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ORIGINAL SCIENTIFIC REPORT

# Surgical Notes: To Play or Not to Play

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## Abstract

*Introduction* Music is any sound that is perceived as pleasingly harmonious. The link between music and healthcare can be traced long back in the history of mankind. Thus, our study aimed at assessing the impact of different genre of music on the cognition functioning, memory and attention levels of the surgeons.

*Materials and methods* It was a single-arm interventional trial assessing 45 surgeons from different specialities. Each participant was expected to do 5 sets of tasks, one set each for the 5 music tracks played. Each task set further contained 5 different types of tasks, namely trail marking, jigsaw puzzle, backward counting, comprehension and memory game using cards. The 5 music tracks included ambient OR noise, music of personal preference, western classical, heavy metal and pop music. Scores were assigned for each task and compared.

*Results* The total score for music of personal choice was much less (19.68) when compared to the other genre and that for pop was the highest (25.03). Memory card tests and backward counting (tests of short-term memory) were comparatively better with music of personal choice. However, trail marking (test of speed) and jigsaw puzzle and comprehension tests (tests of complex neurological functions) were least performed when music of personal choice was played.

*Conclusion* Music of choice may help in short-term memory recall, but an over-familiarity with the music played can serve as a distractor thus affecting the speed and accuracy.

## Introduction

Music can be defined as any sound that is perceived as pleasingly harmonious and is often considered an important attribute of mankind. Music is a language by itself, understood across countries and even across different living organisms with profound effect on the mental status of the listener and thereby on the physical demeanour and productivity [1]. The early reference emphasizing the therapeutic value of music in the operating room (OR) was made by Pickrell et al. [2]. Since then, there has been a continuum of studies that evaluate the beneficial effect of music on patients before, during or after surgery [3, 4]. Independent of such scientific investigations, we know for a fact that music has been widely played in ORs. A study conducted in the USA showed that 63% of the study participants comprising surgeons and OR nurses listen to music in the OR regularly [4]. Another survey conducted in the UK reported that 90% of surgeons in the UK listen to music [5]. Appropriately selected music has been found to decrease the stress levels of staff and may significantly improve the efficiency of those who work in this environment [6]. A randomized controlled trial published in the

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year 2015 concluded that listening to music while operating not only improves the speed with which surgeons performed wound closures, but it also improved the quality of the repair, as assessed by blinded surgeon observers [7]. However, a little is known on whether the choice of music played in the background affects the outcome. Thus, our study aimed at assessing whether the type of music that is played during the surgery has an impact on the cognition functioning, memory and attention levels of the surgeons.

## Materials and methods

This was a single-arm interventional trial conducted in a tertiary care teaching hospital from May 2017 to December 2017. All consenting surgeons who have completed their 3 years of postgraduate training were considered and working in the departments of general surgery, orthopaedics, otorhinolaryngology, ophthalmology, obstetrics and gynaecology were included in the study. Participants who had previously diagnosed hearing impairment or attention disorders were excluded. The sample size was calculated based on the findings of a pilot study conducted among 5 of the study investigators who fulfil the eligibility criteria. Assuming the mean of differences ($\delta$ diff) to be 7 and the standard deviation of differences ($\sigma$ diff) to be 10.75, the calculated sample size with an alpha error of 95% and a power of 80% was 39. Assuming a non-responder rate of 10%, the final sample size was increased to 45.

Written informed consent was obtained from the eligible surgeons, and their choice of music was obtained. Before the day of assessment for each of the surgeon, 4 different music tracks and a control track with ambient OR noise were pre-recorded such that there was a white noise of 30 s that preceded each music track. The 4 music tracks included ambient OR noise, music of personal preference, western classical, heavy metal (grunge) and pop music (FM radio based) in a randomly chosen order for each of the participants. At a time and date of their convenience, the surgeons were given instructions on how to perform the tasks. Each participant was expected to do 5 sets of tasks, one set each for the 5 audio tracks played. There were no tasks planned during the 30 s time of playing white noise. Each task set further contained 5 different types of tasks, namely trail marking, 25-piece jigsaw puzzle arrangement, serial backward counting, passage comprehension and memory game using playing cards that are regularly used in clinical psychology practice. Each set had a unique task of similar types so that they do not repeat between sets. For example, each participant did jigsaw puzzle five times, but all the 5 were different puzzles. The order in which these tasks were performed within each set was decided randomly using lot system a priori. These measures were taken to ensure that there was no possibility of learning occurring between the sets. The tasks were scored objectively on a scale of zero to ten based on pre-determined milestones for each of the tasks. For example, in the jigsaw puzzle, a score of two was given for every 5 pieces put in the right place. The participants were continuously monitored of their heart rate and blood pressure using a multipara monitor at baseline and at the end of each audio track.

Data were entered into Epi Info version 7 (Centers of Disease Control and Prevention, Atlanta, GA, USA, 2011), and analyses were performed using SPSS Statistics for Windows version 20.0 (IBM Corp., Armonk, NY, USA, 2011). Demographic and baseline characteristics were summarized using descriptive statistics. After confirming normal distribution using the Shapiro–Wilk test, repeated measures ANOVA was used to test statistical significance of total scores obtained at various time points and the pulse rates. This was followed by a post hoc analysis using Bonferroni's post hoc test. The individual component scores, however, did not fulfil the normality assumption, and hence nonparametric test called the Friedman's test was used. All the individual test scores except for memory card test and the mean arterial pressure (MAP) which showed that there was a statistical difference between the time points, were subjected to post hoc Wilcoxon signed rank test. In order to compensate for the alpha inflation secondary to multiple comparisons, the p value was adjusted using Bonferroni's correction. The new statistical significance was set at $p < 0.005$ for paired comparisons of scores of individual components between any two time points and $p < 0.002$ for paired comparisons of MAP between any two time points. For all other inferential statistics, the statistical significance was set at $p < 0.05$. The study procedures were done in accordance with the good clinical practice that was adapted from the Declaration of Helsinki. This trial was registered prospectively in the clinical trial registry of India (CTRI/2017/09/009914) and was also approved by the institutional Ethics committee (Reference Number: 135/2017).

## Results

A total of 50 surgeons were screened for eligibility, and 45 of them were recruited. The main reason for screen failures was refusal to give consent. The mean (SD) of age of the study participants was 37.02 (9.14), and two-thirds of them belong to the age group of 30 to 49 years of age. Female participants were more in number (60%), and a majority of the participants (73%) had less than 10 years of surgical experience. Almost 80% of the participants reported that they listen to music while operating, while more than half of them informed us that music of their choice was not

being played. The detailed socio-demographic characteristics of our study participants are depicted in Table 1. Due to the small sample size and India being a culturally diverse nation with many different genres and improvisations, there was no overlap of genres between music of choice and the other pre-decided music track genres.

The mean (SD) scores of individual components and the total score during different genre of music are summarized in Table 2. Higher the score, better is the cognition. The total score for music of personal choice was much less (19.68) when compared to the other genre. Multiple comparisons of total scores obtained between pairs of different genres are summarized in Table 3. This is confirmed that the total scores obtained when music of choice was played significantly lower ($p < 0.001$) than the total scores obtained while playing other music or ambient OT noise. Pop music on the other hand showed better performance though it did not achieve statistical significance when compared with ambient OT noise, western classical or rock music. Multiple comparisons of scores of individual components are given in Table 4. The performance in memory card test was not significantly different between the various music genres. The performance in jigsaw puzzle and comprehension test was highest when rock music was played. The performance in trail marking and backward counting was best when pop and music of personal choice were played respectively.

The mean (SD) of pulse and mean arterial pressure (MAP) measured at baseline, during each of the five music genre and at the end, is summarized in Table 5. There was no significant increase in the pulse rate and MAP across various time points between different genres of music playing except for MAP between baseline and music of choice ($p < 0.001$). These results are summarized in Table 6.

**Table 1** Participant characteristics

| Variable | Frequency (%) [$N = 45$] |
|---|---|
| *Age* | |
| Less than 30 years | 9 (20.0) |
| 30–49 years | 30 (66.7) |
| 50 years and above | 6 (13.3) |
| *Gender* | |
| Male | 18 (40.0) |
| Female | 27 (60.0) |
| *Designation* | |
| Postgraduate demonstrator | 7 (15.6) |
| Senior resident | 17 (37.8) |
| Assistant professor | 9 (20.0) |
| Associate professor | 6 (13.3) |
| Professor | 6 (13.3) |
| *Years of experience* | |
| Less than 10 years | 23 (73.3) |
| 10 years and more | 12 (26.7) |
| *Mother tongue* | |
| Kannada | 11 (24.4) |
| Tamil | 9 (20.0) |
| Konkani | 7 (15.6) |
| Malayalam | 5 (11.1) |
| Telugu | 4 (8.9) |
| English | 1 (2.2) |
| Others | 8 (17.8) |
| *Listening to music while operating* | |
| Yes | 36 (80.0) |
| No | 9 (20.0) |
| *Whether music of choice being played (N = 36)* | |
| Yes | 15 (41.7) |
| No | 21 (58.3) |
| *Opinion on role of music (N = 39)* | |
| Beneficial | 15 (38.5) |
| Blocks out communication | 6 (15.4) |
| Neutral | 18 (46.1) |

## Discussion

In this study, we report the impact of various music tracks played in the background in an operating room on the cognitive abilities and skill set of a surgeon. Each of the tasks used in our study has been used widely in multiple other studies and in regular psychological clinical practice to test the various facets of cognition. The memory recall/recognition was assessed using the memory card test which represents the short-term memory and ability to concentrate [8]. Jigsaw puzzles on the other hand reflect the visuospatial functioning of the participant that indirectly represent the fine skills in a surgeon. It refers to an individual's capacity to identify visual and spatial relationships between objects and is believed to comprise perception, mental rotation, processing speed, flexibility, constructional praxis, working memory, reasoning and episodic memory [9]. Trail marking is yet another cognitive test that measures speed and fluid cognitive abilities [10], while backward digit recall is a measure of working memory in children and short-term memory in adults [11]. Comprehension on the other hand is a higher mental function and processes complex abilities. It is an intelligent power of reasoning and abstract thought in humans [12].

We report that music of personal choice has a negative impact on cognition as a whole which is reflected by the lowest total score. These findings are in contrast to a few other studies [7, 13]. Lies and Zhang [7] reported that the

**Table 2** Mean (SD) score of various components during various music tracks

| Music | Memory card Max: 10 | Jigsaw Max: 10 | Trail marking Max: 10 | Backward counting Max: 10 | Comprehension Max: 10 | Total score Max: 50 |
|---|---|---|---|---|---|---|
| Music of choice | 5.60 (2.397) | 3.29 (2.018) | 2.73 (1.985) | 3.39 (1.575) | 4.67 (3.766) | 19.68 (7.447) |
| OT noise | 5.49 (2.928) | 4.33 (2.449) | 5.57 (2.666) | 3.01 (1.302) | 5.07 (3.374) | 23.47 (7.969) |
| Western classical | 5.11 (2.102) | 3.53 (2.510) | 5.59 (2.610) | 3.05 (1.522) | 6.84 (3.754) | 24.13 (6.858) |
| Pop | 4. 80 (2.040) | 3.38 (2.879) | 7.14 (2.567) | 3.35 (1.186) | 6.36 (3.084) | 25.03 (7.594) |
| Rock | 5.47 (2.361) | 4.64 (2.317) | 4.53 (2.544) | 2.55 (1.256) | 7.78 (3.169) | 24.97 (7.091) |

*OT* Operating theatre

**Table 3** Repeated measures ANOVA with Bonferroni's post hoc test for total scores

| Comparison groups | Mean difference (95% confidence interval) | *p* value* |
|---|---|---|
| M1–M2 | −3.790 (−6.109, −1.470) | <0.001 |
| M1–M3 | −4.451 (−6.833, −2.068) | <0.001 |
| M1–M4 | −5.350 (−8.254, −2.446) | <0.001 |
| M1–M5 | −5.293 (−8.137, −2.448) | <0.001 |
| M2–M3 | −0.661 (−3.369, 2.047) | 1.000 |
| M2–M4 | −1.560 (−4.418, 1.297) | 1.000 |
| M2–M5 | −1.503 (−3.834, 0.829) | 0.663 |
| M3–M4 | −0.900 (−3.425, 1.626) | 1.000 |
| M3–M5 | −0.842 (−3.495, 1.811) | 1.000 |
| M4–M5 | 0.057 (−2.533, 2.648) | 1.000 |

*M1* Music of personal preference, *M2* operating theatre noise, *M3* western classical, *M4* pop, *M5* rock

*There was a significant difference between effects at different time points $F$ (4,176) = 12.402, $p < 0.001$. Assumption of sphericity was not violated

**Table 4** Score comparison of individual components during various music tracks

| | Jigsaw | | Trail Marking | | Backward counting | | Comprehension | |
|---|---|---|---|---|---|---|---|---|
| | MD | *p* | MD | *p* | MD | *p* | MD | *p* |
| M1–M2 | −1.04 | 0.003 | −2.83 | <0.001 | 0.38 | 0.030 | −0.40 | 0.537 |
| M1–M3 | −0.24 | 0.563 | −2.86 | <0.001 | 0.34 | 0.073 | −2.18 | 0.001 |
| M1–M4 | −0.09 | 0.978 | −4.41 | <0.001 | 0.04 | 0.672 | −1.69 | 0.002 |
| M1–M5 | −1.36 | <0.001 | −1.80 | <0.001 | 0.84 | <0.001 | −3.11 | <0.001 |
| M2–M3 | 0.80 | 0.037 | −0.02 | 0.832 | −0.04 | 0.954 | −1.78 | 0.002 |
| M2–M4 | 0.96 | 0.026 | −1.58 | <0.001 | −0.34 | 0.031 | −1.29 | 0.005 |
| M2–M5 | −0.31 | 0.504 | 1.03 | 0.063 | 0.46 | 0.005 | −2.71 | <0.001 |
| M3–M4 | 0.16 | 0.529 | −1.56 | <0.001 | −0.30 | 0.039 | 0.49 | 0.446 |
| M3–M5 | −1.11 | 0.008 | 1.06 | 0.078 | 0.50 | 0.004 | −0.93 | 0.036 |
| M4–M5 | −1.27 | 0.002 | 2.61 | <0.001 | 0.80 | <0.001 | −1.42 | 0.002 |

Friedman's test was not significant for memory card ($p = 0.309$). However, it was $< 0.001$ for all other 4 tests. The new $p$ value after Bonferroni's correction is $< 0.005$

*M1* Music of personal preference, *M2* operating theatre noise, *M3* western classical, *M4* pop, *M5* rock

**Table 5** Mean (SD) pulse and mean arterial pressure

| Time period of measurement | Pulse (beats / min) | MAP (mm of Mercury) |
|---|---|---|
| Baseline | 86.84 (14.479) | 94.22 (11.609) |
| After M1 | 92.93 (16.230) | 104.71 (15.805) |
| After M2 | 87.98 (18.998) | 99.02 (13.973) |
| After M3 | 88.91 (14.475) | 98.49 (13.792) |
| After M4 | 91.42 (14.556) | 99.00(15.116) |
| After M5 | 91.53 (14.011) | 100.58 (14.269) |
| Final | 88.56 (13.725) | 97.56 (11.802) |

*M1* Music of personal preference, *M2* operating theatre noise, *M3* western classical, *M4* pop, *M5* rock, *MAP* mean arterial pressure, *SD* standard deviation

**Table 6** Statistical significance of difference in pulse and mean arterial pressure

| Comparison group | Pulse* | MAP# |
|---|---|---|
| Baseline–M1 | 0.026 | <0.001 |
| Baseline–M2 | 1.000 | 0.009 |
| Baseline–M3 | 1.000 | 0.040 |
| Baseline–M4 | 0.143 | 0.016 |
| Baseline–M5 | 0.384 | 0.005 |
| Baseline–final | 1.000 | 0.042 |
| M1–M2 | 0.978 | 0.007 |
| M1–M3 | 0.426 | 0.003 |
| M1–M4 | 1.000 | 0.004 |
| M1–M5 | 1.000 | 0.040 |
| M1–final | 0.252 | 0.008 |
| M2–M3 | 1.000 | 0.302 |
| M2–M4 | 1.000 | 0.750 |
| M2–M5 | 1.000 | 0.487 |
| M2–final | 1.000 | 0.282 |
| M3–M4 | 0.924 | 0.599 |
| M3–M5 | 1.000 | 0.248 |
| M3–final | 1.000 | 0.837 |
| M4–M5 | 1.000 | 0.341 |
| M4–final | 0.419 | 0.362 |
| M5–final | 1.000 | 0.236 |

*M1* Music of personal preference, *M2* operating theatre noise, *M3* western classical, *M4* pop, *M5* rock, *MAP* mean arterial pressure, *SD* standard deviation

*Repeated measures ANOVA: $F$ (3.538, 155.653) = 2.799, $p < 0.034$. Assumption of sphericity was violated—hence Greenhouse–Geisser correction was utilised. Statistical significance: $p < 0.05$

#Freidman's test was significant ($p < 0.001$). Statistical significance: $p < 0.002$ after Bonferroni's correction

speed of wound closure was fast when music of choice was played. However, the sample size was small ($n = 12$) and the absolute difference was a meagre 0.9 min that corresponds to a difference of just 7%. Shakir et al. [13] also conducted the study among 12 volunteers and found the music of preference helped better composite instrument motion analysis. We would further be able to explain the differences between these studies by the mere fact that the measure of outcome is different in our study as well as the other two studies, and since cognition is a complex neurological phenomenon, we are aware that music affects the various facets of cognitive abilities differentially [14].

Music as a potential distractor has also been reported in a few studies. A study conducted by Miskovic et al. among 45 novice surgeons concluded that any "activating music" resulted in the worst performance among surgeons when compared to no music. This may be true in our case, as it is most likely that the participants were singing along with the music of their personal choice, thereby leading to distraction [15]. It has also been reported that surgeons show a notable decline in task performance (assessed by overall task score, number of errors and time taken to complete) and a significantly raised levels of irritability to the other staff in the operating room [16]. Hence, distraction influences the surgeons' performance in terms of accuracy, speed and memory consolidation which also influences ones' learning ability [17].

An in-depth, component-wise analysis in our study shows that memory card tests and backward counting, both of which test the short-term memory, were comparatively better with music of personal choice than when other music tracks were played. However, trail marking which is a test of speed and jigsaw puzzle and comprehension tests which are tests of complex neurological functions were least performed when music of personal choice was played. From these findings, one may include that though music eases stress, relaxes the surgeon and aids in better recall or recognition, the familiarity with the music or the perceived noise from an unfamiliar music behaves as a distractor affecting the speed and skills. In the perspective of other operating room staff (anaesthetists and nurses), however, a majority of them report music as a distractor as it interferes with the communication among various members of the operating team [18, 19].

The results of our study suggest that pop or rock music helps a surgeon achieve better overall scores in the task. There is a controversy in this regard once again, based on the findings of other published studies. Hawksworth et al. [19] reported that, of all music genres, the two most distracting ones were reggae and pop, whereas Corhan and Gounard reported that rock music helps improve performance [20]. Hence, it is difficult to conclude that a particular genre of music can be universally claimed to have positive effects on the surgeons considering the varied cultural and traditional preferences prevalent in the world. Also, it was not feasible to compare the differences

observed, with metrics such as minimal clinically important difference (MCID) derived from other studies as the tasks used in each set were slightly different from each other, i.e. the picture used in a jig saw puzzle is not the same. However, we were convinced that such comparisons are not essential in this study as these metrics are usually compared to inpatients suffering from a disease condition where MCID would translate into a better quality of life. Here, we are evaluating a surgeon for his/her best skills and would prefer an ideal score as every unit fall in the score would invariably mean a modest increase in the probability of errors.

On analysing the pulse and blood pressure values, there was an obvious increase in the pulse rate and MAP from baseline to any music type being played but did not achieve statistical significance except for MAP between baseline and music of choice ($p < 0.001$) This can be explained physiologically as the participants were performing multiple tasks in a time-bound manner causing an increase in the autonomic reactivity.

The strength of our study is that it evaluated the basic and fundamental fine skills which are invariably used by surgeons of all faculty despite the different anatomical regions they operate on. Since they are skills applicable to any technical person, and the fact that any abnormality in these fine skills in surgeons would ultimately impact the surgeon's outcomes, we consider that the measures we have evaluated in this study are surrogate markers of a surgeon's skill set. Our study has a few limitations. The cognitive abilities of a surgeon were not assessed while performing an actual surgery on a patient. Secondly, the feeling of being monitored by another colleague as a study investigator would have had an impact on the participants' performance, and thirdly, the continuous monitoring of pulse and blood pressure in between the various task sets would have created an environment far from the natural operating room environment of a surgeon. Lastly, the predecided music tracks were of the English language, while majority of our participants had languages other than English as their mother tongue.

## Conclusion

In conclusion, music of choice can serve as a double-edged sword. Based on our study findings, it may help in short-term memory recall, but an over-familiarity with the music played can serve as a distractor thus affecting the speed and accuracy. Also, it is difficult to conclude a particular genre of music as an ideal one to be played in the operating room as the influence of music on surgeons' capabilities is greatly dependent on the cultural and traditional background of the surgeon. We recommend that larger studies in a natural operating room environment be done to confirm the findings of our study.

**Compliance with ethical standards**

**Conflict of interest** No conflicts of interests or disclosure.

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