Effect of Different Music Genre: Attention vs. Meditation

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***Abstract*—It is challenging to quantitatively evaluate the effect of music on human mind. In this paper, effect of music on human mind is studied using brainwaves. Changes in alpha and beta brainwave signal patterns are analyzed for meditation and attention states. Parameters mean, standard deviation and normalized standard deviation are used. First, the effect of 8 different music genres on states of human mind is studied. Next, the effect of music genre selection, i.e., with the subjects choice or random selection is also studied. Effect of classical music is highest for meditation state, across 15 subjects. It indicates quantitatively the effects of classical music on calming the mind and leading to meditation. Average meditation levels are also higher for preferred music for both male and female subjects. It infers that the preferred classical music helps leading the human mind to meditation state faster than the attention state. The study can help studying other affective states as well.**

1. Introduction

The human brain in an interconnected network of billions of neurons (nerve cells) that communicate with each other in the form of electrical signals or impulses [1], [2]. This communication takes place over threadlike fibers called axons, and the point of contact of these axons is called synaptic joints [2]. The electrical signals produced in the brain are called brainwaves [2], and are divided into different categories based on their frequencies. Delta brainwaves (below 4 Hz), Theta brainwaves (4–7 Hz), Alpha brainwaves (8–13 Hz), Beta brainwaves (13-38 Hz), and Gamma brainwaves (above 38 Hz) [3], [4]. Alpha and beta brainwaves are usually associated with meditation and attention, respectively; although, deep meditative states usually lead the brain to theta brainwaves where the brain activities are much reduced. Listening to the right type of music soothes the brain and has several positive effects, be it for pure leisure or therapy. Our brain almost always produces alpha brainwaves while listening to slow-rhythmic song genres.

Music creation and listening involve the activation of both the left and right hemispheres of the brain [5]. In a study [6] related to creation and understanding of music, 16 professional classical and rock musicians were made to listen to music (classical and rock) while performing visual brainstorming tasks. The accuracy for reaction time while listening to classical music across listening conditions was 100% but for rock music it was 98%. However, rather than observing the responses of the brain to random music, it is much more a challenging task to study the response of the brain to the individual's choice of genre. This was seen in [7], where it was stated that self-selection of music by the individual is much more likely to influence positivity in that individual.

Several studies related to music genre preferences have been seen in recent years. A study [8] has shown that musical preferences have a rather marginal effect on the activation of the limbic system (a part of the brain which is mainly responsible for the controlling emotions). Due to the activation of this region of the brain, listening to classical music encroaches more upon the unconscious mind; whereas, appreciation of music, which demands the understanding of and familiarization with the music, conforms more to the conscious cognition [5]. Rock music was found to elicit a much lesser emotional reaction than classical music, among 24 undergraduate students [9]. In [10], it was observed that the responses of the brain to preferred genre music of two groups of individuals (one group prefers Latin American music, and the other Heavy Metal music) could easily be discriminated regardless of whether or not the individual is performing a rigorous task.

Epressive voice speeches play important roles in stimulation of certain emotions in the listener. Expressve 'Noh' voices were studied [11] using modified Zero Frequency Filtering (ZFF) for obtaining sequence of excitation impulses. Expressve voice and paralinguistic sounds activate the limbic and paralimbic systems of the brain. These were studied in terms of cry sounds (mainly infants) [12], [13] and shout sounds [14], [15], [16], [17], which are expressive forms of anger and sad emotions. Laughter sounds, however, are pleasant expressive voices [18], [19] and represents happy emotions. The separation of vocal and non-vocal (background) part of music by using several windowing techniques, on classical music to discriminate the features of aalap and lyrical compositions has been performed in [20], [21].

Cough database was collected in [22] for cough speech sounds - ailment cough sounds, similated cough sounds,

978-1-5386-0680-3/17/$31.00

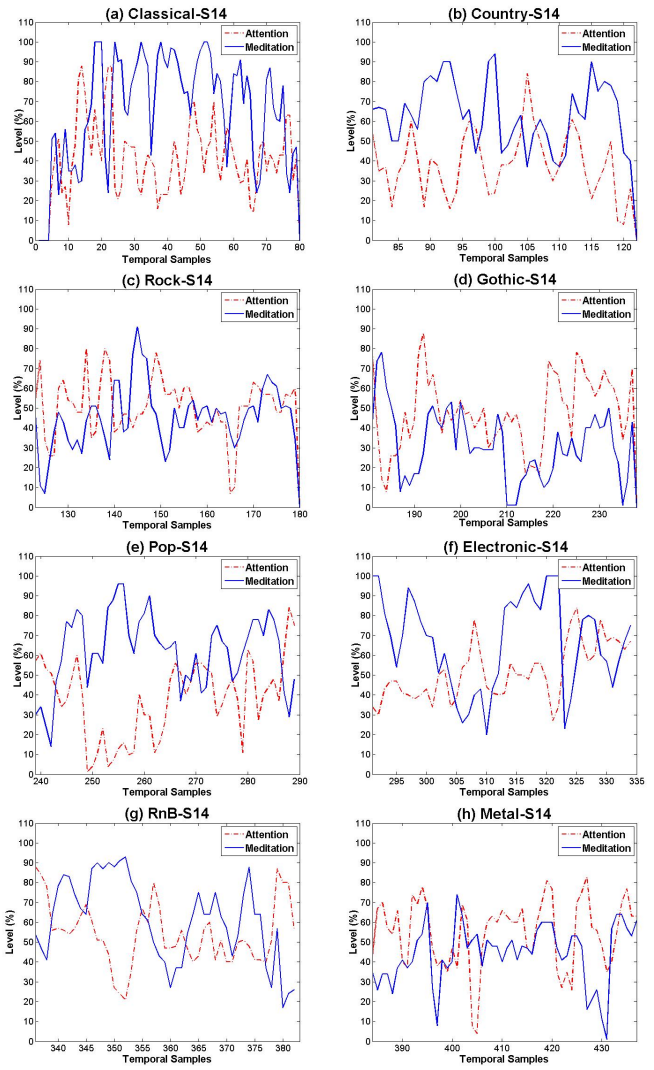

Figure 1. Illustration of brainwaves plots for *attention* and *meditation* levels for (a) *Classical*, (b) *Country*, (c) *Rock*, (d) *Gothic*, (e) *Pop*, (f) *Electronic*, (g) *Rhythm and Blues (RnB)*, and (h) *Metal*, genres of music for subject S14(.

and normal speech sounds. Cough sound analysis [23] has been seen where spectrograms were used to analyze the changes in instantaneous fundamental frequency (F0). Characteristics of cough sounds were also studies [24] where simulated (healthy) cough sounds were characterized from ailment (cold) cough sounds. This was carried out using certain features like instantaneous F0, Signal Energy and Mel Frequency Cepstral Coefficients (MFCCs).

This study deals with the effect of music on different genres and additionally see two cases for preferred choice of genre of the subjects and randomly selected genre. Changes in the brainwave patterns are examined using the EEG signals for recording the brainwaves patterns. The *attention* and *meditation* states of human mind are observed for 8 different genres of music, namely, Classical, Country, Rock, Gothic, Pop, Electronic, Rhythm and Blues (RnB) and Metal, on the states of human mind, is examined.

The paper is organized as follows. The data collection for the study is described in Section 2. The analysis methodo used is discussed briefly in Section 3. The experiments carried out are discussed in Section 4. In Section 5, the results of the experiments are discussed along with the analysis and inferences drawn. Finally, a summary is given in Section 6, along with the scope of future work that can be carried out on this topic further.

2. Data Collection

Brainwave signals are recorded using a single EEG device NeuroSky MindWave Mobile headset [25]. The ThinkGear ASIC Module (TGAM) chip captures the brainwave signals and send it to a laptop via bluetooth, where a real-time plotting of the attention-meditation level takes place, using Matlab2013 as the interface. The horizontal axis represents the temporal samples varying with time, while the vertical axis shows the attention-meditation level (attention being represented as a red dashed-line, meditation represented as a blue line). These values are simultaneously recorded in Excel sheets for further analysis.

For the first part of this study, 8 music files (each music file of 3 minutes) were selected for the 8 music genres. These music files were played to 15 subjects. A total of 120 brainwave signal files (8 music x 15 subjects) were collected, which gives a total of 360 minutes (3 minutes x 8 music x 15 subjects) worth of brainwave recording time.

For music genre preference, a similar pattern was followed. Firstly, the subjects were asked to choose two music genre of choice (each music file of 3 minutes). Then, two music files were selected at random by the experimenter. So, for this part of the study, a total of 80 brainwave files (4 music files x 20 subjects) were recorded, which totals to 120 minutes (3 minutes x 2 music x 20 subjects) of recording time.

3. ANALYSIS METHOD

The *qualitative analysis* of the experimental data was carried out by plotting the brainwave recordings in real-time. The alpha and beta brainwaves were recorded in the form of meditation and attention levels, respectively, upon which comparisons were made on the graph plots.

Qualitative analysis was performed by processing the brainwave signals and interpreting the results for *attention* and *meditation* levels (in %). Three statistical parameters have been derived from the brainwave levels (attention and meditation), which are - mean *(μ)*, standard deviation *(σ)*, and normalized standard deviation *(σ_N)*. Relative temporal fluctuations are measured by normalized standard deviation. It is computed as:

$$\sigma_N = \frac{\sigma}{\mu} \tag{1}$$

Relative changes in the average brainwave levels (%), for *attention* and *meditation* states, are measured by changes in

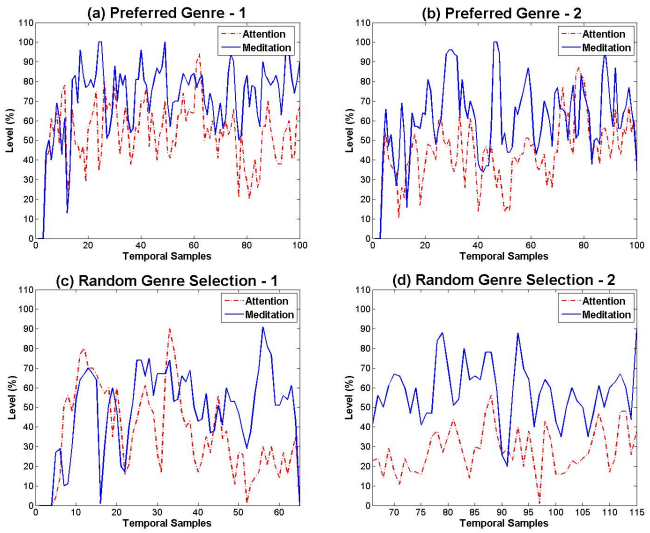

Figure 2. Brainwaves plots for *attention* and *meditation* levels for (a) *first preferred genre*, (b) *second preferred genre*, (c) *first randomly selected genre*, (d) *second randomly selected genre*.

mean for meditation (μ_M) from that for attention (μ_A). The changes in the *mean* for meditation from attention can be computed as:

$$\Delta\mu(\%) = \frac{\mu_M - \mu_A}{\mu_A} \times 100 \quad (2)$$

Relative changes in the fluctuations in brainwaves levels (%) are measured by computing the changes in the *normalized standard deviation* (σ_N) for *meditation* (i.e., σ_{N_m}), from that for *attention* (i.e., σ_{N_a}), w.r.t. σ_N for attention. It can be computed as:

$$\Delta\sigma_N = \frac{\sigma_{N_m} - \sigma_{N_a}}{\sigma_{N_a}} \times 100 \quad (3)$$

The larger negative value of $\Delta\sigma_N$ would thus indicate the relatively more reduction of fluctuations in alpha brainwaves levels (%) for *meditation* state, as compared to that for *attention* state of mind.

4. EXPERIMENTS

In the two experiments performed, the NeuroSky MindWave Mobile headset worn by the subjects, with earphones plugged in, was used for recording the EEG signals for brainwaves. The *attention* and *meditation* states in each case, were inferred from the recorded brainwaves patterns.

(a) Experiment 1 - Music Genre: In order to see the effect of 8 different music genre on attention and meditation levels, the brainwave patterns of 15 subjects were examined in the first experiment. This is to find out which type of genre is best suited for increasing relaxation and meditation, and could further suit in music therapy. The list of music genre along with the artiste and song name is shown in Table 1. The best average meditation level was obtained for classical music. Fig. 1 illustrates the different attention and meditation levels of a subject S14 for all 8 genres.

TABLE 1. LIST OF MUSIC GENRE, ALONG WITH ARTIST AND SONG NAME.

Genre	*Artist*	*Song name*
Classical	Adnand Sami	O re Piya
Country	Dixie Chicks	Tonight the heartache's on me
Rock	Hinder	How long
Gothic	Within Temptation	Caged
Pop	Katy Perry	Roar
Electronic	Owl City	Hello Seattle
RnB	Chris Brwon ft. Keri Hilson	Superhuman
Metal	Nightwish	The Pharoah sails to Orion

(b) Experiment 2 - Preferred choice and Random selection: The second experiment was performed to study the variations in attention and meditation between male and female, under 2 different cases, namely - preferred music genre and randomly selected genre. In this experiment, no particular genre music was pre-defined for subjects' preferences. However, songs of only pop and rock genre were selected at random, by the experimenter. For preferred music genre selection, Pop music was the most commonly selected genre by the subjects (approximately 95% of the subjects preferred Hindi songs, whereas the remaining 5% preferred English songs). The plots for attention and meditation levels in preferred music genre and randomly selected music genre are illustrated in Fig. 2.

5. RESULTS AND DISCUSSIONS

In the first experiment, the effect of different *music genres* on attention vs. meditation states of mind was examined. The average levels of brainwaves for attention and meditation states for 15 subjects (7 female and 8 male) are given in Table 2. Music with slow tempo such as classical music, displays higher levels of meditation (60.07%), than those with faster tempo such as metal (48.26%) and pop (45.69%). The attention levels in the latter music genres are comparatively higher, indicating that the subject is more attentive and the sudden change in elements such as screaming and death growl are present relatively more in the Metal and Pop music. Brainwaves level for meditation state is lowest among these music genres. It is possible that the song choice can be an influencing factor, as a very popular song which every person in the subjects' age group was familiar with, was chosen in this particular experiment. Fig. 3 and 4 illustrate the average attention and meditation of the first five subjects for Exp. 1. Distinct variations are seen from these subjects alone; for example, the attention level in Fig. 3 for subject S3 is above 50% for all the genre, as a result, in Fig. 4, it is seen that meditation level lies below 60%. For these particular subjects, it can be observed that electronic and RnB music genre have only a percent difference in attention level and meditation level.

TABLE 2. AVERAGE BRAINWAVES LEVELS (%), FOR *attention* AND *meditation* STATES OF HUMAN MIND, ACROSS 8 DIFFERENT MUSIC GENRES: (A) CLASSICAL MUSIC, (B) COUNTRY MUSIC, (C) ROCK MUSIC, (D) GOTHIC MUSIC, (E) POP MUSIC, (F) ELECTRONIC MUSIC, (G) RHYTHM AND BLUES (RNB) MUSIC, AND (H) METAL MUSIC. HERE, (A) SUBJECTS, AND (B), (D), (F), (H), (J), (L), (N), AND (P) ARE THE AVERAGE BRAINWAVES LEVELS (%), FOR THE *attention* STATE OF MIND, FOR THE MUSIC GENRES (A), (B), (C), (D), (E), (F), (G), AND (H) RESPECTIVELY. LIKEWISE, (C), (E), (G), (I), (K), (M), (O), AND (Q) ARE THE AVERAGE BRAINWAVES LEVELS (%), FOR *meditation* STATE, FOR THE MUSIC GENRES (A), (B), (C), (D), (E), (F), (G), AND (H) RESPECTIVELY.

	(A) Classical		*(B) Country*		*(C) Rock*		*(D) Gothic*		*(E) Pop*		*(F) Electronic*		*(G) RnB*		*(H) Metal*	
(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*	*(l)*	*(m)*	*(n)*	*(o)*	*(p)*	*(q)*
S1	53.27	46.5	57.28	36.28	43.13	43.91	54.20	52.43	51.62	53.47	50.29	55.33	57.54	67.54	66.82	58.55
S2	33.23	61.41	55.25	59.51	67.26	49.14	49.28	60.29	40.75	59.75	34.03	47.37	31.06	29.61	54.42	50.00
S3	57.28	48.16	73.28	54.62	68.16	50.88	64.28	50.22	69.72	48.82	60.51	47.28	50.46	48.12	63.55	46.44
S4	32.76	58.69	39.89	51.26	27.86	44.52	27.11	38.96	36.21	39.27	37.47	43.44	44.11	44.97	36.06	52.39
S5	66.80	74.02	57.72	66.58	54.45	64.79	55.37	42.90	54.21	23.46	39.39	33.16	51.45	44.41	56.70	43.24
S6	40.65	56.00	45.39	68.51	36.70	67.81	35.74	65.58	47.90	37.92	43.54	36.2	44.96	36.11	43.88	40.35
S7	63.42	68.55	49.97	60.73	56.21	63.59	64.59	52.02	55.08	66.59	41.61	71.77	49.23	52.30	43.98	43.88
S8	48.64	64.58	57.32	27.49	32.10	42.61	40.77	48.38	45.27	48.23	52.70	53.27	55.04	56.81	47.77	57.72
S9	47.83	57.46	56.68	55.76	53.07	65.38	57.21	58.10	59.86	63.69	53.14	73.32	56.08	64.62	49.28	57.07
S10	49.88	52.69	63.51	46.19	49.82	41.44	49.79	49.88	58.37	44.43	51.95	49.43	38.74	51.19	33.13	44.57
S11	61.27	60.13	46.19	68.83	45.25	41.71	42.38	54.29	43.84	41.06	47.70	46.14	52.76	53.02	53.76	52.68
S12	55.65	60.89	56.51	47.19	48.01	49.56	51.31	53.72	48.80	47.76	44.36	43.70	44.76	51.53	47.09	55.33
S13	28.55	64.27	34.88	56.88	35.89	59.46	35.00	60.03	29.88	47.18	33.52	55.16	45.70	55.34	56.18	48.44
S14	41.32	66.33	38.63	63.68	51.02	45.53	47.82	31.40	37.96	62.18	51.57	66.89	54.28	61.43	54.57	44.07
S15	38.49	61.42	58.17	58.66	50.21	37.07	41.96	38.72	45.04	57.55	43.57	60.73	42.02	61.51	44.81	29.19
μ	49.93	60.07	52.71	54.81	47.94	51.16	47.79	50.46	48.30	49.42	45.69	52.21	47.88	51.90	50.13	48.26
σ	11.83	7.34	10.20	11.69	11.63	10.28	10.72	9.27	10.27	11.54	7.76	11.94	7.25	10.32	9.25	7.87
σ_N	0.25	0.12	0.19	0.21	0.24	0.20	0.22	0.18	0.21	0.23	0.17	0.23	0.15	0.20	0.18	0.16
$\Delta\ \mu$	*25.33*		*3.98*		*6.72*		*5.59*		*2.32*		*14.27*		*8.40*		*-3.73*	
$\Delta\ \sigma_N$	*-52*		*10.53*		*-16.67*		*-18.18*		*9.52*		*35.289*		*33.33*		*-11.11*	

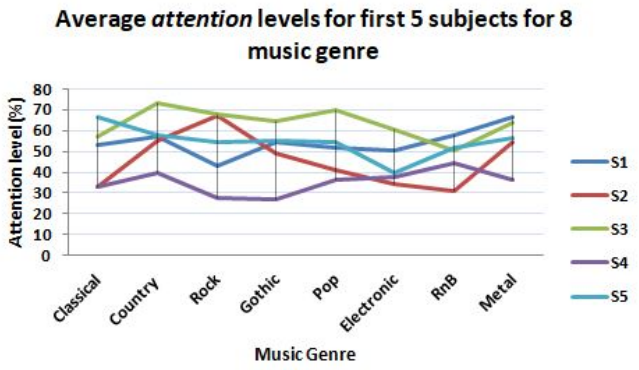

Figure 3. Illustration of Attention levels of first 5 subjects for 8 different genres of music.

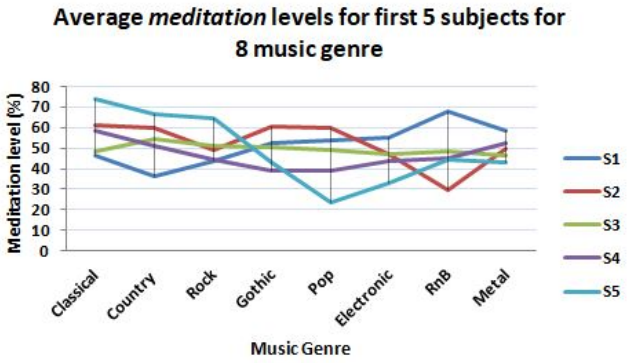

Figure 4. Illustration of Meditation levels of first 5 subjects for 8 different genres of music.

The music genre in decreasing order of their average mean values in the meditation level are : *(a) Classical, (b) Country, (c) Electronic, (d) RnB, (e) Rock, (f) Gothic, (g) Pop, and (h) Metal*.

In Exp. 2, the subjects' average meditation levels were higher in the case of preferred music for male subjects. However, for female subjects, there was no drastic improvement in the meditation levels as compared to attention levels. A greater percentage of the female subjects preferred pop genre songs, which could be the reason behind higher attention levels in case of the subjects' first selected songs, as was the case in Exp. 1, where it was found that the relative difference between attention and meditation levels for Pop music was less and attention was clearly emphasized. Therefore, the genre of the selected songs play a crucial role in determining the level of attention and meditation.

The average attention and meditation levels for 20 subjects (10 male and 10 female) is depicted in Table 3. Fig. 5 and 6 illustrate the average attention and meditation levels, respectively, for the first 5 subjects on preferred music genre

TABLE 3. AVERAGE BRAINWAVES LEVELS (%), FOR *attention* AND *meditation* STATES OF HUMAN MIND: (A) FIRST PREFERRED GENRE SELECTION, (B) SECOND PREFERRED GENRE SELECTION, (C) FIRST RANDOM SELECTION, (D) SECOND RANDOM SELECTION. HERE, (A) SUBJECTS, AND (B), (D), (F), AND (H) ARE THE AVERAGE BRAINWAVES LEVELS (%) FOR *attention* STATE, FOR THE SELECTIONS (A), (B), (C), AND (D), RESPECTIVELY. LIKEWISE, (C), (E), (G), ARE (I) ARE THE AVERAGE BRAINWAVES LEVELS (%) FOR *meditation* STATE, FOR THE SELECTIONS (A), (B), (C), AND (D), RESPECTIVELY.

	(A) Preferred 1		*(B) Preferred 2*		*(C) Random 1*		*(D) Random 2*	
(a)	*(b) Att.*	*(c) Med.*	*(d) Att.*	*(e) Med.*	*(f) Att*	*(g) Med.*	*(h) Att.*	*(i) Med.*
S1 (M)	67.37	61.75	61.91	57.24	55.00	61.52	61.64	62.94
S2 (M)	58.02	48.19	38.90	62.10	30.52	73.48	50.59	39.94
S3 (M)	44.31	71.21	61.92	61.92	30.41	63.40	67.30	40.40
S4 (F)	61.21	52.09	56.69	50.28	65.11	70.30	63.54	74.44
S5 (F)	45.88	45.89	38.07	63.80	31.63	51.97	26.60	59.56
S6 (F)	54.42	55.05	58.40	54.64	62.35	58.08	44.94	63.30
S7 (F)	56.45	50.75	53.12	50.57	58.40	39.52	61.30	38.00
S8 (F)	51.86	55.13	47.51	48.10	51.38	43.78	40.52	47.60
S9 (F)	52.46	46.72	58.55	38.32	30.70	53.27	32.70	49.04
S10 (M)	53.61	62.05	54.77	40.99	49.92	40.17	53.86	53.54
S11 (F)	59.28	57.84	52.91	62.62	61.28	61.90	51.48	64.08
S12 (F)	44.48	51.88	60.75	66.00	52.81	71.16	45.40	67.06
S13 (M)	53.66	58.28	58.19	56.36	46.17	64.79	47.62	52.86
S14 (M)	48.72	58.03	49.84	58.18	53.76	44.59	60.56	54.72
S15 (M)	52.85	71.65	43.71	61.07	37.49	49.33	28.08	57.88
S16 (M)	34.35	72.02	42.11	46.23	50.11	50.63	42.92	62.92
S17 (F)	58.87	34.96	48.95	70.51	68.30	50.76	54.56	38.74
S18 (M)	40.40	68.35	56.76	54.55	60.32	69.08	66.80	62.24
S19 (M)	39.18	55.82	58.38	72.12	58.60	53.90	64.90	46.82
S20 (F)	44.33	45.43	41.47	39.35	43.13	46.00	33.46	44.60
Mean (μ)	51.09	56.15	52.15	55.75	49.87	55.88	49.94	54.03
Std. dev.(σ)	8.29	9.82	7.84	9.78	12.21	10.62	12.96	10.58
σ_N (σ/ μ)	0.16	0.17	0.15	0.18	0.24	0.19	0.26	0.20
Δ μ	*9.90*		*6.90*		*10.76*		*8.19*	
Δ σ_N	*6.25*		*20.00*		*-20.83*		*-23.08*	

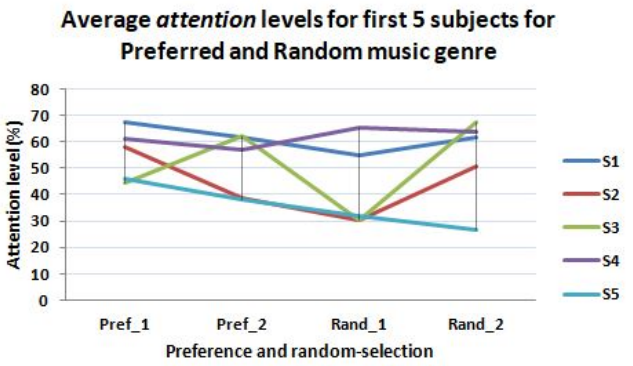

Figure 5. Illustration of Attention levels of first 5 subjects for preferred music genre and random music genre.

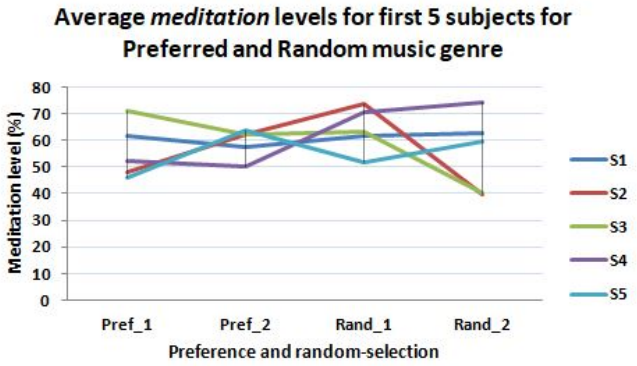

Figure 6. Illustration of Meditation levels of first 5 subjects for preferred music genre and random music genre.

and randomly selected music genre. It can be inferred that meditation level increases significantly for the first randomly selected music genre, which was pop.

Pop music was the common choice of music genre. None of the subjects preferred to choose Gothic, Metal or Country music genre. Bollywood pop and contemporary songs were the first and second choice of music genre for 17 subjects; 1 subject preferred English pop songs for both his first and

second choice of music genre; and, 2 subjects chose one Hindi pop song and one English pop song.

In addition, subjects were asked to give feedback on the music genre selected at random by the experimenter. For most subjects whose preferred genre was Pop or Rock, but who listened to Classical music or Country (selected at random) claimed that the songs were either dull, hard to enjoy, or boring. Subjects complained that the music was either too noisy and annoying when Gothic or Metal music genre was chosen. Only one male subject was recorded to enjoy Gothic music.

6. SUMMARY AND CONCLUSION

This study deals with finding the effect of different music genre on meditation and attention level of the human mind. It was seen that the fluctuations in alpha brainwave (meditation against attention) was relatively higher in case of Classical music genre, and the least for Metal music genre. The alpha brainwaves are also highly emphasized in the presence of binaural beats. But in the case of metal music and pop music genres, the alpha brainwaves are relatively less enhanced, rather beta brainwaves are emphasized. Additionally, the effect preferred genre selection was also observed, where it was found that brain activities seem to increase when known or familiar music genre was playing. This could be compared with the statement in [6] that appreciation and familiarization of music requires conscious cognition of the brain. Hence, the average mean values of attention levels and meditation levels were not distinct from each other.

This study can be helpful to find the effect of music on the states of mind of a person. It may also help in further studies on the relative significance of each music genre and their application areas, using brainwaves. This study also establishes that classical music is most soothing for meditation and relaxation. Hence, music therapy with this music genre can possibly be used to reduce the repercussions of problems such as autism, anxiety, and depression, among others.

Further extensions can be made by stimulating basic emotions through audio-visual stimuli. The brainwave signals while in such emotion states could then be captured to see the effects of genre of movies like horror, thriller, comedy, and action.

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