy scores were statistically higher in Malaysian music and control group compared to their Indian counterparts. p<0.001 in music group and p=0.001 in control group. (Table 3)
4. Figure recall was higher in Malaysian music group compared to Indian music group and showed statistically significant difference p=0.013. (Table 3)
5. Malaysian music group showed highest scores for recall of the complex figure compared to all groups. (Table 3)

1. Scores of figure copy showed highest values in Malaysian boys in music group (35.5±1.12) followed by Malaysian girls in control group (35.4±0.82). (Table 4)
2. Scores of figure copy showed lowest values in Indian boys in music group (32.1±3.53) followed by Indian girls in control group (32.8±2.33). (Table 4)
3. Scores of figure recall showed the highest values in Malaysian boys in music group (26.3±4.65) followed by Malaysian girls in music group (25.8±5.35). (Table 4)
4. Scores of figure recall showed lowest values in Indian girls in music group (21.9±5.02) followed by Indian girls in control group (22.2±3.01). (Table 4)
5. Comparison of Indian boys with music and Malaysian boys with music showed statistically significant values for both copy (p=0.001) and recall (p=0.04). (Table 4)
6. Statistically significant difference (p=0.025) was seen for recall between Indian girls with music and Malaysian girls with music. Table 4.

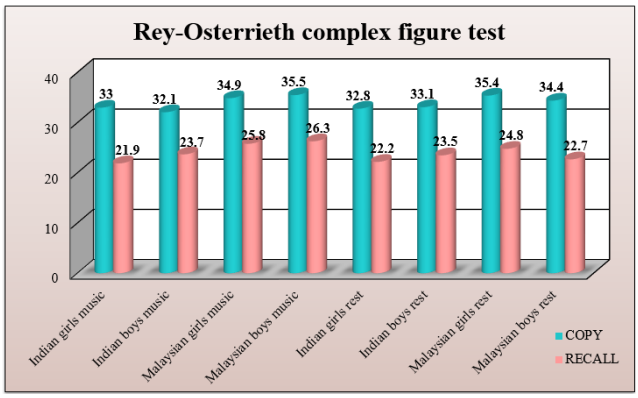

Fig. 3: Rey-osterrieth complex figure test scores in all eight subgroups

Table 3: Rey-osterrieth complex figure test scores and comparison (as p-values) for copy and recall in various groups

(Total score=36)	(Mean ± SD)	(Mean ± SD)	p- value
	Indian music group	Indian control group	
Copy score	32.5 ± 3.04	32.9 ± 2.69	0.623
Recall score	22.8 ± 4.76	22.8 ± 4.01	1
	Malaysian music group	Malaysian control group	
Copy score	35.2 ± 1.32	34.9 ± 1.47	0.336
Recall score	26.1 ± 4.93	23.8 ± 5.95	0.114
	Indian music group	Malaysian music group	
Copy score	32.5 ± 3.04	35.2 ± 1.32	< 0.001*
Recall score	22.8 ± 4.76	26.1 ± 4.93	0.013*
	Indian control group	Malaysian control group	
Copy score	32.9 ± 2.69	34.9 ± 1.47	0.001*
Recall score	22.8 ± 4.01	23.8 ± 5.95	0.472

* Statistically significant p-value. (< 0.05)

Table 4: Rey-osterrieth complex figure test scores in all 8 subgroups

Group	Subgroup	Copy (Mean ± SD)	Recall (Mean ± SD)
Music group	Indian girls	33 ± 2.51	21.9 ± 5.02
	Indian boys	32.1 ± 3.53	23.7 ± 4.46
	Malaysian girls	34.9 ± 1.47	25.8 ± 5.35
	Malaysian boys	35.5 ± 1.12	26.3 ± 4.65
Control group	Indian girls	32.8 ± 2.33	22.2 ± 3.01
	Indian boys	33.1 ± 3.08	23.5 ± 4.83
	Malaysian girls	35.4 ± 0.82	24.8 ± 6.21
	Malaysian boys	34.4 ± 1.8	22.7 ± 5.71

Analysis of concentration test was done based on pre-test, during and pot-test of music and rest session. The results are published elsewhere.[3]

5. Discussion

The present study thus recruited 120 medical students, 60 Indian and 60 from Malaysian nationality who were age and sex matched. Even though, there were about 8-9% Indians among the population of Malaysia, they are living in that nation for more than 3 generations. Hence, the ethnicity may not matter for the general outlook of behavioral / habitual outcomes. A classical instrumental musical piece was used on half the students from both nationality and its effect was assessed on working memory. This was compared to control group who performed the above said tests without background music.

ROCF was used to assess visual working memory. Test scores showed no significant difference between music and control group. Salame P and Baddeley (1989),[11] 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)[12] suggested that any type of background music or auditory distractions hamper memory, especially short term memory, called the "irrelevant sound effect" (ISE)(Neath I 2000).[13]

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 (Klatte M 2010).[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 (Furnham A 1999; Salame P 1989; Hallam S 2002).[8,11,16] Steady state sounds have a minor effect or no effect at all (Neath I 2000).[13] Our study supports ISE and has shown that instrumental music, which is continuous and rhythmic, has a minor effect on memory component. Our study partly corresponds to the reviews of Salame P and Baddeley[11] but does not support the finding that no-music group does better.

On analysis of the four subgroups it was seen that, Malaysian students, both girls and boys, performed significantly better than Indian counter parts irrespective of whether they belonged to music group or control group. This suggests that Malaysian students have a better working memory capacity than Indian students and music probably does not have a significant influence on it. Our study supports the possibility that there is variable distribution of intelligence worldwide, the causes for which have been hypothesized by many researchers including variations in nutrition, temperature, ecological correlates, infection rates etc. (Eppig C 2010; Lynn R 1993; Kanazawa S 2008; Barber N 2005).[17–20]

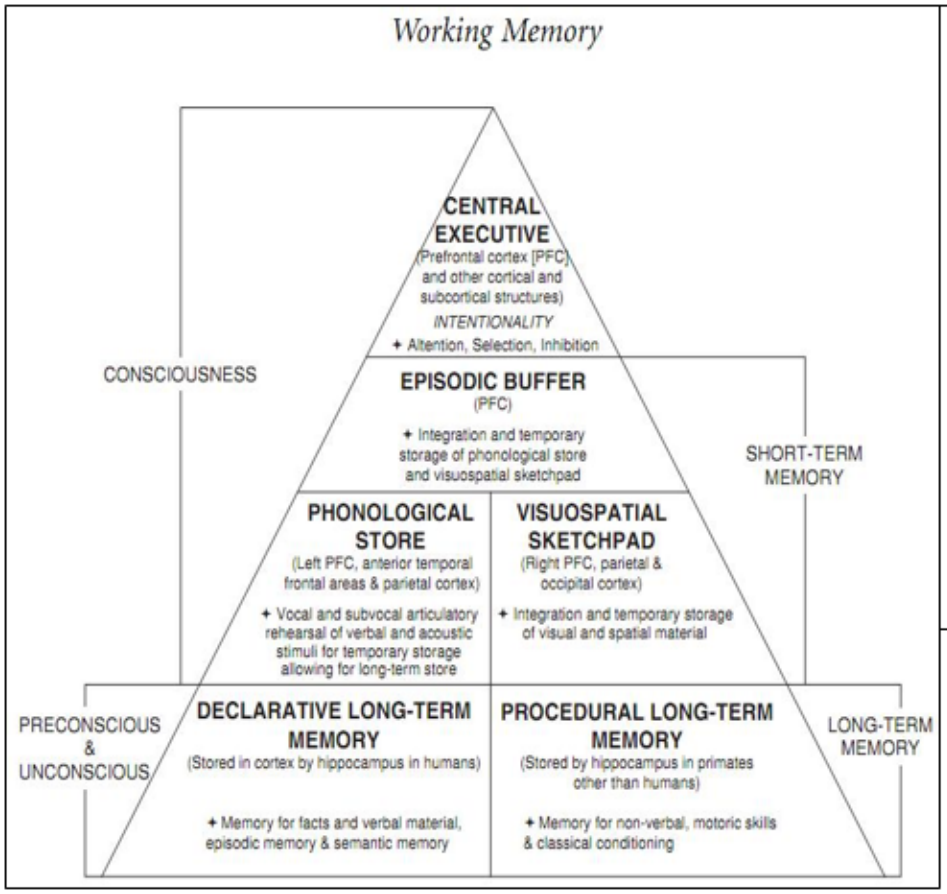

Figure 3 illustrates extended model of working memory. Previous study suggests that vocal music affects either phonological storage or probably weakens association between adjacent items in memory list. Our study used instrumental music, which, according to our study, did not affect positively or negatively working memory components.

Fig. 4: Extended model of working memory with associated brain regions.(Davies GM 1993). [14]

6. Conclusion

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. As a diverse population, Malaysian students are bestowed with a much efficient working memory than Indian students. Music has no differential influence on the working memory of the two ethnic groups.

7. List of Abbreviations

1. ROCF: Rey-Osterrieth Complex Figure Test.
2. ISE : Irrelevant Sound Effect.

8. 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.(MDC/PG/742)

9. Informed Consent

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

10. Source of Funding

No funding obtained to declare.

11. Conflict of Interest

The authors declare that they have no conflict of interest.

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