RESEARCH ARTICLE

THE EFFECTS OF MUSIC ON STRESS

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Abstract
At the most basic level, stress is our body’s response to pressures from a situation or life’s event. Although in short occurrence or at optimum level stress may be considered to have positive effects, excess and prolonged stress can cause physiological as well as psychological health disorders. Stress cannot be avoided or omitted, but one can reduce or manage the level of stress using several relaxation techniques. Through age-long research, listening to music has been proven to be a powerful tool for stress reduction. Music has been reported to have direct effects on nervous system, immunological and endocrine system of the human body. Amongst various neuroimaging techniques, electroencephalogram (EEG) is a useful electrophysiological biomarker to monitor the neuronal activities of the human brain with high temporal resolution. In research setting EEG signals are used in mental stress study. The present article attempts to review scientific literature in support of the pivotal role of music on stress reduction. Discussions on stress and its effects on human health are followed by the quantification of stress by EEG for identification and classification of stress. The role of music on stress reduction has been discussed with a light on musical neurofeedback as an effective measure for stress reduction. This comprehensive review would provide theoretical support for claims that music would act as stimuli for stress characterization and also would have its ability to serve as effective and potential measure for stress reduction in everyday life.

Introduction:-
The technological growth in the modern world has thrown challenges to thrive on severe competition which leads to increase in physical as well as mental stress in all humans irrespective of gender, age and profession. As a result, quality of life gets tremendously affected and the work-life balance gets perturbed. The rising trends in hypertension, heart disease, depression, anxiety related disorders are caused by the stress of modern life. Stress has effects on neurotransmitters which is a detriment to good health. It is true that a certain degree of stress is accepted as necessary for performance and productivity, but uncontrolled and prolonged stress appears to be aggressively alarming. Although stress is inescapable in this digital world, people can cope with it strategically to restore the balance of life. Listening to music is one of the coping techniques which helps people feel relaxed, calm and relieved from burden of stress. Much research has been done on establishing the prominent influence of music on the neuronal activities in the brain. Among various neuroimaging techniques, electroencephalogram (EEG) being a

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non invasive and cost effective biomarker to monitor and analyze brain waves with high temporal resolution, has been effectively used to characterize stress to study the effects of music on the brain for stress reduction.

This comprehensive review article has aimed at reviewing novel work on effects of music on stress from neurocognitive perspective. The section after describing the methods begins with definitions of stress and stressors followed by the effects of stress on psychosomatic health of humans. Characterization of stress plays a pivotal role in stress management. Detailed attention is paid in contributing to the overview of brain waves and discussing quantification of stress using EEG mentioning different computational methods for stress identification and characterization. Effects of music on brain waves, emotion and the neurotransmitters have been explicitly discussed which corroborate the efficacy of music on stress relief. A short discussion on the selection of music has also been taken into consideration. Neurofeedback or EEG Biofeedback, with a special focus on the alpha and alpha/theta protocol for stress reduction has been discussed along with few studies on musical neurofeedback. The paper concludes with a few suggestions on future work for deeper understanding of the role of music as an effective potential aid to cope with stress.

**Methods:**
PubMed and Google Scholar have been used as search engines and Digital Object Identifier (DOI) as the identifier for searching relevant scholarly literature since 1980 to 2020. Papers older than 25 years are cited mainly for providing historic evidences whereas the original research papers and review papers from year 1995 onwards are cited as relevant work references.

**Stress and Stressors:**
The term “stress” defined by János Hugo Bruno "Hans" Selye, a great Hungarian-Canadian endocrinologist, as the non-specific response of the body to any demand made upon it (Selye, H. 1956, 1973). Stress is a complex reaction pattern that often has psychological, cognitive and behavioural components (Michael, F. et al. 1986). Eustress (In Greek, “eu” means “good”) is the healthy stress giving one a feeling of fulfilment like motivation, alertness, challenge and overall well being. Distress (commonly known as stress) is the persistent stress that is not resolved through coping or adaptation and may lead to anxiety, withdrawal and depressive behaviour imparting negative implications (Selye, H. 1946). Any threatening or challenging situation or event is referred to as a stressor. Psychological stressors are social and physical environmental circumstances that challenge the adaptive capabilities and resources of an organism (Monroe, S. M. & Slavich, G. M. 2016). According to The General Adaptation Syndrome (GAS) model proposed by Selye, a stressful event leads to a three-stage bodily response (Selye, H. 1946) as shown in Figure 1. Alarm is the first and instantaneous reaction to a stressor in which humans exhibit a “fight or flight” response and stress hormones like cortisol and adrenaline are released into the bloodstream to respond to the danger. In the Resistance phase, the body remains on red alert and focuses resources against stressor; stress hormones continue to circulate at high levels and the heart rate, blood pressure and breathing rate increase. Finally in the Exhaustion stage, the body’s resistance to stress gradually reduces and collapses as the immune system becomes ineffective resulting in alarming health conditions.

![Fig. 1:- Diagram of General Adaptation Syndrome (GAS) Model](http://commons.wikimedia.org/wiki/File:General_Adaptation_Syndrome.jpg)
Psychosomatic effects of stress:
Stress has detrimental effects upon physical and psychological health of humans. 60-80% of outpatient visits may be related to stress (Avey et al. 2003; Hughes, G. H. et al. 1984). Stress is linked to all leading physical causes of death e.g. heart disease, cancer, stroke (Cohen et al. 2007). Significant amount of work on the effects of stress on human physiological health has been done which is summarized in Table 1.

**Table 1:** Effects of stress on physiological health.

| Author | Area of Work                                |
|--------|---------------------------------------------|
| Pickering, T. G. 2001; Lederbogen, F. et al. 2011; Allen, A. P. et al. 2014; Ursin, H. & Eriksen, H. R. 2004 | Hypertension, cardiovascular disease |
| Holmes, S. D. et al. 2006 | Coronary artery disease |
| Khorana, S. 1983. | Peptic ulcers & ulcerative colitis |
| Garg, A. et al. 2001 | Skin disorders like Eczema |
| Valsamakis, G. et al. 2019 | Female reproductive dysfunction |
| Joachim, R. A. et al. 2003 | Respiratory ailments like asthma |
| Mönnikes, H. et al 2001 | Gastroesophageal reflux disease (GERD) |
| Kruk, J. et al. 2019 | Cancer |
| Stojanovich, L. & Marisavljevich, D. 2008 | Autoimmune disease |
| Dragoș, D. & Tănăsescu, M. D 2010 | Defense system |
| Aschbacher, K. et al. 2014 | Obesity |

Prolonged Stress is associated with development of most major mental health problems like depression, post-traumatic stress disorder (PTSD), pathologic aging (Marin, et al. 2011) and anxiety disorders (Karthikeyan, P. et al. 2011). During stress, the hypothalamic-pituitary-adrenal (HPA) axis activates the release of glucocorticoids with consequent increases in heart rate, blood pressure, and metabolism which are associated with stress related disorders like depression (Chida, Y. & Steptoe, A. 2009). Neuroimaging studies have revealed positive correlation between the depressive persons’ plasma cortisol, a stress hormone in humans, with the activity of the left amygdala (Drevets, WC. et al. 2002). Increased secretion of major cortisol leads to impairments in attention, memory and emotion processing in humans (Lupien, S. J. et al. 2005). When subjected to stress, the healthy brain regulates the nervous, endocrine and the immune system to maintain allostasis, an organism’s ability to “achieve stability through change” (McEwen, B. S. 1998). Even low stress intensity can lead to allostatic overload resulting in brain damage (McEwen, B. S. 2012). Cognitive decline was almost 30% faster in individuals experiencing distress compared to those with no distress (Han, B. et al. 2016).

**Brain waves and stress quantification by EEG signals:**
Stress quantification is very important for clinical intervention and disease prevention. As Stress is originated from brain, neurological signals have significant importance in measuring mental stress. Brain (or neural) oscillations refer to the rhythmic and/or repetitive electrical activity generated spontaneously and in response to stimuli by neural tissue in the central nervous system (Basar, E. 2013). Human brain consists of billions of neurons, which all generate electrical impulses. When these neurons work in synchrony, tiny alternating electrical potentials occurs at the synapses. The more the neurons work, the larger the potential of the electrical oscillations measured in micro volts. The faster the neurons work together, the higher the frequency of the oscillations measured in hertz (Hz). Based on their frequency, brainwaves are of five categories which correspond to different states of thought or experience (Figure 2, Table 2).
Diagram illustrating different brain waves bands characterized by frequency (Hz); (Source: http://choosemuse.com 2018).

Table 2: Human brain waves: Frequency (Hz) and Amplitude (microvolt) range.

| Name of waves | Frequency (Hz) | Amplitude (microvolt) |
|---------------|----------------|-----------------------|
| Delta         | 0.5-4          | 100-200               |
| Theta         | 4-8            | Higher than 30        |
| Alpha         | 8-13           | 30-50 or higher       |
| Beta          | 13-32          | 2-20 or higher        |
| Gamma         | 32-100         | 3-5 or higher         |

In a stressful situation, the sympathetic nervous system dominates and the brain’s natural response is to accelerate from slow alpha and theta waves to fast beta frequencies (Hoffmann, E. 2005). Both decreased and increased in alpha and beta power have been found as a sign of mental stress (Puterman, E. et al. 2011). During rest and relaxation, the parasympathetic nervous system dominates and as a result the brain waves are slowed down from beta to alpha wave frequencies and during excessive parasympathetic activity to theta waves (Hoffmann, E. 2005).

Considering factors like temporal or spatial resolution, specificity and coverage in selecting non-invasive neurological methods for stress measurement, Electroencephalogram (EEG) is an important tool for studying the transient dynamics of the human brain’s large-scale neuronal circuits. It is one of the most common quantifiable measures to identify and classify human stress using real-time digital technology to record electrical activity of the brain with high temporal resolution in millisecond scale (Berka, C. et al 2004). The changes in autonomous nervous system can be effectively represented by EEG signals (Seo, S. H. et al. 2010). Long-term stress has been classified with machine learning algorithms using resting state EEG signal recordings (Saeed, S. 2020). The ratio of power spectral densities of alpha and beta bands has been computed for the analysis of physical stress (N H A Hamid et al. 2010). The changes in EEG absolute power and other connectivity measures such as coherence have been observed to analyze stress (Alonso, J. F. et al. 2015). For stress identification and stress state classification using EEG, different computational methods are used (Table 3). Activities in the right hemisphere of the brain dominate the activities in the left hemisphere of the brain during negative emotions (Horlings, R. et al. 2008) which indicates the area for stress detection. Rapid beta wave frequencies are considered as the characteristic indicators of stress (Lin, T. A. & John, L. R. 2006). Stress pattern can be indicated by high Beta power and low Alpha power on anterior side of...
human brain (Seo, S. H. et al. 2010). Slope of EEG linear regression has been a feature to determine the relaxation level of an individual (Teplan, M. et al. 2006) and a combination of EEG Asymmetry and Spectral Centroids techniques has also been used as a feature to detect unique patterns of human stress (N Sulaiman, et al. 2011).

Table 3: Different computational methods used for identification and classification of stress.

| Computational methods                        | Researchers                  |
|---------------------------------------------|------------------------------|
| Decision trees                              | Dharmawan, Z. & Rothkrantz, LJM 2007 |
| Artificial Neural Network (ANN)              | Alic, B. et al. 2016         |
| Support Vector Machines (SVM)                | Sani, M. M. et al. 2014      |
| Random Forest                               | Haouij, Neska. et al. 2018   |
| Bayesian classifiers                         | Horlings, R. et al. 2008     |
| K-nearest neighbors                          | Khosrowabadi, R. et al. 2011 |
| EEG eigenvalue decomposition                 | Paul, M. P. et al. 2013      |
| Brain Wave Balancing Index (BBI)             | Adnan, N. et al. 2012        |
| Discrete Wavelet Transform (DWT)             | Murugappan, M. et al 2010    |

Coping with stress using music:
Lazarus and Folkman have defined coping as "the process of managing demands (external or internal) that are appraised as taxing or exceeding the resources of the person" (Lazarus, R. S. & Folkman, S. 1984). Coping models may be of two types: instrumental and palliative (Hanser, S. 1985). The instrumental model implies direct action in an attempt to change the troubled transaction. The regulation of emotions associated with stress constitutes the palliative approach. Music being the language of emotions (Langer, S. K. 1957) is best classified as emotion-based palliative coping strategy that involves the use of music in order to reduce stress and its allied physiological and psychological ailments. Music is a powerful inducer of emotions and mood arousal (Ilie et al. 2002) and has an effect on activity in the brain’s emotional core (Blood, A. J. & Zatorre, R. J. 2001; Juslin, P. N. & Västfjäll, D. 2008; Koelsch, S. 2010; Koelsch, S. & Siebel, W. A. 2005; Koelsch, S. 2010) and also to alter the dynamical brain responses, i.e. oscillatory component(s) of the EEG signals, particularly theta frequency band. Music-induced chills produce reduced activity in brain structures associated with anxiety (Blood and Zatorre, 2001).

Music on brain:
From ample research on music and the brain, it is manifested that music has a biological basis and the brain has a functional organization for music (Weinberger, N. M. 2004). Listening to music is reported to influence varied regions in the brain, including multiple cortices (auditory, visual, motor), the cerebellum along with the deeper emotional area (amygdala, orbitofrontal, anterior cingulate cortex), memory (hippocampus), mesolimbic reward structures and dopaminergic neural networks (Koelsch, S. & Siebel, W. A. 2005; Koelsch, S. 2010) and also to alter the dynamical brain responses, i.e. oscillatory component(s) of the EEG signals, particularly theta frequency band. Music-induced chills produce reduced activity in brain structures associated with anxiety (Blood and Zatorre, 2001). Mainly two types of brain waves responsible for mental relaxation and stress reduction are the alpha wave (8–13 Hz) during relaxation and theta wave (4–8 Hz) during deep relaxation. Studies have found that brain waves can be altered by music (Levitin, D. J. & Tirovolas, A. K. 2009). Alpha and theta brain waves increase either by relaxing music or by other relaxation techniques (Jacobs, G. D. & Friedman, R. 2004). Different types of music (Light, Country, Jazz, Rock) have been reported to cause the decline of the energy intensity of the waves from different areas which strongly supports the hypothesis that different types of music will have different impact on the human brain and EEG waves (Sun, C. et al. 2013). The first neuroscientific study of the effect of listening to archaic sounds (monochord) was done in patients demonstrating the changes in complexity in brain oscillation patterns in comparison with progressive muscle relaxation (PMR) (Bhattacharya, J. & Lee, E. J. 2016). Studies on the effects of music on alpha and theta waves are summarized in Table 4.

Table 4: Effect of music on alpha and theta waves.

| Researchers                          | Area of Work                       |
|--------------------------------------|------------------------------------|
| Kabuto, M. et al. (1993)             | The relaxation effects of music are also reported to be associated with a change in the total theta power. |
| Sakharov, D. S. et al. (2005); Sammler, D. et al. (2007) | Pleasant music would elicit an increase of Frontal midline (Fm) theta power. |
|                                      | Pleasant music is observed to produce a decrease in the |
A frontal asymmetry in the lower alpha-band has been found (Mikutta, C. et al. 2012) which may be associated with activations of subcortical limbic structures during periods of high arousal in music as shown in other studies (Davidson, R. J. 2004). Although mood induction and emotion regulation are not exactly the same because moods are affective states lower in intensity than emotions (Juslin, P. N. & Sloboda, J. A. 2010) yet mood induction is of high concern in stress reduction.

**Music on stress relief:**

Numerous studies on the effect of music listening on stress and anxiety have shown the ability of music to improve an individual's emotional as well as physical health by reducing the stress level (Koelsch, S. and Stegemann, T. 2012; Krause, A. E. et al. 2015). It is one of the most convenient approaches for stress relief and relaxation in everyday life. The structural features of music not only help convey an emotional message to the listener, but also express and create emotion in the listener (Bhatti, A. M. et al. 2016) which shows beneficial effects on stress related physiological and emotional processes. Music has been shown to be effective for the reduction of anxiety (Koelsch, S. and Stegemann, T. 2012) both in the laboratory settings (Knight, W. E. J. & Rickard, N. S. 2001) and in out-of-lab experiments (Ventura, T. et al. 2012). Listening to slow, quiet classical music has shown a decline in the perceived level of psychological stress and an increase in the stress coping ability of an individual (Ventura, T. et al. 2012). Music can reduce depression (Aalbers, S. et al. 2017), blood pressure (Sutoo, D. & Akiyama, K. 2004), heartbeat (Cervellin, G. & Lippi, G. 2011) and stabilize people’s psychological and physiological state with visible positive effects on heart diseases (Bradt, J. et al. 2013), stroke (Magee, W. L. et al. 2017) dementia and Alzheimer’s disease (Svansdottir, H. B. & Snædal, J. 2006), schizophrenia (Tseng, P. T et al. 2016). Many studies have shown that background music has its positive impact toward patients with moderate stressful conditions (Wang, Kun. et al. 2016).

The effect of music on human subjects under mental stress has been studied (Nawaz, R. et al. 2018) in three different stress levels: low, high and moderate (using congruent, incongruent and mix stroop color test); with and without background music and the corresponding EEG has been recorded. For congruent and mix stroop test higher alpha power is observed in the presence of music indicating a positive effect of music under low and moderate stress conditions whereas for incongruent case the alpha power is reduced in the presence of music indicating the negative effect of music under high stress. The stress behavior of females is reported to be more sensitive to music as compared to males (Asif, A. et al. 2019). Listening to a piece of classical piano music has been reported to evoke activity changes in the amygdala and the orbitofrontal cortex (Koelsch, S. 2014) which plays a pivotal role in stress reduction in daily life. According to the study of Frances H Rauscher and his team (Rauscher, F. H. 1993), significantly better spatial reasoning skills were observed on normal subjects after listening to Mozart's sonata for two pianos (K448) for 10 minutes than after periods of listening to relaxation instructions designed to lower blood pressure or silence (Jenkins, J. S. 2001).

The controlled use of a specific kind of music and its ability to influence behavioral, emotional, and psychological changes in a human being during the treatment of a disability or illness is usually referred to as music therapy (Watkins, G. R. 1997). Many literatures have reported music therapy as a well-established, non-invasive, safe and inexpensive measure with its ability to exhilarate positive emotions promoting calmness and a feeling of relaxation in mental stress related problems (Archie, P. et al. 2013; Burrai, F. et al. 2019; Mondanaro, J. F. et al. 2017; Raglio, A. et al. 2015). The stress response of terminally ill cancer survivor to a music therapy intervention has been studied in a randomized controlled trial and a positive emotional effect along with a significant decrease in tiredness, anxiety and breathing difficulties as well as an increase in levels of overall well being have been reported (Ramirez, R. et al. 2018). The effects of Indian Hindustani classical raga Desi-Todi (played on flute) on three physiological (alpha EEG frequency, systolic and diastolic blood pressure and heart rate), three psychological (depression, state and trait anxiety), and four components of anxiety (somatic, cognitive, behavioral and affective) have shown a significant increase in the alpha EEG frequency and a significant decrease in the scores on depression and the four

| Source | Effect on EEG and Psychological Measures |
|--------|-----------------------------------------|
| Sammler, D. et al. (2007) | Alpha power at the left frontal lobe and unpleasant music evokes a decrease in the alpha power at the right frontal lobe. |
| Chan A S et al. (2008) | Fm theta power is related to heightened mental effort and the subjective scores of the pleasantness of the emotional experience and an increase in posterior theta power is shown while listening to classical music. |
components of anxiety (Gupta, U. & Gupta, B. S. 2005). Music Therapy has been observed as an evidence-based novel therapeutic tool to reduce stress eliciting the cognitive, sensory, communicative and emotional domains.

Music on neurotransmitters and immunological stress markers:
Studies (Table 5) suggest that pleasant music releases dopamine, the main neurotransmitter in the reward system. Different music has its effects on the levels of other neurotransmitters like norepinephrine, serotonin, endorphin and cortisol (Table 6). Stress induces major changes in the immune system (Koelsch, S. & Siebel, W. A. 2005). The study of Brennan and Charnetski (Brennan, F. X. & Charnetski, C. J. 2000) indicated that there is a positive relationship between relaxing music and immunological stress markers. Listening to and playing music are reported to modify the level of certain immunological components such as immunoglobulin A (IgA) and natural killer cells (Enk, R. et al. 2008) and to elevate level of stress markers like cytokine IL-6 level and IL-10 improving mood (Wachi, M. et al. 2007). Some of the relaxing properties of music are also reported to elicit biochemical measurable stress-reducing effects, such as reduction of inflammatory markers (Wachi, M. et al. 2007).

Table 5:- Study of dopamine and opioids to musical pleasure (Source: Chanda, M. L. & Levitin, D. J. 2013).

| Author                          | Outcome measures                        | Conditions                              | Participants          | Observations                          |
|---------------------------------|-----------------------------------------|-----------------------------------------|-----------------------|---------------------------------------|
| Blood, A. J. and Zatorre, R. J. (2001) | rCBF using PET; self-reported chills | self-selected music, neutral music, noise, and rest | Music students | Chills increase rCBF in ventral striatum and midbrain |
| Brown, S. et al. (2004)         | rCBF using PET; self-reported musical pleasure | Experimenter-selected music Vs rest | Non-musicians | Music increases rCBF in NAc, insula, hippocampus |
| Menon, V. and Levitin, D. J. (2005) | rCBF using fMRI, network connectivity; self-reported pleasantness | Experimenter-selected music Vs scrambled versions of same | Non-musicians | Music increases rCBF in NAc, VTA and insula; strong connectivity of NAc, VTA, hypothalamus and insula |
| Koelsch, S. et al. (2006)       | rCBF using fMRI; self-reported pleasantness | Experimenter-selected music, pleasant Vs unpleasant | Non-musicians | Pleasant music increases CBF in ventral striatum; rCBF in amygdala, hippocampus, parahippocampal gyrus and temporal poles |
| Salimpoor, V. N. et al. (2011)  | D2 binding using ligand-based PET; self-reported chills | Self-selected Vs neutral music | Unselected for musical ability | Chills increase D2 binding in NAc; Anticipation " D2 binding in caudate |

Abbreviations: D2, dopamine D2 receptor; mPFC, medial prefrontal cortex; NAc, nucleus accumbens; PET, positron emission tomography; rCBF, regional cerebral blood flow; VTA, ventral tegmental area.

Table 6:- Studies of different music on different neurotransmitters.

| Researchers       | Music Type       | Neurotransmitters | Study Outcome (Increase/decrease) |
|-------------------|------------------|-------------------|-----------------------------------|
| Yamamoto, T. et al. 2003 | Slow music      | Norepinephrine    | Decrease in the level             |
| Evers, S. & Suhr, B. 2000  | Pleasant music  | Serotonin         | Increase in the level             |
|                    | Unpleasant music |                   |                                    |
| Gerra, G. et al. 1998     | Pleasant music  | Endorphin         | Increase in the level             |
|                        | Techno Music     | Cortisol          | Increase in the level             |
| Khalfa, S. et al. 2003   | Relaxing music  | Cortisol          | Decrease in the level             |
| Kreutz, et al. 2004      | Classical choral song | Cortisol        | Decrease in the level             |
| Suda, M. et al. 2008     | Major music (Mozart’s) | Cortisol    | Decrease in the level             |
Selection of music:
Selection of appropriate music is of huge significance and the effects of different music genres on reducing stress have been explored in several studies. Classical music is found to be more stress relieving than non-classical music such as heavy metal and hard rock (Labbé, E. et al. 2007). Sedative music or silence reduces tension and has a relaxing effect, as compared to stimulative music or noise (Lingham, J. et al. 2009). Listening to self selected music while being in curative radiation therapy has been reported to lower anxiety and treatment-related distress (Clark, M. et al. 2006). A meta-analysis of the effectiveness of music use of stress reduction revealed the importance of preferred music in a decrease of arousal due to stress (Pelletier, C. L. 2004). Relaxing music which is specially formulated music with binaural beats (alpha brainwave range, 8–13 Hz) for relaxation (alpha state) has been reported (Pheanah, S. W. & Nisar, H. 2017) to produce more alpha brainwaves hence higher alpha power causing a better soothing effect on the participants compared to the participants' favourite music.

Musical neurofeedback in stress reduction:
Neurofeedback, also known as EEG biofeedback, involves utilizing EEG signals to measure brain wave activity with the use of audio or visual signals to reorganize or retrain these brain signals. Musical Neurofeedback has become frequently used technique for treating stress related disorders. (Álvaro J. Bocanegra-Pérez, et al. 2020). It teaches self-control of brain functions to subjects by measuring brain waves and providing a feedback signal. Over the past decade, neurofeedback has been found to be effective in producing significant improvements in medical conditions related to stress such as depression (Hammond, D. C. 2004), anxiety (Kerson, C. et al. 2009), migraine (Walker, J. E. 2011).

The most commonly used neurofeedback protocols in treating stress and emotional disorders are alpha, theta, and alpha/theta ratio. The upper alpha frequency band has been examined as a neurofeedback criterion (Zoefel, B. et al. 2011) and shown to modulate amygdala complex connectivity associated with post-traumatic stress disorder (PTSD), leading to symptom reduction (Nicholson, A. A. et al. 2016) and relaxation to the anxiety patients (Rice, K. M. et al. 1993). Increasing of alpha power at the right frontal cortex has been reported to reduce negative emotion and anxiety symptom (Mennella, et al. 2017). Theta treatment reduces anxiety, depression, emotional disorders (Vernon, D. J. 2005). Alpha/theta protocol of neurofeedback has been studied (Gruzelier, J. 2009) for raising the theta–alpha ratio which showed reduction of depression and anxiety in alcoholism and resolved post traumatic stress disorder (PTSD).

The potential benefits of combining music, neurofeedback and emotion detection have been investigated by Rafael Ramirez and his team (Ramirez, R. et al. 2015) for improving elderly people's mental health with a goal to investigate the emotional reinforcement capacity of automatic music neurofeedback systems and its effects for improving depression in elderly people. The study (Ramirez, R. et al. 2015) proposed a new neurofeedback approach which allowed users to manipulate expressive parameters in musical performances using their emotional state which had been characterized by a coordinate in the arousal-valence plane decoded from their EEG activity. The positive results of their clinical experiment suggested a new research with the proposed musical neurofeedback approach. A combination of music therapy with the real-time EEG-based human emotion recognition algorithm has been proposed by Olga Sourina and her team (Sourina, O. et al. 2012) by which the user’s current emotional state could be identified and based on such neurofeedback the music therapy could be adjusted to the patient’s needs. A pilot study has been conducted by Alexander Ivanovich Fedotchev (Fedotchev, A. 2018) with an aim to examine the efficiency of music stimulation online controlled by feedback signals from patient's EEG oscillators for the correction of stress-induced functional disturbances. The result showed normalization of the EEG, reduction of stress sensations, and positive shifts in mental and emotional status of the patients.

Conclusion:-
Stress has been identified as a serious and escalating issue having severe impacts on both individuals and society. Growing experimental evidences show that the effects of music on human brain with precise identification and classification of stress by EEG monitoring could be a potential clinical method to manage and treat the stress related health hazards. Music being a cost effective subjective stimulus, it is quite evident from studies that properly selected music would be beneficial as a therapeutic to the common people suffering from stress related health problems. Musical Neurofeedback training would also cast a new light on stress research.
A preliminary literature support has been attempted through this review paper to provide the evidences for the effects of music to facilitate stress relief. But there is an absolute need of more focused neuroscientific research to explore the clinical efficacy of music interventions on stress with more detailed insights. The author would have liked to suggest a few ideas where future research needs to be looking next. As levels of stress may vary from mild to moderate to severe, more work is required on the identification of different levels of stress and the effects of music should be observed accordingly for detailed characterization. Comparative studies can also be done with instrumental and vocal music for finding the better option of minimizing stress levels in humans. The review conclusively suggests that on precise identification and classification of stress, music can be considered as a prospective aid to cope with stress. Future investigations would certainly validate the conclusions by exploring exclusive association of music with human brain which would help in achieving a deeper understanding of beneficial effects of music on stress.

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