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EFFECT OF BINAURAL BEATS MUSIC THERAPY ON ANXIETY VIA EEG USING ANN & MACHINE LEARNING – A SURVEY

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ABSTRACT

Over the past two decades, anxiety has been gradually growing in prevalence, particularly among adolescents and young adults. Antidepressant medications have recently been utilized to treat anxiety related disorders that might lead to addiction. An individual's excessive anxiety level might raise their risk of hypertension, stroke, and other disorders. Binaural auditory beats are perceptual phenomena that happens whenever each ear is confronted with two sounds with significantly different frequencies. Binaural beats can substantially change our brain's frequency to the desired condition. Binaural beats have been demonstrated that impact cognition and mental states, among other aspects. Therefore, the purpose of this survey was to see how binaural beats influences on anxiety levels. In addition to this, the influence of artificial neural network and machine learning technology on the processing of binaural beats have been studied.

Keywords: *Binaural Beats, Anxiety, Artificial Neural Network (ANN), Machine Learning, EEG Signals*

1. INTRODUCTION

This In the last 24 years, the prevalence of anxiety has gradually increased, especially among adolescents and young adults [1]. The COVID-19 pandemic lockdowns have elevated anxiety even further, with individuals in the United States three times more likely to screen positive for anxiety disorders in April/May 2020 than in 2019 [2]. Anti-anxiety treatments (selective serotonin reuptake inhibitors, serotonin-norepinephrine reuptake inhibitors, benzodiazepines) [3-7], cognitive tactics, behavioral approaches (cognitive behavioral therapy, exposure, relaxation), mindfulness, as well as acceptance-based approaches are among the many anxiety treatments available [8-9]. Many anxiety sufferers, meanwhile, may not respond to conventional treatments, and many more confront therapeutic obstacles [10]. As a result, it's critical to discover alternate or complementary ways to standard therapies. Many individuals generally utilize music to help them control their mental health, and music-based anxiety therapies possess the potential in meeting such demand [11].

Music can help people feel less anxious [12-15], and some research shows that it may be more helpful than anti-anxiety medications like midazolam [16]. This might be related to music's neurochemical impacts, which include higher endogenous opioid as well as dopamine levels [17-19]. Moreover, if the mood of the music is matched to an individual's original emotional state before being altered to the desired condition, the mood regulating characteristics of music may be increased [20]. This method of music sequencing is based on the ISO principle, which was initially presented as a technique of mood management aided by music.

Auditory Beat Simulation (ABS) is a non-invasive neuromodulators approach that employs sound waves to generate combination tones, binaural beats, or monaural beats in the alpha (8-13 Hz), beta (14-30 Hz), theta (4-8 Hz), gamma (30-50 Hz), or delta (1-4 Hz) frequency ranges with the goal of eliciting a neural frequency following response [21-23]. Superposing two sine waves of adjacent frequencies can generate combination tone signals. Transmission of amplitude modulated beat signals to either one or both ears at the same time, is known as monaural beat. A binaural beat percept is generated whenever individual sine waves were delivered dichotically [24]. A two-tone experience of 400 as well as 405 Hz delivered to each ear independently, for example, shall be regarded by the listener as a modulated wave of 5 Hz [25]. ABS

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in the theta and delta frequency ranges have been observed to decrease anxiety and enhance self-reported relaxation [26-28].

The perspective of a solitary imaginary sound of a frequency equivalent to the average frequency of the two tones as well as an amplitude which oscillates with a frequency equivalent to a gap among two sounds results from the demonstration of two purest sinusoidal sounds to each ear individually at a constant concentration also with a small change in frequency [29]. Recent study seems to back up the idea that binaural beats can change operational connectivity among brain regions [30-32] and also cortical network connectivity [33-35]. Other scholars, on the other hand, have been unable to show proof of neural dispersion, and have proposes upsurge in inter-hemispheric cohesiveness among the aural cortices, that expresses synchronization among the neural fluctuations of both hemispheres, is a way for the mechanism of hearing for alleviate a difficult binaural perceptual problem through boosting interaction among the two hemispheres [36]. Even though no consensus exists on the mechanism behind binaural auditory beats, there is emerging evidence that they have an impact on cognitive as well as psychophysiological conditions.

To our knowledge, only a few studies have focused on survey about binaural beats [37-38]. Those study was based solely on the effects of binaural beat stimulation on focus and relaxation. Motivated by such a limited number of studies with limited information, this survey article concentrates on conducting a survey of several directions for experimentation on binaural beat stimulation.

The main contribution of this survey paper is to provide the readers about the binaural beats, its wave types, the materials are used for doing the experimentation with binaural beats. Also this paper concentrates on the survey of effect of binaural beats on human anxiety, stress & depression, pain, working memory, also it focuses on the processing of binaural beats through artificial neural network and machine learning approaches. This survey article can assist the researchers who need to work on measuring the effect of binaural beats on human brain waves. This article surveyed various research directions on estimation of binaural beats effect.

The remainder of the article is arranged as follows: section 2 comprises of survey on effect of binaural beats and its processing; section 3 includes summary of survey; finally, section 4 has the conclusion.

2. EFFECT OF BINAURAL BEATS

For the brain to perceive the binaural beat, the tones should have a frequency of less than 1,000 hertz (Hz). The variation in frequency of sounds approaching the left and right ear is something that an individual experience as a binaural beat [38], it should not be exceed 30dB. listened to binaural beats for a certain amount of time could devise an influence on an individual's behavior as well as sleep patterns. It is noted that, there are five different brain wave types of binaural beats, which is explained as follows and depicted in figure 1.

•**Gamma pattern:** This frequency pattern covers the 30–50 Hz range. Such frequencies help to keep a person's arousal level up while they're awake.

•**Beta pattern:** The beta pattern's binaural beats have a frequency of 13–30 Hz. Such a spectrum of frequencies can aid focus and attentiveness. Conversely, at the extreme range of the scale, it might induce anxiety.

•**Alpha pattern:** Binaural beats in the alpha pattern have a frequency of 7–13 Hz that were thought to help people relaxed.

•**Theta pattern:** Binaural beats in the theta pattern at a frequency of 4–7 Hz are used by therapists. In the rapid eye movement (REM) state, theta rhythms help with meditation, creativity, as well as sleep.

•**Delta pattern:** Binaural beats in the delta pattern have a frequency of 0.5–4 Hz and are associated with dreamless sleep. According to electroencephalogram (EEG) brain scan data, those who got a delta wave frequency throughout sleep reached the deepest state of sleep.

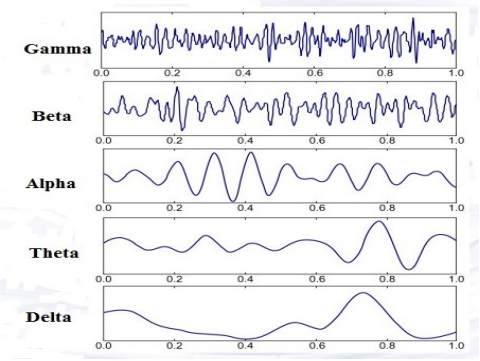

Figure 1: Types of brainwaves

Figure 1: Types of brainwaves

Before studying the effect of binaural beats on human brain system, one has to understand the difference between monaural beats and binaural beats. As mentioned earlier, binaural beats have been generated through the difference of two frequencies. However, such unchanged amplitude-modulated signal is applied on both ears at the same time, that generate monaural beat stimulation. Such physical beat signal was modified in the cochlear before being transmitted to the auditory cortex through brain stem neurons. The monaural and binaural beats stimulation has been depicted in figure 2 and 3 respectively. Also table 1 presents the difference between monaural beats stimulation as well as binaural beats stimulation.

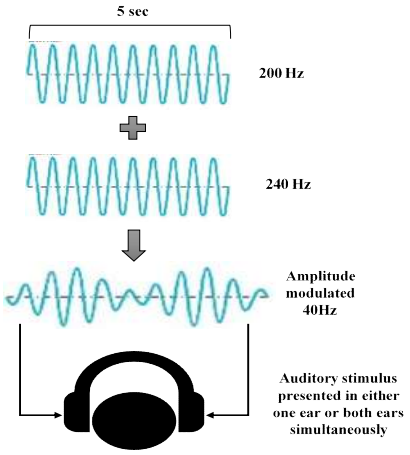

Figure 2: Monaural beats stimulation [39]

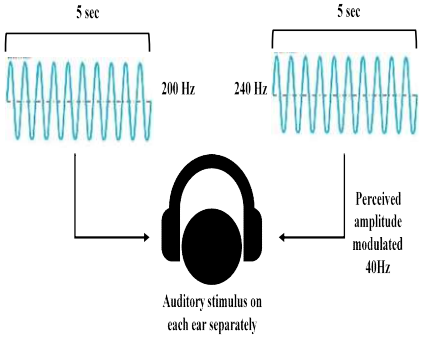

Figure 3: Binaural beats stimulation [39]

Table 1: Difference between Monaural and Binaural beats stimulation

Monaural Beats	Binaural Beats
Composite frequencies are delivered to either one or both ears at the same time.	Each ear receives a separate presentation of difference of frequencies.
Physical/objective beats	Subjective beats
Peripheral	Central
Demodulated in cochlea.	The medial superior olivary nuclei are where the processing takes place.
The ability to be heard in one or both ears.	Both ears must be active at the same time.
Heard at higher carrier tones and throughout a larger beat frequency range.	Whenever beat frequencies remain lower also carrier sounds are lower than 1000 Hz, this becomes observable.

2.1 Survey on Effect of Binaural Beats on Anxiety:

Le Scouranec, et al [40] evaluated if mildly anxious persons could experience reduced anxiety upon hearing to recordings embedded with tones which generate binaural beats on a regular basis for one month, and whether people would have a consistent tape selection among three tapes. A group of 15 mildly anxious individuals that volunteered at the Clinique Psyché in Montreal, Quebec. Subjects are instructed to listened to one or more of three music recordings having sounds which generate binaural beats in the electroencephalogram delta or theta pattern of frequencies at least five times weekly for four weeks. Before and after hearing to the recording or recordings, participants were instructed to keep track of their recording utilization, recording preferences, as well as anxiety ratings in a journal. According to the findings, hearing the binaural beat recordings in the delta or theta EEG wave pattern can assist for mild anxiety.

Sung, et al [41] Alternative medicine and neuroscience researchers are both interested in

music containing binaural beats. Binaural beats have been used to induce brain-wave states that have been shown to reduce anxiety in individuals with persistent anxiety. A 10-Hz binaural beat can urge the brain to create a 10-Hz beat equivalent to a peaceful (alpha) level of mindfulness via brain synchronization. Music containing binaural beats has been proven to produce calm by changing human brain waves, and thus anxiety could have decreased. As an outcome, the anxiety mean score of the subjects reduced considerably from 39.79 at baseline to 36.05 at post-test. The individuals' anxiety levels were significantly reduced when hearing tracks having a binaural beat of 10 Hz ($Z = 2.86$, $p = 0.004$), according to Wilcoxon signed rank results.

Weiland, et al [42] examined if one listens to specially composed tracks or sounds creations with or without integrated binaural beats, one can notice a difference which affects the self-rated levels of anxiety in emergency department (ED) patients. While comparing the effect of who received simulated ED ambient sound (pre-experimental mean, 40; post-experimental mean, 41) or headphones only (44; 44), patients exposed to electroacoustic tuneful configurations (39; 34), auditory field soundtracks (42; 35), otherwise auditory field soundtracks using implanted binaural beats (43; 37) showed significant reductions (all $P<0.001$) in anxiety. State anxiety was decreased by 10%–15% in moderately anxious ED patients after exposure to purpose-designed sound treatments.

Alipoor, et al [43] determined the effect of brainwave synchronization on anxiety reduction employing binaural beats. Through random sampling and replacement, 30 workers from an engineering research business were chosen and separated into two groups: control and experimental. The Spielberger's State-Trait Anxiety Inventory (STAI) were completed by all subjects. The intervention class listening the binaural beats produced on a non-vocal genre of artwork for four weeks, three times a week. Each session was around 20 minutes long. The control group, on the other hand, listening to background music with no entrainment sound. Both groups performed the anxiety questionnaire at the conclusion, and the anxiety ratings acquired pre and post intervention were compared. The results indicated that brainwave entrainment with binaural beats reduced state anxiety ($P<0.001$) as well as trait anxiety ($P<0.018$) significantly. Binaural beats brainwaves synchronization was a beneficial element in reducing state, trait anxiety, therefore it may be utilized to treat anxiety in psychological facilities.

Wiwatwongwana, et al [44] examined the anxiolytic benefits of binaural beat entrenched music in subjects experiencing cataract surgeries with confined anesthetic. Each of the binaural beats (BB) and music intervention (MI) class had 44 subjects, while the control class had 47. While comparing the control class, subjects in the MI and BB groups have significantly lowest STAI state scores following music intervention ($P<0.001$), however, a distinction among MI and BB subgroups was not significant (STAI-S score MI group -7.0, BB group -9.0, $P=0.085$). Although the two classes didn't vary in any way ($P=1.000$), systolic blood pressure was considerably lower in both MI ($P=0.043$) and BB ($P=0.040$). Only the BB group showed a substantial decrease in heart rate (BB versus control $P=0.004$, BB vs MI $P=0.050$, MI vs control $P=0.303$). Music, both with and without a binaural beat, has been shown to reduce anxiety and lower systolic blood pressure. In terms of reducing operational anxiety, binaural beat entrenched harmonious intercession might be more effective than musical intervention alone.

Chaieb, et al [45] Despite the fact that binaural and monaural beats have relatively identical EEG effects, this study looked at anxiety, mood, and memory performance are all affected by monaural beat stimulus. For address emotions related to anxiety levels with overall well-being, as well as long-term or active memory functions, using monaural beats inside the range of key brain oscillations. For 5 minutes, healthy volunteers were exposed to theta (6 Hz), alpha (10 Hz), and gamma (40 Hz) beat frequencies, as well as a control stimulation. Following every stimulating session, questionnaire was used to measure their current emotional states then perform cognitive tasks assessing long-term and working memory functions, as well as an attentiveness test. State anxiety was observed to be reduced by monaural beat stimulation. All monaural beat conditions had beneficial impacts on state anxiety after retorts were evaluated for determining specific pulse frequencies.

Isik, et al [46] In dentistry, the usefulness of binaural beats in decreasing preoperative anxiety was investigated. 60 participants (experimental group: 20 women and 10 men, mean age 24 (18-35) years, and control group: 22 women and 8 men, mean age 28 (15-47) years) who were scheduled to have affected third molars extracted were examined. Anxiety levels of all patients were measured using a visual analogue scale (VAS). The patients were administered a local anesthetic and ordered to wait for 10 minutes while listening to

binaural beats using stereo headphones in the experimental group (200 Hz for the left ear and 209.3 Hz for the right ear). Anxiety was subsequently measured again in both groups, and the tooth was extracted as normal. The control group's anxiety level remained unaffected subsequently to the next assessment ($p = 0.625$), but the experimental group's anxiety level decreased significantly ($p = 0.001$). Binaural beats might beneficial in decreasing preoperational anxiety in dentistry, according to the researchers.

Sung, et al [47] aimed to see how listening to music containing alpha binaural beats affect blood pressure, heart rate variability, as well as stress levels in older adults with depressed signs, also to see if it's feasible for them. A one-group pre- and post-test configuration were utilized in this analysis. A total of 35 elderly people living in a nursing home took part in the report. In a private space in the afternoon, every subject listening 30-minutes of conversant tune having alpha binaural beats through a headset when sitting on a chair or lying in bed. The music compact disc included Taiwanese old songs from the 1950s to the 1970s, which were common to the majority of Taiwanese seniors. The findings reveal that, in long-term care environments, listening to conversant tune having alpha binaural rhythms may be a noninvasive also appropriate intercession to encourage calm as well as reduce suicidal anxiety in older adults having depressing signs.

Gálvez, et al [48] deployed periodic binaural beats to Parkinson's Disease (PD) sufferers to see if it had any effect on the disease's symptoms and electrophysiology (EEG). Patients ($n = 14$, age 62) were given two 10-minute sound stimulation treatments separated by at least seven days. The following results were obtained immediately before and after both stimulations: (1) a drop in theta activity, (2) a generalized reduction in Functional Connectivity (FC), and (3) an increase in active memory function. The patients' walking performance, pulse rate, or anxiety level, though, showed no significant improvements. Anxiety or gait characteristics did not alter as a result of this effect on brain activity.

Nawaz, et al [49] presented the EEG-based emotions identification systems deployed multiple phases. The subjects select their favorite tunes based on their preferences, and it falls into one of seven musical genres. Alpha binaural beats are used in relaxing songs. Prior to hearing to tunes, as well as following hearing to their favorite tunes plus calming tunes, EEG data is gathered from all subjects. The extracted features are then fed into an emotional model, which determines whether or not there has been a change in emotions. The study used a two-dimensional (Arousal-Valence) emotion model to describe variations in the feelings of individuals who are in good health while listening to various types of tunes. Greater Arousal as well as Valence scores are good for eliciting pleasant feelings according to this model. Based on the findings, they concluded that both types of music were effective in shifting participants' emotional states toward a more optimistic state.

Chairinkam, et al [50] investigated the comparing the impacts of binaural beats overlaid on responsive audio hearing with relaxing treatment on anxiety in university students. The 134 students who took part in the double-blind randomized controlled experiment were chosen at random from a group of 539 anxious students. The participants were divided into three groups: overlaid binaural beat ($n = 45$), receptive music listening ($n = 45$), and blank audio ($n = 44$) using block randomization. Over the course of five days, each of the three groups got a 20-minute daily relaxation therapy. The median variations in anxiety level for the overlaid binaural beat, music listening, and control groups was evaluated using the self-administered STAI Form-Y pre and post treatment at -20.00, -16.00, and -15.00, correspondingly. There were statistically substantial variations among the overlaid binaural beat class as well as control ($P = 0.04$) also music listening ($P = 0.02$) classes. Anxiety levels are successfully decreased in 100% of individuals in the overlaid binaural beat group, which was significantly greater than the rates in the control class (84.09 percent: $P<0.01$). Overlaid binaural beat-based treatments might be more helpful than music listening and general relaxation in reducing anxiety among university students.

Roshani, et al [51] investigated the impact of binaural beat music (BBM) on anxiety, discomfort, as well as pleasure in subjects undergoing eye operation. Sixty patients were randomly allocated to one of two groups: binaural beat music group ($n = 30$) or control group ($n = 30$) in this therapeutic experiment. In addition to the fentanyl, Audio with binaural beats were blasted for 5 minutes before to operation through the finish. The BBM group had considerably reduced state anxiety subsequent to operation than the control group ($P < 0.05$). After surgery, the BBM group's state anxiety, trait

anxiety, and pain levels all dropped considerably (P < 0.05). Furthermore, after surgery, the control group's mood and trait anxiety dropped considerably (P < 0.05). Nevertheless, there is no discernible change in pain measures in the control category before and after operation (P > 0.05). In sedated patients undergoing eye surgery, binaural beat music is excellent in lowering anxiety and may be a good alternative to narcotic and sedative medicines.

Yusim, et al [52] investigated the effectiveness of a binaural beat meditating approach in treating anxiety disorders in mental outpatients as well as non-patients. Over the period of two weeks to two months, twenty mental outpatients having anxiety disorders also eight members was made available to the medical professionals this meditation technique. Throughout the research, all individuals' notches on the State-Trait Anxiety Inventory was evaluated. Nine of the twenty outpatients that participated in the research finished the treatments as intended, whereas 11 would not for a myriad of purposes. As a result, three treatment groups were formed: psychiatry + meditation (n = 8), psychiatry only (n = 10), and meditation only (n = 8). The psychiatry + meditation group exhibited a 13.5-point (26.5%) reduction in State-Anxiety (t = 5.28, p = 0.001), a 14.1-point (24.7%) reduction in Trait-Anxiety (t = 5.12, p = 0.001), and a 27.6-point (25.6%) reduction in Total Anxiety (t = 7.63, p = 0.001). The results show that using this meditation technology in the context of psychiatry/psychotherapy may have a beneficial impact on self-reported anxiety measures.

Sekirin, et al [53] The study included two groups of 66 individuals who were scheduled to have hip joint endoprosthetics. Patients in the main group (n = 32) were given 5 binaural beats as part of a lessening programme. The patients in the comparison group (n = 34) were given a standard set of measurements to help them prepare for the procedure. The homogenous hospital scale for anxiety and depression (HADS) was used to assess all patients for depression and anxiety before to the research. The Spielberger – Hanin test was then used to capture the first levels of reactive and personality anxiety. After 7 days, the exam was repeated in both groups to assess the test's dynamics. The results of the study indicated that responsive (from 57.2±3.8 to 42.4±5.2 points, p = 0.014) and personal anxiety (from 58.9±4.1 to 44.7±3.8 points, p = 0.003) was considerably decreased in the main group when binaural beating techniques were used. Furthermore, using the binaural beats approach resulted in a substantial reduction in HADS alarm subscale scores (p<0.001) in subjects in the control group, dropping from 12.8±2.8 to 8.5±0.7 points.

Ölçücü, et al [54] investigated the impacts of mono binaural beats on anxiety and pain notches in male subjects experiencing diagnostic cystoscopy (DC) and ureteral stent removal (USR) under local anesthesia. Patients in the DC and USR groups (DCG and USRG) they are divided into three subgroups depending on the therapies used: DCG-1 and USRG-1 listened to binaural beats; DCG-2 and USRG-2 listened to classical music; and DCG-3 and USRG-3 wore headphones but were not exposed to audio (control group). Anxiety and pain levels were estimated using the State-Trait Anxiety Inventory (STAI) and Visual Analog Scale (VAS), respectively. Demographic information, initial STAI, intervention tolerance rate, terminal STAI (STAI-T), STAI differences (delta STAI, STAI-D), and VAS ratings were compared. Binaural beat groups had a considerably lower tolerance rate than the other groups (p<0.05 for all). When DCG-1 and DCG-2 were compared to DCG-3, and USRG-1 and USRG-2 were compared to USRG-3, there were significant reductions in STAI-T (p<0.05 for all). In men, listening to pure binaural beats might be a simple and effective way to minimize anxiety and pain related with the DC and USR procedures.

Menziletoglu, et al [55] investigated Binaural beats plus tunes with a frequency of 432 Hz were shown to be effective in reducing preoperational dental anxiety in affected third molar operation and assess which treatment is more successful. Ninety participants are divided into three groups: binaural beats, music, or control. In the first assessment, a visual analogue scale was employed to assess oral anxiety before local anesthetic. Patients in the binaural beats group wore earphones for 10 minutes while hearing the binaural beats (220 Hz for the right ear and 210 Hz for the left ear). The research comprised 27 male patients and 53 female patients. The initial assessment revealed that all three groups had the same degree of anxiety (p=0.811). In the second assessment, both the binaural beats and music groups had a substantial reduction in anxiety (p<0.001).

Mallik, et al [56] In a broad group of people, the anxiety-reducing ability of quiet music mixed with theta auditory beat stimulation (ABS) was investigated. Anxiolytics participants (n = 318)

were randomly allocated to one of four sound-based treatments: combination (music and ABS), music alone, ABS alone, or pink noise alone (control). Somatic and cognitive state anxiety measures, as well as trait anxiety, personality traits, and musical preferences, were collected before and after the intervention. There were reductions in somatic anxiety that were greater in the combined and music-alone conditions than in the pink noise condition, and reductions in cognitive state anxiety that were greater in the combined condition than in the music-alone, ABS-alone, and pink noise conditions among participants with moderate trait anxiety.

Table 2: Cumulative survey on anxiety

Ref.	Nature of Participants	No. of Participants	Age group	Wave type	Participants belongs to BB group	BB listening time period (min)	Experiment span (day)	*p*-Value
[40]	Mildly anxious patients	15	NA	Delta/ Theta	15	30	30	NA
[41]	Older adults	19	NA	Alpha	19	5	NA	0.004
[42]	Emergency department patients	170	≥18	Alpha	34	20	73	<0.001
[43]	Employees from engineering firm	30	NA	NA	15	20	28	State<0.001 Trait<0.018
[44]	Cataract surgery patients	141	60-76	Alpha, Beta	44	20	Once	<0.001
[45]	Healthy individuals	25	22-26	Theta, Alpha, Gamma	25	5	Once	0.197
[46]	Dentistry patients	60	18-35	Alpha	30	10	Once	0.001
[47]	Older people in retirement home	35	> 65	Alpha	35	30	5	<0.001
[48]	Parkinson's Disease patients	14	56-68	Theta	14	10	7	0.429
[49]	Healthy university students	25	NA	Alpha, Beta	25	3	Once	0.041
[50]	Anxious students	134	NA	Alpha	45	20	5	<0.01
[51]	Patients undergoing eye surgery	60	52-62	NA	30	From 5 minutes before to end of surgery	Once	<0.001
[52]	Psychiatric outpatients and non-patients	28	Around 40	Delta, Theta, Alpha	8	20	Once	≤0.001
[53]	Patients with hip joint endoprosthetics	66	NA	Delta, Theta, Alpha, Beta, Gamma	32	NA	7	<0.001
[54]	Patients undergoing diagnostic cystoscopy and ureteral stent removal	411	40-72	Alpha	102	5-9	Once	<0.001

[55]	Patients on third molar surgery	90	18-48	Alpha	30	10	Once	0.003
[56]	Participants taking anxiolytics	318	18-63	Theta	93	24	Once	0.01

2.2 Survey on Effect of Binaural Beats on Stress & Depression:

Puzi, et al [57] EEG is used to examine the impact of binaural beats sound of 10Hz (Profound Meditation) on Alpha and Beta brain waves. At Universiti Teknologi MARA Shah Alam, 33 right-handed individuals (22 females and 11 men) were randomly chosen. They expressed an interest in investigating this study project following their test session. Individuals are presently readily worried as a result of a variety of external causes such as family difficulties, financial troubles, contentment with life, as well as other comparable concerns. As a result, some people meditate by listening to sounds associated with relaxation, such as binaural beats, to relieve tension. EPOC EMOTIV EEG apparatus with 14 electrodes was utilized in this study.

Wahbeh, et al [58] Binaural beat technology solutions are traded globally as resources for personal growth and health enhancement. Decreased stress, anxiety, also enhanced attention, concentration, motivation, confidence, as well as depth in meditation, are all suggested as benefits of listening to binaural beats on a daily basis, according to the developers. For 60 days, subjects hearing the compact disc containing delta (0-4 Hz) binaural beat frequencies. Among the presented benefits, the level of anxiety has been measured through the state-trait anxiety inventory. Trait anxiety decreased ($p = 0.004$), according to the results. Binaural beat technology, it was determined, may have a beneficial influence on self-reported psychosocial indicators, particularly anxiety.

Norhazman, et al [59] concentrates on the impact of binaural beats on persons who are stressed, particularly the impacts on their EEG signals. Meditation is one of several ways for reducing anxiety and stress. This act, however, is difficult for some people to do. As a result, they move to another therapy, binaural beat stimulation, that indeed extremely easy also less complicated nonetheless has comparable adverse impacts as meditation. The subjects' EEG signals are captured in three different states: baseline, following anxiety introduction as well as synchronization using binaural beats. The Alpha Symmetry technique was used to analyze the data, specifically to look at the influence of stress as well as binaural beat synchronization on the participants' alpha waves.

Norhazman, et al [60] Meditation is one method of stress reduction. Some people, however, find it difficult to do this deed because their minds refuse to accept the command to be silent and focused. Thus, brainwave entrainment, especially binaural beat, is one technique for individuals to get in the mood more easily and quickly. The influence of binaural beats at 10Hz on the fontal alpha liveliness imbalance in ordinary as well as stressed participants is the focus of our research. The total number of participants is 42, with 18 in the ordinary class as well as 24 in the stress class. Before and afterwards listened the binaural beats, the EEG is recorded in two sessions. Normal participants had a 90.1 percent increase in frontal alpha asymmetry, but stress sufferers only have a 1.37 percent increase. The findings showed such frontal alpha liveliness asymmetry might be a sign of binaural beats' beneficial impact on human brainwaves.

Gkolias, et al [61] binaural beats (BB) at 5Hz (theta beats) was administered in a double-blind, randomization, cross-over trial, contrasted to sham stimulation (SS), for 30 minutes underneath concurrent EEG measurements, accompanied for unrestricted, on-demand utilization whilst chronic pain patients for a week. Pain (numeric scale, NRS), anxiety (STAI), and medication use (defined daily doses, DDD) were all measured at baseline, 30 minutes, and at the end of the week. Both treatments considerably decreased anxiety after 30 minutes, however only the BB group's anxiety remained lower at the end of the week. Despite experiencing discomfort intensities that are comparable to the SS mean, the BB intervention used substantially less analgesic medicine (DDD, g) over the week (3.9 ± 3.7 vs. 4.6 ± 4.1, $p<0.05$). In chronic pain sufferers, acoustic BB decreased pain intensity, anxiety, and analgesic usage when compared to SS.

Table 3: Cumulative Survey On Stress & Depression

Ref.	Nature of Subjects	No. of Subjects	Age group	Wave type	Subjects belongs to BB group	BB listening time period (min)	Experiment span (day)	Result
[57]	Right handed students	33	NA	Alpha	33	20	Once	Positive effect on 61% subjects
[58]	Healthy adults	8	28-68	Delta	8	60	60	P=0.004
[59]	Right handed subjects	29	22-42	Alpha	29	20	Once	Sig.=0.917
[60]	Stressed and normal right handed subjects	42	20-45	Alpha	42	20	Once	Stressed subjects experience 1.37% increment
[61]	Patients with chronic pain	17	>18	Theta	17	30	7	P<0.001

2.3 Survey on Effect of Binaural Beats on Pain:

Le Zampi, et al [62] The research evaluates whether an external auditory neural stimulation had any influence on restoring the chronic-pain brain neuro signature to equilibrium, relying on the neuro matrix theory. Financial business community bulletin boards in Richmond, Virginia were used to recruit individuals who consciously as having chronic pain. Throughout two 2-week intervals, this statistical investigation used a repeating measurements crossovers model to evaluate two treatments (theta-binaural beats treatment and placebo treatment) to two sequences (theta-binaural beats first, then placebo; placebo first, then theta-binaural beats). Binaural beat treatment is noninvasive, portable, measurable, non-additive, painless, and affordable. Binaural beat treatment would be a field of research that offers promise for a variety of diseases, based on these reasons and the findings of prior acute pain research and so this chronic pain research.

Le Gkolias, et al [61] binaural beats (BB) at 5Hz (theta beats) was administered in a double-blind, randomization, cross-over trial, contrasted to sham stimulation (SS), for 30 minutes underneath concurrent EEG measurements, accompanied for unrestricted, on-demand utilization whilst chronic pain patients for a week. Pain (numeric scale, NRS), anxiety (STAI), and medication use (defined daily doses, DDD) were all measured at baseline, 30 minutes, and at the end of the week. Both treatments considerably decreased anxiety after 30 minutes, however only the BB group's anxiety remained lower at the end of the week. Despite experiencing discomfort intensities that are comparable to the SS mean, the BB intervention used substantially less analgesic medicine (DDD, g) over the week (3.9±3.7 vs. 4.6±4.1, $p<0.05$). In chronic pain sufferers, acoustic BB decreased pain intensity, anxiety, and analgesic usage when compared to SS.

Ecsy, et al [64] Endeavor to modify the experience of a somewhat unpleasant acute laser stimulation by entraining three frequencies throughout the alpha band: 8, 10, and 12 Hz, independently. Subjects was given either visual and auditory stimulus at three alpha-band frequencies, as well as a control frequency. After 10 minutes of flashed LED goggles treatment and 10 minutes of binaural beat stimulation over the alpha region, subjects were asked to rate the discomfort of laser stimuli verbally. When contrasted to the control scenario, both auditory and visual stimulus resulted in a substantial decrease in pain scores across all three frequencies. The 10-Hz stimulation resulted in a substantially greater decrease in the visual subgroup than the 8- and 12-Hz stimulation settings.

Table 4: Cumulative Survey On Pain

Ref.	Nature of Subjects	No. of Subjects	Age group	Wave type	Subjects belongs to BB group	BB listening time period (min)	Experiment span (day)	Result
[62]	Patients with chronic pain	32	NA	Theta	32	20	14	P<0.001
[61]	Patients with chronic pain	17	>18	Theta	17	30	7	P<0.001
[63]	Teenagers	18	7-16	Theta	10	7	3 sessions	Decrease 1.7 points
[64]	Healthy right handed subjects	64	≥18	Alpha	32	10	Once	The analgesic impact of 10Hz stimulation is much greater.

2.4 Survey on Effect of Binaural Beats on Memory:

Kennerly, et al [65] People effectiveness on two memory tests plus two memory-related tasks were investigated using beta frequency binaural-beat acoustic signal. 50 undergraduate pupils are arbitrarily allocated to the reference or test categories using a double-blind technique. Ambient music was played for the reference group. The test group heard the same track that was accompanied by binaural-beat acoustic signals. A 25-item lists of words recall test, a 25-item lists of words recall test, as well as the WAIS-digit R's sign and digit span questions was utilized as response variable. On the lists of words memory task, the digits' symbols questionnaire, as well as the digit span questionnaire, the test group showed statistical significant (p>.05) improvements in mean values. The findings show that beta frequency binaural-beat acoustic impulses have become an excellent approach for improving basic free recall memory, attention, and perseverance during everyday motor activities.

Kraus, et al [66] The study looked at the impact of binaural beats on working memory capacity (WMC). It is thought that whenever the binaural beat at frequencies that correlates to the condition of alpha wave band, the total brain function alters. Brainwave action in the alpha band was already linked to a variety of cognitive processes, including improved working memory. As a result, it is hypothesized in this investigation that binaural beats matching to the alpha wave band would improve WMC. Subjects are separated into two parts in the present research. Whilst hearing the audio of the ocean, one set was given binaural beat stimulus. The second set was only hearing the ocean, with no binaural beat stimulus. Utilizing the OSPAN technique, researchers assessed working memory capacity at start and after treatment. Just those who used binaural beats improved their WMC, as predicted.

Beauchene, et al [67] The impact of binaural beats on working memory, the mechanism that controls transitory memory, including online arrangement of ideas for effective goal-directed activity, just haven't been thoroughly investigated. Using EEG signals, researchers investigated the impacts of various sonic stimulus settings on subject responder correctness as well as cortical network structure throughout a visuo - spatial working memory activity. None, Pure Sound, Classical Music, and 5Hz, 10Hz, 15Hz binaural beats are utilized as auditory stimulus present experiment. It was shown that hearing the 15Hz binaural beats throughout a visuo - spatial working memory test improved responses correctness even while altering the intensities of cortical networks. When the visuospatial working memory task, brain activity under 15Hz binaural beats generated networks with valuable information transmission and stable link intensities.

Garcia-Argibay, et al [68] to see how binaural audio beats affect long-term memory Upon been subjected to binaural audio beats with in beta (20 Hz) or theta (5 Hz) frequency bands, and background noise as a controlled group, subjects (n = 32) conducted both the spontaneous recognition memory tasks. In recognition activities, beta-frequency binaural beats resulted in a larger proportion of properly recalled terms as well as a larger sensitivity rating, but theta-frequency binaural beats resulted in a lower proportion of properly recalled terms as well as a lower sensitivity factor. The probability distribution for recall provided identification did not alter among beta versus theta frequencies or background noise, implying all the reported variations in identification was attributable to the remembrance element. Those results suggest that, based on the amount

utilized, binaural auditory beats can influence long-term memory in both favorable as well as unfavorable ways.

Jirakittayakorn, et al [69] Since binaural beat generates frequency tracking responses, the stimulation employed in research investigation were a 40-Hz binaural beat. The goal of the investigation was to look at the brain oscillations which react to a 40-Hz binaural beat, as well as to assess working memory as well as affective moods while hearing to it. Depending on the study's objectives, two experiments was created. EEG are obtained in the first test when individuals exposed to the stimuli for 30 minutes. Within 15 minutes, the frontal, temporal, and central areas appeared to be engaged, according to the findings. In the next trial, participants were given a lists of words recall test pre and post hearing to the stimuli for 20 minutes. The analysis indicates that after hearing, the number of remembered terms in the working memory part of the list increased. After responding to the stimuli, the Brunel Mood Scale, a questionnaire used to assess emotional responses, indicated differences in mental states. Such alterations are compatible with the generated brain oscillations, according to the emotional outcomes.

Beauchene, et al [70] While on an N-back working memory test, researchers measured subject reaction correctness as well as cortical network architecture using EEG recordings, and we looked at the impact of varied sonic stimulus settings. None, Pure Tone, Classical Music, 5Hz BB, 10Hz BB, and 15Hz BB was employed as the auditory stimulus settings. Through an N-Back working memory test, hearing to 15Hz BB enhanced selective reporting accuracy, altered cortex resonant frequency, and affected cortical network link strengths. In comparison to the None scenario, just the 15Hz BB caused a substantial difference in great precision. When contrast to certain other auditory stimulus settings, hearing to 15Hz BB throughout the N-back task engaged prominent frequency regions and generated networks with better data transmission.

Mujib, et al [71] demonstrate a link among stimulation-evoked BB rhythmic brain function and a behavioural reaction in a short-term memory test. For 15 minutes, 20 subjects in Groups A, B, as well as C were exposed to alpha (10 Hz), beta (14 Hz), and gamma (30 Hz) BB, correspondingly. The EEG were collected in three different states: before, throughout, and after the BB. Before and after a BB exercise, subjects underwent a digit span test. Just Group A showed a substantial gain in cognitive score, whereas Groups A and C showed a substantial reduction in response time. After BB, Group A experienced a substantial drop in theta and a rise in alpha power, whereas Group B saw a considerable rise in theta and a fall in gamma imaginary coherence (ICH). After BB, Group C exhibited a substantial rise in theta and gamma power, as well as a rise in theta and gamma ICH. The efficacy of BB is determined by the frequency with which it is stimulated. An elevation in theta ICH in the parieto-frontal as well as interhemispheric frontal networks is thought to be a possible neurological cause.

Table 5: Cumulative survey on memory

Ref.	Nature of Subjects	No. of Subjects	Age group	Wave type	Subjects belongs to BB group	BB listening time period (min)	Experiment span (day)	Result
[65]	Undergraduate students	50	NA	Theta	27	15	Once	p>0.05
[66]	University students	40	Around 21	Alpha	40	12	Once	p>0.05
[67]	Healthy adults	28	19-46	Theta, Alpha, Beta	28	5	Once	Beta have higher accuracy
[68]	Subjects from high school & university	32	14-51	Beta, Theta	Theta=16 Beta=16	15	Once	Memory recall upgrading Beta-0.13 Theta-0.10
[69]	NA	47	Around 21	Gamma	47	20	Once	Recall increased
[70]	Healthy adults	34	18-46	Theta, Alpha, Beta	34	30	Once	Beta is significant
[71]	Healthy subjects	60	23-27	Alpha, Beta, Gamma	Alpha=20 Beta=20 Gamma =20	15	Once	Increased in theta

2.5 Survey on Binaural Beats processing using ANN & ML:

da Silva Junior, et al [72] about 6 distinct participants were given a 5Hz binaural beat to see if their brainwaves changed before and after the stimulus. In ten independent sessions, 20 minutes of stimulation were administered. Authors analyzed the discrepancies using a Multi-Layer Perceptron classifier in contrast to non-parametric testing and Low-Resolution Brain Electromagnetic Tomography (eLORETA). In High Alpha, eLORETA exhibited tremendous changes. Both the eLORETA and MLP methods indicated significant changes in high Beta. Theta brainwaves were significantly affected by MLP. High Alpha modulation was seen in the limbic lobe in this investigation, suggesting that sympathetic system activity was reduced in the participants. The major eLORETA findings point to a significant rise in the current distribution, primarily in Alpha 2, in the Anterior Cingulate, which is linked to the monitoring of social behaviour, emotion identification, and expression. We also discovered that MLPs are capable of evidencing the key variations in Delta and Theta with excellent separability. However, the MLP shows better performance only on delta waves.

Chouhan, et al [73] An adapted variant of model entropy characteristic of the Electroencephalogram is used to assess a person's degree of attentiveness. The data acquisition module is made up of an Emotiv EPOC headset that records EEG signal from a participant's scalp utilizing electrodes. The information from the headphones was analyzed by the signal processing module. The headset's sampling frequency was 128 Hz. The module is divided into three phases: (i) preprocessing, (ii) entropy estimation, and (iii) attention quantification. Pre-processing was necessary to improve the signal-to-noise ratio of the recorded EEG through eliminating noises in preparation for prospective processing. In order to eliminate any abrupt, erroneous change in results owing to artifacts like Electrooculogram, to acquire merely 64 values, subsequent observations are pooled. However, the attention related movements are providing the similar results, which could reduce accuracy.

Lee, et al [74] Using MATLAB R2017a, three forms of CS were built and displayed using Psychtoolbox. The following are the cumulative ratios: I CS1 – binaural beats with ASMR triggers of 45:60; (ii) CS2 – binaural beats with ASMR triggers of 30:60; and (iii) CS3 – binaural beats with ASMR triggers of 20:60. The OpenBMI toolbox and the BBCI toolbox were used for all data analysis in MATLAB R2017a. The EEG data was downsampled to a frequency of 250 Hz. Between 0.5 and 50 Hz, a band-pass finite impulse response filter was used since it is robust and simple. In addition, at 60 Hz, a notch filter was used to eliminate power transmission lines. For spectrum analysis, the FFT were used to translate from the time domain to the frequency domain. The alterations of auditory stimuli were studied in five frequency bands: delta (0.5–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (30–50 Hz), which are typically separated into the spectral components of EEG signals. To discover the best combination of binaural beat and ASMR trigger for inducing sleep, researchers tested a variety of factors (such as decibel, exposure length, and frequency). In this investigation, however, they only utilized three decibel ratios.

Jayasinghe, et al [75] show a software that uses feedback from the Apple Health Kit and the Google Fit app to identify and minimize stress. The program has succeeded to identify stress using a machine learning classifier, K-Nearest Neighbours, as well as Naive Bayes, and then goes on to eliminate stress based on the choices of the participant also handling records utilizing the ANN. The study also critiques how the present application progression workings as well as how it might be upgraded despite using conventional methods. Because this study was based on the outcomes of traditional techniques, the pathway was somewhat tweaked utilizing binaural beats. As a consequence, these auditory waves are predicted to have a similar impact to meditation in a shorter reaction time. But the k-nearest neighbor shows better performance on some particular brainwaves alone, not in all brainwaves.

Amarasinghe, et la [76] EEG signals are noisy and have a lot of outliers, and they're also multidimensional. As a result, the contribution of this work is an approach based on Self-Organizing Maps (SOM) for detecting thinking patterns. The proposed idea recognition approach is a three-step procedure that includes unsupervised clustering of preprocessed EEG data using SOM and classification using feed-forward ANN. The proposed approach was used to identify two thinking patterns: "move forward" and "rest" on five distinct users. Some additional artifacts can be introduced in older adults, which cannot be removed by DFT.

Thafa'i, et al [77] investigated an alternate approach for detecting stress in females by comparing EEG signals from stressed and non-stressed participants. Collecting EEG data from

individuals and utilizing an Artificial Neural Network (ANN) classifier to classify EEG signals are two of our research efforts. The Energy Spectral Density (ESD) characteristics derived from the recorded EEG signals were fed into this classifier as input data. Objective of this work is to see if an artificial neural network (ANN) can classify EEG data from stressed and non-stressed females. In addition, the importance of brain area characteristics as classifier inputs is investigated. However optimal channel selection is difficult with ANN.

Adavanne, et al [78] For the simultaneous sound event detection (SED) issue, a layered convolutional and recurrent neural network (CRNN) with a 3D convolutional neural network in the first layer was described. The 3D CNN enables the system to simultaneously acquire both inter- and intra-channel features from multiple auditory inputs. Multichannel audio datasets with various numbers of audio streams combine in order to assess the suggested technique. Each dataset contains four-channel first-order Ambisonic, binaural, and single-channel versions, that are used to evaluate the performance of SED using the suggested approach in order to investigate the potential of SED utilizing multichannel audio. The error can be generated due to the back propagation.

Cheah, et al [79] highlighted the capacity of CNN to categorize EEG signal while hearing the various types of tones without the need for manual features. The long-term trial included 10 individuals, five of whom were allocated to the control class as well as other five to the alpha-binaural-beats-listening class. Just two out of the three types of EEG signal were utilized for the binary classification problem in the short-term trial. In the short-term experiment three-class classification task, all three classes of EEG signal are employed. However, it may not consider the generalization issue.

Andrian, et al [80] provided a solution for people who have a lot of depression through using brainwave stimulators that enhance alpha brainwaves. It was hoped that by using a brainwave stimulator, the excessive stress issue, which is usually handled with drugs, could be alleviated. As a result, the issue of substance addiction did not emerge. A 9 Hz blinking white LED and binaural beats of 209 Hz right tone and 200 Hz left tone were used in the stimulator. Centered on DASS-21, standard vital health parameters, and daily sleep cycles, three individuals with typical stress levels were examined with this stimulation. In this test, each therapy lasted 30 minutes. However, the artifacts due to eye blinking and muscle movements are not considered, which could reduce accuracy.

El Houda, et al [81] The impact of marijuana binaural beats on the brain is investigated. Three groups are assigned for this purpose: before, during, and after 10 minutes of hearing binaural beats. The Bitalino sensor was used to detect the electroencephalogram (EEG) data, which was then processed using Matlab software. Bispectrale analysis is used to compute the synchronization degree parameter. A total of 23 healthy students volunteered for the study. Before, during, and after 20 minutes of hearing Marijuana binaural beats, an EEG signal was observed. The subjects were awake and comfortable, with their eyes open. Three electrodes were utilized. The first electrode is put on the forehead, the second on the lobe of the ear, and the third on the parietal region of the head. Nevertheless, the usage of discrete Fourier transform for filtering could reduce the original energy of the EEG signal.

Zaini, et al [82] Monitoring EEG data, which may be examined to record the changed brainwave patterns and attributes they display, can be used to assess the outcomes of binaural beats synchronize with brainwaves. Our study concentrates on recording then evaluating the connections among distinct binaural beats characteristics and the associated EEG and perceived mental states in relation to the monitoring procedure. A basic approach is provided, as well as further information on the proposed Semantic-based Bayesian Network Engine, that was the primary approach for collecting correlations. This technique is presented initially because of Bayesian Network's well-known capacity to describe causal and effect aspects. Second, with the addition of the semantic concept, the engine is now even better equipped to allow dynamic Bayesian Network creation based on its semantics. Even though, the implementation outcomes are not provided in detail manner.

Jirakittayakorn, et al [83] examined the impact of a 3-Hz binaural beat on sleep phases, which would be a condition of mind. The experimental and control groups each had twenty-four people. The trial lasted three nights, with an adaptation night, a baseline night, and an experimental night in between. Both classes went through the identical processes, however on the experimental night, the 3-Hz binaural beat has only been heard by the intervention class. The fast Fourier transform was used to examine electroencephalogram data acquired during the baseline and experimental nights, night 2 and night 3, in the frequency domain. In both the experimental and control

groups of night 2 and night 3, another FFT was conducted on EEG data with the epoch regarded as night 2 sleep stage to show delta activity characteristics in each condition. Besides that, event-related potential (ERP) should be evaluated at the moment of stimulation to assess the brain's reaction to a quick shift in auditory intensity, such as the transition from ambient sound to stimulus intensity, but the technique should be time-fixed.

Table 6: Cumulative survey on Binaural beats processing

Ref.	Technique Used	Benefits	Limitation
[72]	Exact-Low Resolution Electromagnetic Tomography (e-LORETA)	The e-LORETA research also produced a visual depiction of the impact of binaural beats in various brain anatomical regions.	The MLP shows better performance only on delta waves
[73]	Modified form of sample entropy feature	As ocular movements cause lower readings for attention levels, either a pre-processing stage should be utilized to filter out ocular artifacts or another algorithm should be used to estimate attention levels when ocular movements, especially shifts in one's focus, are present.	The attention related movements are providing the similar results, which could reduce accuracy
[74]	Autonomous sensory meridian response (ASMR)	This can lessen the annoyance of binaural beats while also improving the impact of brainwave entrainment. This approach might lessen the annoyance of binaural beats while also improving the advantages of brainwave entrainment.	This can lessen the annoyance of binaural beats while also improving the impact of brainwave entrainment. This approach might lessen the annoyance of binaural beats while also improving the advantages of brainwave entrainment.
[75]	Artificial neural network	The application has succeeded to identify stress using a machine learning classifier, K-Nearest Neighbors, and Naive Bayes, and then goes on to eliminate stress using an artificial neural network depending on the user's preferences and treatment records.	the k-nearest neighbor shows better performance on some particular brainwaves alone, not in all brainwaves.
[76]	DFT - Self-organizing map - ANN	Mental pattern recognition with great accuracy	Some additional artifacts can be introduced in older adults, which cannot be removed by DFT.
[77]	Energy Spectral Density (ESD) features – ANN	Since the entire brain was used instead of just the frontal area, excellent accuracy values were obtained in identifying females with and without stress.	Optimal channel selection is difficult with ANN.
[78]	A stacked convolutional and recurrent neural network with intra and inter channel convolutional neural network (C3RNN)	With the same amount of weights as the baseline CRNN, the suggested C3RNN achieves better performance with high training speed.	The error can be generated due to the back propagation.
[79]	Convolutional Neural Network	The CNN model provided is capable of accurately distinguishing not only the EEG of individuals listening to music from that of subjects without auditory input, but also the EEG of participants listening to various music.	It may not consider the generalization issue.
[80]	Brainwave stimulator	The stimulator was able to promote the production of Alpha brainwaves,	The artifacts due to eye blinking and muscle movements are not

		which can be utilized to decrease stress in people. The stimulator was able to promote the production of Alpha brainwaves, which can be utilized to decrease stress in people.	considered, which could reduce accuracy.
[81]	Bi-spectral analysis	It allows to extract several features which provides information about both distribution and dispersion of signals.	The usage of discrete Fourier transform for filtering could reduce the original energy of the EEG signal.
[82]	Semantic-based Bayesian Network Engine	It can record and analyze the correlations between various binaural beats, EEG, and perceived mental states.	The implementation outcomes are not provided in detail manner
[83]	Fast Fourier transform	Entrainments after the perception of a binaural beat can be used to alter actions, cognitions, and behaviors, and FFT can show them based on the associated EEG rhythm.	Event-related potential (ERP) should be evaluated at the moment of stimulation to assess the brain's reaction to a quick shift in auditory intensity, such as the transition from ambient sound to stimulus intensity, but the technique should be time-fixed

3. SUMMARY:

In this summary section, the overview of the procedure of methodology for acquiring EEG signals from participants, and processing on it to identify the impact of binaural beats on anxiety are described in detail.

Initially, to study the effect of binaural beats, number of participants has been selected with some eligibility criteria, among that, they were separated into control group and binaural beats (BB) groups generally. Before hearing the binaural beats, the anxiety level of participants has been measured through the State-Trait Anxiety Inventory (STA-I) scores. The STA-I is a tool that assesses two types of anxiety concepts: trait as well as state. The test consists of two measures, one for assessing anxiety another for assessing trait-anxiety, both of which comprise 20 questions with four options each. For each item, the candidate should choose the option that best describes his or her feelings (1 - "nearly never"; 2 - "occasionally"; 3 - "frequently"; 4 - "almost usually"). The overall score on the test ranges from 20 to 80, with 20-40 points indicating a low anxiety level, 41-60 points indicating a medium anxiety level, and 61-80 points indicating a high anxiety level.

A Nexus-32 system paired with Biotrace+ software can be utilized to gather and amplify EEG data. The Nexus-32 features 32 data acquisition channels. The sampled EEG may be synchronized, stored, processed, and exported using Biotrace+. Its versatility and mobility make it ideal for a wide range of biofeedback and physiological monitoring procedures. Although the Nexus-32 can interact with PCs through Bluetooth, the data transmission via optic fiber cable was preferred in these tests, and the EEG sample rate for collection was 256Hz. EEG is often recorded at sample rates ranging from 250Hz to 2000Hz. The EEG should be recorded at a sample rate that is three times the high-frequency filter setting. Higher rates, on the other hand, are always better. To avoid the aliasing effect, the sample rate must be high enough.

For acquiring the EEG signals from participants, an EEG cap with 21 electrodes has been placed on their head. There are 19 electrodes for data collection and two electrodes for reference on each of the subject's ears. According to the international 10-20 system, nineteen active electrodes were placed on the scalp, which can be depicted in figure 4 and table 7.

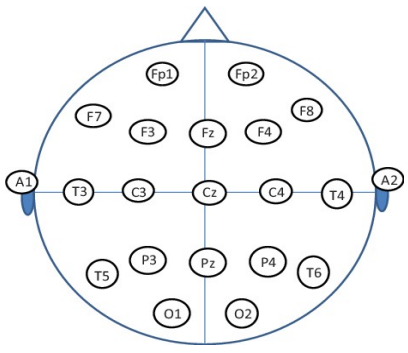

Figure 4: Electrode placement based on 10-20 system

Mental states. A sample flow diagram of processing of EEG signals has been depicted in figure 5.

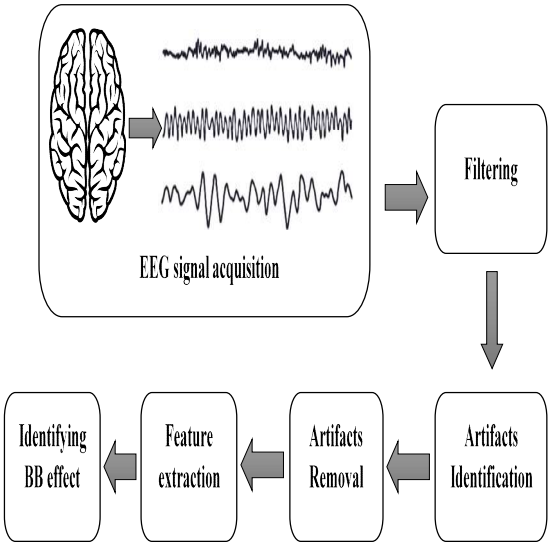

Figure 5: Flow diagram of EEG signal processing

Table 7: Placement Of Electrodes On Scalp Regions

Scalp region	Electrodes
Prefrontal	Fp1, Fp2
Frontal	F3, F4
Front Midline	Fz
Central	C3, C4
Central Vertex	Cz
Parietal Midline	P3, P4
Anterior Temporal	F7, F8
Medial Temporal	T3, T4
Posterior Temporal	T5, T6
Posterior Midline	Pz
Occipital	O1, O2
Ears (auricular reference electrodes)	A1, A2

The EEG signals of participants on both groups were acquired periodically based on the scheduled sessions. The acquired EEG signals are then processed through the MATLAB software. On the processing of EEG signals, the filtering and artifacts removal are the important steps as preprocessing. Then artificial neural network or machine learning approaches are utilized for investigation of EEG signals on variations in mental states.

The filtering of signals can be performed through the band pass filters. The artifacts are identified and removed on the preprocessing stage. The artificial neural network or various machine learning approaches are utilized for feature extraction. Finally, the impact of binaural beats on EEG signals has been identified.

From the survey on analyzing the effects of binaural beats, it can clear that, several experimentations can be done on analyzing binaural beats effects on anxiety, stress, depression, pain relief, and working memory. These studies are assuring that the binaural beats can be helpful on reducing anxiety, depression, pain and improve the mindfulness, working memory power, oxygen level. The anxiety was investigated only on state anxiety and trait anxiety levels. From our knowledge, the four different levels of anxiety through the binaural beats have not been analyzed yet. Likewise, the effect of binaural beats on improving oxygen level of patients has not been experimented yet.

On the other hand, the extracted EEG signals are processed in offline using Matlab or Python platform. In that, several filters like fast Fourier transform, discrete Fourier transform, wavelet transforms are utilized for removing the artifacts from the EEG signals and extracting features from signals. However, the introduction of artifacts due to eye blinking, muscle movements, and external noises has not removed accurately with the presented filters. In addition, previously employed machine learning and deep learning classifiers are not optimal for all types of brainwaves. Thus there is an open door for the researches to investigate the binaural beats effects optimally.

4. CONCLUSION:

Binaural beats, also known as digital drugs, are sounds that are believed to be capable of altering brainwave patterns and causing an altered state of consciousness close to that produced by deep meditation. In recent covid-19 scenario, peoples are affected by the reduced immunity and oxygen level also increased anxiety. Binaural beats stimulation is

the one, which can reduce the level of anxiety on people. Thus this study comprises all the previous researches exists on the experimental of reducing anxiety through the meditation with binaural beats. Also this work incorporates the processing of binaural beats using ANN and machine learning. This survey is more beneficial for the researches, who wants to make a research on measuring effect of binaural beats on reducing anxiety level.

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