

STUDY OF EFFECT OF MUSIC ON EEG BRAINWAVE RESPONSE

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Abstract

A potential communication mechanism between users and systems is Brain Computer Interface (BCI). To give commands and complete the interaction, it does not need any kind of exterior devices or muscle involvement. To generate assistive devices, research society has at first developed BCIs with biomedical applications. They have already worked on the restoring the motion capability of physically retarded and substituting lost motor ability. To research the participation of BCI of non-paralyzed humans via medical applications, the BCI has encouraged the research society. However, the research area has been broadened to involve non-medical applications. To investigate the generation of hands-free applications, researchers have aimed non-paralyzed individuals by utilizing BCIs as a new input device. The main question of this work knows what type of music like Hindi, Punjabi and English have effect on brain? If it does yes, it can be further argued that the altered states of consciousness produced by music or meditation are similar, and thus music may help to meditate because it helps activating important brain areas for meditation.

Keywords: EEG, alpha waves, beta waves, creativity, classical music.

1.1 Brain Computer Interface

A potential communication mechanism between users and systems is Brain Computer Interface (BCI). To give commands and complete the interaction, it does not need any kind of exterior devices or muscle involvement. To generate assistive devices, research society has at first developed BCIs with biomedical applications. They have already worked on the restoring the motion capability of physically retarded and substituting lost motor ability. To research the participation of BCI of non-paralyzed humans via medical applications, the BCI has encouraged the research society. However, the research area has been broadening to involve non-medical applications. To investigate the generation of hands-free applications, researchers have aimed normal individuals by utilizing BCIs as a new input device. Some doubts have been raised on the usage of Brain Computer Interface interfaces for non paralyzed users. The difficulty in poor information transfer rate (ITR) [2] of BCIs and its consequence on decreasing the commands user can issue has been discussed. Poor ITR confined Brain Computer Interface usage for locked-in users as it won't be capable of keeping up with regular communication ways.

1.1.1 BCI using EEG monitoring

Electroencephalogram - EEG calculates electric brain activity [3] due to the movement of currents throughout synaptic excitations in the neurons and is very receptive to secondary currents. By placing electrodes on the scalp, electroencephalogram signals are effortlessly stored in a non-invasive manner. That's why it is the most famous recording modality till now. However, the signals have to go through the skull, scalp, and various layers; therefore quality of the signals received is very poor. As a consequence EEG signals are weak and difficult to obtain. The mechanism is majorly impacted due to background noise generated either externally over scalp or inside brain.

This recording system has A/D converter, amplifiers, electrodes [4], and a recording device. Electrode's function is to obtain the signal through the scalp; the amplifiers increase the amplitude of the analog signal so that the A/D converter can digitalize the signal in a much precise manner. At the end, the recording device such as laptop or computer, records, and presents the data.

Minimum requirement for the configuration for EEG contains on active, a reference & a ground electrode - which is generally made of silver chloride and compute differential voltage between active and reference points. The formula to compute Electroencephalogram signal is the difference over time between signal/active electrode and reference electrode. Multiple channel configurations consist of 128 or 256 active electrodes. Electrode-scalp contact impedance range is $1k\Omega$ to $10k\Omega$ to record correct signal [5]. The electrode-tissue interface is both resistive and capacitive; hence act as a low pass filter. EEG gel makes a conductive passage via skin and each electrode that decreases the impedance. Electrodes that do not require gels are known as 'dry' active or passive electrodes are also available in the market.

1.1.2 Effect of Music on Brain

The theory of "Brainwave Entrainment" (BE) [6] initially shows us what Entrainment is. It is the procedure in which two interacting oscillating systems, who have dissimilar periods when they work independently, presume the same period. These oscillators may synchronize. So simply, Entrainment is synchronization between biological rhythm and an environmental signal. BE refers to the brain's electrical reply to rhythmic sensory stimulation for example light or some pulses of sound. When input is given to brain, via skin, nose etc., it gives an electrical charge in reply known as "Cortical Evoked Response".

These electrical replies move all through the brain to turn into what you see, smell, listen and the rest. These actions can be evaluated through connecting sensitive electrodes to scalp. Let's take the example of tuning fork and guitar. Hit the tuning fork and keep it close to the guitar and observe the G string on the guitar starts to vibrate. This event demonstrates that tuning forks frequency entertains the guitar's frequency. How it relates to the human brain? It in fact relates with brain when you comprehend that the brain is pulsing with electrical impulses.

These electrical actions can be evaluated with apparatus EEG [7], which computes frequency of the electrical current in Hertz (Hz). The interesting part is - the major frequency that your brain is resonating with at some specific time can be related with status of your mind. In other words status of your mind such as calm, tensed, tired etc. can be seen through brainwave frequencies at that specific instant. In earlier times, the major technique used by yogis to attain deep states of mind is exercising meditation for hours every day calming their mind into various states. All of us can see the astonishing benefits of BE by hearing special brainwave music that can facilitate to attain these states in a small number of sessions. Many researchers observed 'symmetrical' entrainment that is two systems jointly effects one another's when subjects are asked to harmonize their index finger or leg movements with that of some other people.

1.2 Recording EEG Brain Activity Rhythms

The EEG is normally clarified alongside regards to attention that is rhythmic transients [8]. The attention that is rhythmic tear into groups by frequency. To a little extent, these regularity clusters are a matter-of nomenclature (in supplementary words each rhythmic task amid 8 to 12 Hz might be delineated as "alpha"), though these designations arise due to the rhythmic task inside a particular frequency scope was observed to have a particular allocation above the head or a particular biological significance. Frequency clusters normally are removed employing spectral habits (as an example Welch) as requested for instance in freely presented EEG multimedia such as EEGLAB [x] or the Nero physiological Biomarker Toolbox [x]. Computational processing for the EEG is normally shouted Quantitative electroencephalography. The entire cerebral signal noticed in the scalp Electroencephalogram falls into selection of 1 to 20 Hertz. Waveforms incline to be further divided into bandwidths denoted to as alpha, beta, theta, and delta to signify a lot of the Electroencephalogram utilized in health exercise.

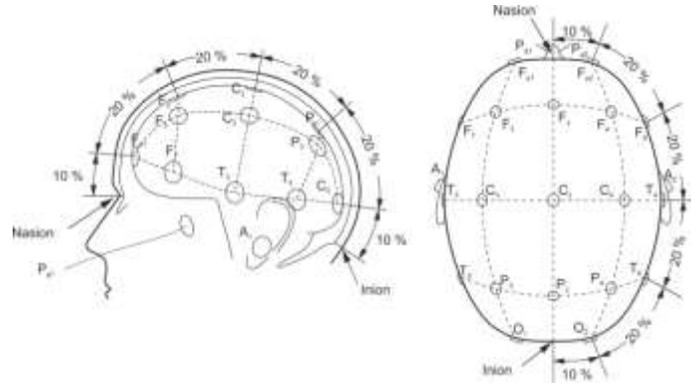


Fig 1: Electrode placement over scalp.

As mentioned earlier, EEG is recorded via electrodes. According to the American Electroencephalographic Society standard electrodes placed over the scalp are generally based on the International 10 to 20 system. To define the electrode location, this standard uses two reference points on the scalp. 1. Inion - found at the base of the skull in the bony lump. 2. Nasion - located at the top of the nose at the same level as the eyes. The transverse and median planes carve head from Inion and Nasion. To determine electrode locations we need to mark these planes at gap of 10% and 20% as shown in Figure 1. In this figure alphabet O symbolizes occipital area, A symbolize - ear lobe, F – frontal, C - central region, Pg - nasopharyngeal, P – parietal, and Fp - frontal polar.

1.2.1 Alpha waves

Alpha wave [x] is the frequency scope starting at 7 Hz to 14 Hz. Hans Berger yelled the main rhythmic EEG attention observe as the "alpha wave". This was the "posterior frank rhythm" (also yelled the "posterior dominant rhythm" / "posterior alpha rhythm"), observed in the posterior spans of the head on both factions, elevated in amplitude on the dominant side. It arises alongside closing of the eyes and alongside relaxation, and attenuates alongside eye onset or mental exertion. The posterior frank rhythm is honestly slower than 8 Hz in youthful children.

1.2.2 Beta waves

It is the frequency scope from 15 Hz to considering 30 Hz [x]. It is observed normally on both factions in symmetrical allocation and is most evident frontal. Its attention is connected to motor deeds and is normally attenuated across alert movements. Low amplitude beta alongside countless and fluctuating frequencies is oftentimes related alongside alert, hectic or nervous thoughts and alert attentiveness. Rhythmic beta alongside a dominant set of frequencies is related alongside varied pathologies and drug aftermath, exceptionally benzodiazepines. It might be missing or cut in spans of cortical damage. It is the overriding rhythm in persons who are attentive or nervous or who have their eyes open.

1.2.3 Gamma waves

It is the frequency scope considering 30 to 100 Hz [x]. Its rhythms are trusted to embody relating of disparate populaces of neurons jointly into a web for the aim of carrying out a precise cognitive or motor purpose.

1.3 Experimental Setup

The study was conducted in collaboration with the Kurukshetra University for study of effect music on brain. We have selected few subjects each subject is given a 10 sec pause and 10 sec audio recording of a selected music from Hindi, English or Panjabi. Afterwards their electrical response is recorded using EEG.



Figure 1 Channel NeuroMax EEG system by Medicaid , Chandigarh [14]

The EEG data was captured using Neuromax developed by Medicaid, Mohali for research purposes. As shown in Figure 1, the device has USB interface, no external power required. can record 2D, 3D Brain mapping with different colours in their software as shown in the figure below

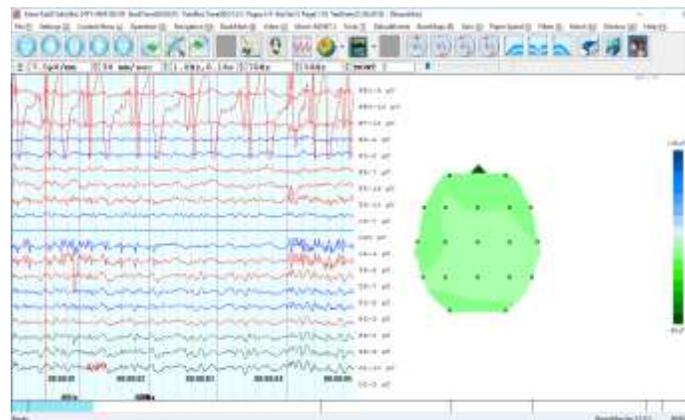


Figure 2 : Neuromax EEG software by Medicaid.

Age	Subjects	EEG Recording
18-25	Subject 1	10 Sec Pause and then Hindi Music 10 Sec
18-25	Subject 1	10 Sec Pause and then English Music 10 Sec
18-25	Subject 1	10 Sec Pause and then Punjabi Music 10 Sec
18-25	Subject 2	10 Sec Pause and then Hindi Music 10 Sec
18-25	Subject 2	10 Sec Pause and then English Music 10 Sec
18-25	Subject 2	10 Sec Pause and then Punjabi Music 10 Sec

18-25	Subject 3	10 Sec Pause and then Hindi Music 10 Sec
18-25	Subject 3	10 Sec Pause and then English Music 10 Sec
18-25	Subject 3	10 Sec Pause and then Punjabi Music 10 Sec
25-30	Subject 1	10 Sec Pause and then Hindi Music 10 Sec
25-31	Subject 1	10 Sec Pause and then English Music 10 Sec
25-32	Subject 1	10 Sec Pause and then Punjabi Music 10 Sec
25-33	Subject 2	10 Sec Pause and then Hindi Music 10 Sec
25-34	Subject 2	10 Sec Pause and then English Music 10 Sec
25-35	Subject 2	10 Sec Pause and then Punjabi Music 10 Sec
25-36	Subject 3	10 Sec Pause and then Hindi Music 10 Sec
25-37	Subject 3	10 Sec Pause and then English Music 10 Sec
25-38	Subject 3	10 Sec Pause and then Punjabi Music 10 Sec
35-40	Subject 1	10 Sec Pause and then Hindi Music 10 Sec
35-41	Subject 1	10 Sec Pause and then English Music 10 Sec
35-42	Subject 1	10 Sec Pause and then Punjabi Music 10 Sec
35-43	Subject 2	10 Sec Pause and then Hindi Music 10 Sec
35-44	Subject 2	10 Sec Pause and then English Music 10 Sec
35-45	Subject 2	10 Sec Pause and then Punjabi Music 10 Sec
35-46	Subject 3	10 Sec Pause and then Hindi Music 10 Sec
35-47	Subject 3	10 Sec Pause and then English Music 10 Sec
35-48	Subject 3	10 Sec Pause and then Punjabi Music 10 Sec

Table 1: EEG Study design for Participants

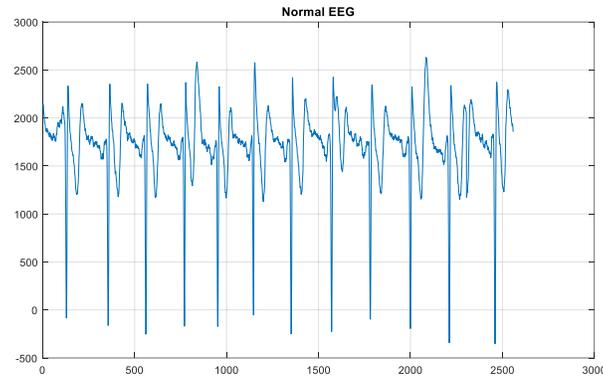


Figure 3: Normal Recorded EEG of a Patient aged between 25-30.

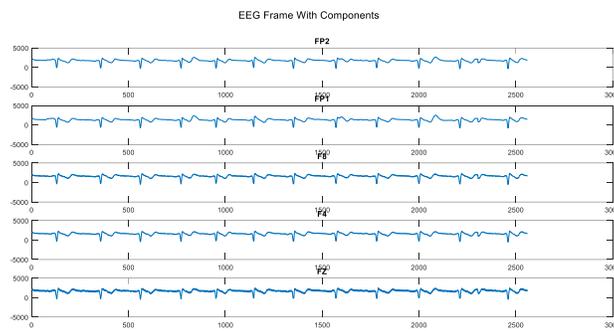


Figure 4 : Various Recorded Component of EEG of a Patient aged between 25-30.

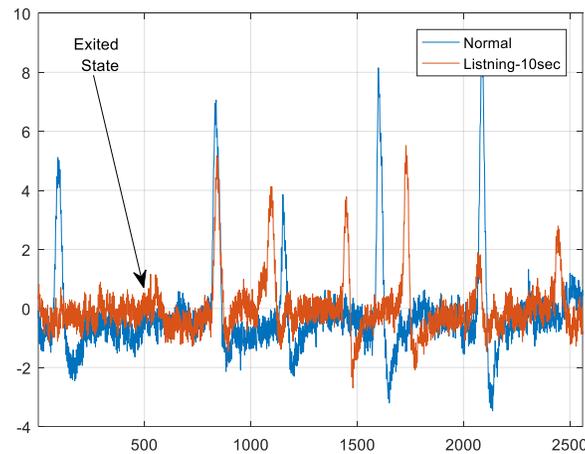


Figure 5 : Studing Effect of Music on subjects of various age having altered mind state after listening Music for 10-sec.

1.4 Effect on Brain Waves

Table 2: Brainwave and their Effect on Mood

Brain Wave	Min	Max	Frequency	Effect Low	Optimal	Effect High
Alpha	8	12	Moderate	high stress	Relaxation	too relaxed
Beta	12	40	High	poor cognition	Conscious focus	anxiety
Gamma	40	100	High	learning disabilities	information processing	stress
Delta	0	4	Slowest	poor sleep	natural healing	inability to think
Theta	4	8	Slow	poor emotional awareness	Creativity	impulsivity

Table 3 Effect of Hindi Music on Various Brain Waves optimal values are highlighted

Age Range	Alpha	Beta	Gamma
18-25	7.76	42.71	38.14
25-30	8.03	25.18	56.93
35-40	8.32	41.17	85.65

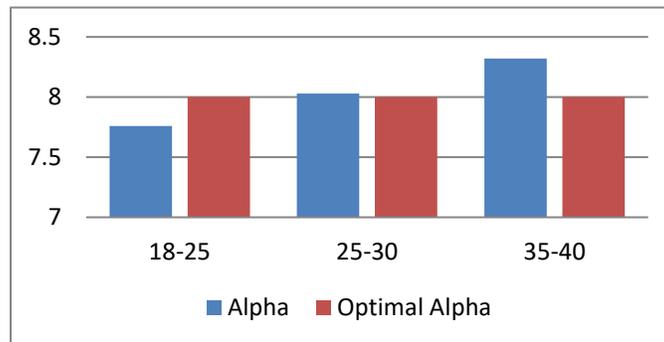


Figure 6: Its Clear from Hindi Music has most optimal Effect on age range 35-40 with optimal alpha wave values triggering relaxation.

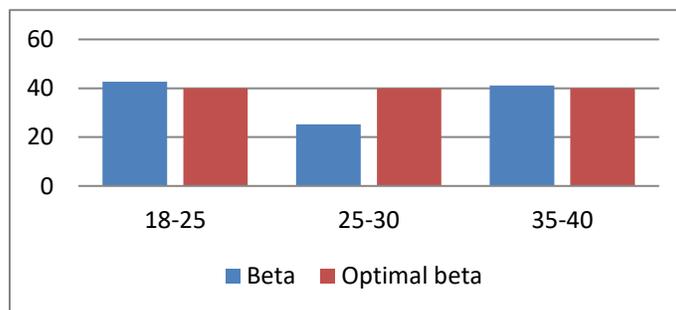


Figure 7: Punjabi Music has most optimal Effect on age range 25-30 with optimal beta wave values, Conscious focus processing in young adults.

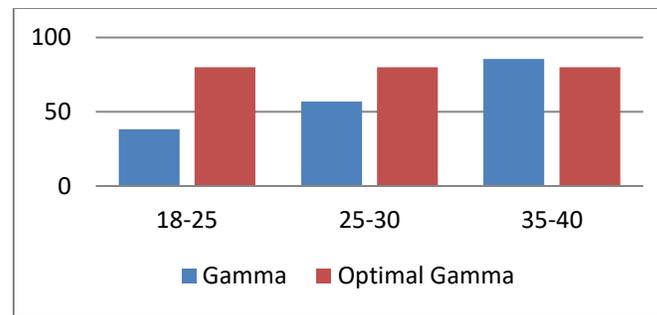


Figure 8: English Music has most optimal Effect on age range 18-25 with optimal beta wave values, triggering information processing in young adults.

1.5 Conclusion

This research supports the hypothesis that hearing to music may increase functional brain actions happening in non paralyzed adult. We have found slowed Electroencephalogram brain wave actions. Every person's emotional reaction to music of their interest can perform a major role in the response of their brain wave activity. It is probable that persons are more occupied by music of their given option for example (Hindi, English and Punjabi) in comparison to the music randomly played to them. Engagement in a task is probable to be seen in the reduction in alpha and beta wave activity. The Hindi music showed the most optimal actigttivity in almost all age ranges showing alertness and engagement because of optimal Alpha and Beta Waves. The reduction in beta activity was an unexpected outcome in our study. Reduction in the beta activity noticed to take place with greater cognitive activity and an elevation in reduction arousal.

1.6 References

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