

A REVIEW OF THE ANXIOLYTIC EFFECT OF MUSIC AND ITS CLINICAL APPLICATIONS

Dr. Sivaprakash B *

Introduction

Neuroscience has established beyond doubt that the mind is a product of the brain. It is also known that the central and peripheral nervous systems extend their cells and synapses throughout the body.¹ The mind exerts a profound influence on physical health through intricate and widespread neuro-endocrine and neuro-immune pathways. Mental health is a key determinant of overall health. Anxious and depressed moods, for example, initiate a cascade of adverse changes in endocrine and immune functioning, and create increased susceptibility to physical illnesses.² The field of psychosomatic medicine emphasizes the unity of mind and body and the significance of psychological factors in all disease states.³ Concepts derived from psychosomatic medicine influenced the emergence of complementary and alternative medicine (CAM).³

CAM refers to the various disease-treating or disease-preventing practices whose methods and efficacy differ from traditional or conventional biomedical treatment.⁴ Some of these approaches can be and are used in conjunction with traditional/allopathic medicine.⁴ According to the National Center for Complementary and Alternative Medicine, USA, CAM is a group of diverse medical and health care systems, practices, and products that are not generally considered to be part of conventional medicine. Mind-body medicine is a domain within CAM that focuses on the interactions among the brain, mind, body, and behavior, and the powerful ways in which emotional, spiritual, and behavioural factors can directly affect health. Mind-body interventions include music therapy, yoga, meditation, biofeedback etc.⁴ Music therapy is the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship.⁵ Music therapy has been shown to be an efficacious and valid adjunctive treatment option for patients with a variety of diagnoses.⁵

Bradt and Dileo⁶ have explained the concepts of music medicine and music therapy. Interventions are categorized as music medicine when passive listening to pre-recorded music is offered by medical personnel. In contrast, music therapy requires the implementation of a music intervention by a trained music therapist, the presence of a therapeutic process, and the use of personally tailored music experiences. These music experiences include listening to live, improvised or pre-recorded music, performing music on an instrument etc. Music therapy provides opportunities for anxiety and stress reduction, non-pharmacological management of pain and discomfort, and positive changes in mood and emotional states.⁵

Systematic research on the effects of music and music therapy on patients has burgeoned during the past 20 years. A substantial body of literature exists to support the effectiveness of music therapy. In a recent review, Lake⁷ notes that anxious adult patients randomly assigned to music-assisted reframing experienced greater reductions in overall anxiety than patients who received conventional cognitive therapy. Frequent listening to music probably has beneficial effects on endorphins and other neurotransmitters that mediate improvements in depressed mood⁷. Music alone or in combination with guided imagery improves mood in depressed cancer patients⁷. Depressed outpatients reported significant improvements in mood and beneficial changes in heart rate and blood pressure soon after listening to tranquil music⁷. Regular singing, engaging in dance therapy, listening to music, and participating in musical games improve cognitive and behavioural functioning in individuals with severe dementia, who experience reduced agitation, reduced wandering, enhanced social interaction, improved mood, reduced irritability or fear, and increased cooperative behavior⁷. Calming background music significantly reduces irritable behavior, anxiety, and depressed mood in nursing home patients with dementia⁷.

* Dr. Sivaprakash B, Professor of Psychiatry

Mahatma Gandhi Medical College and Research Institute, Puducherry 607402, India.

Music therapy can help to relieve pain and reduce stress and anxiety for the patient, resulting in improved respiration, lower blood pressure, improved cardiac output, reduced heart rate, relaxed muscle tension.⁵ Music therapy has been shown to have a significant effect on a patient's perceived effectiveness of treatment, self-reports of pain reduction, relaxation, respiration rate, anxiety levels, and amount of analgesic medication.⁵

There are a number of individual factors that influence responses to music. These include age, gender, cognitive function, severity of stress, anxiety, discomfort and pain, training in music, familiarity with and reference for the music, culture, and personal associations with the music.⁶ The response of patients/subjects to music therapy is thus highly subjective. Published Indian research literature on music therapy appears to be meagre and elusive. Given the promising results of music therapy research performed in other countries and the fact that culture and socioeconomic factors significantly influence response to music therapy, it may be worthwhile for the scientific community of our nation to start building a repository of indigenous research on music therapy.

Research reports on the impact of music on normal human physiological processes in healthy individuals are not as abundant as research data on the therapeutic effects on music in the context of human illness. It stands to reason that the precise nature of the physiological impact of music needs to be elucidated in through systematic research on healthy subjects, before music can be routinely prescribed with confidence in the clinical setting. In addition, rigorous randomized controlled trials involving the exposure of healthy subjects to music will help to clarify and establish the role of music in disease prevention, health promotion, and positive psychology. Existing research data pertaining to these issues needs to be replicated in the Indian context, for reasons mentioned earlier.

This review starts with a brief overview of fundamental physiological correlates relevant to the theme of this study, including the neurobiology of anxiety. Salient aspects of the autonomic nervous system are discussed, followed by the relationship between anxiety and the autonomic nervous

system. The physiological impact of anxiety on the cardiovascular and respiratory systems is reviewed, in brief. Recent research findings pertaining to the neurophysiology of music are highlighted. A brief sketch of the physiological effect of music on healthy subjects is provided, followed by an elaborate review of research on the anxiolytic effect of music in diverse clinical scenarios. Health implications of anxiety, elevated heart rate and blood pressure are discussed briefly. The review ends with an emphasis on the need for further research on the impact of music on human physiology.

Overview of basic physiological correlates

Neurobiology of anxiety

Anxiety is a reaction to stress that has both psychological and physical features. The feeling is thought to arise in the limbic system, a brain region that governs many intense emotional responses. The prevailing neurocircuitry models of anxiety disorders emphasize interactions among limbic structures, especially the amygdala, hippocampus, hypothalamus, and periaqueductal gray, and cortical regions within the sensory association areas and the medial and orbital portions of the prefrontal cortex.⁸

Autonomic nervous system

It is well known that the hypothalamus is a crucial component of the neural circuitry regulating not only emotions, but also autonomic, endocrine and some somatic functions.⁹ The limbic system integrates the highly processed sensory and cognitive information content of the cerebral cortical circuitry with the hypothalamic pathways that control autonomic and endocrine systems.⁹ Stimulation of the lateral nucleus of the hypothalamus via afferent projections from the central nucleus of the amygdala, bed nucleus of the stria terminalis, or ventral striatum activates the sympathetic nervous system, producing increases in blood pressure and heart rate, sweating, piloerection, and pupillary dilation.⁸ During stress, the secretion of CRH from the PVN of the hypothalamus increases peripheral ACTH levels, which stimulates the adrenal glands to secrete cortisol.⁸

Emotions, autonomic nervous system and the cardiovascular system

Autonomic nervous system activity is viewed as a major component of the emotion response in many recent theories of emotion.¹⁰ Anxiety is characterized by sympathetic activation and vagal deactivation, a pattern of reciprocal inhibition.¹⁰ Peripheral manifestations of anxiety include hypertension and tachycardia.¹¹ The autonomic nervous system of some patients with anxiety disorder exhibit increased sympathetic tone.¹¹ There are descending tracts to the medullary vasomotor area from the cerebral cortex (particularly the limbic cortex) that relay in the hypothalamus. These fibres are responsible for the blood pressure rise and tachycardia produced by emotions such as sexual excitement and anger.¹²

Anxiety and the respiratory system

One common symptom associated with anxiety is hyperventilation. Abnormal respiratory behavior has been identified in anxiety disorders, particularly panic disorder.¹³ Dyspnoea can coexist with anxiety.¹⁴ Anxiety is often a component of dyspnoea experienced by patients with chronic respiratory illness.¹⁴

Neurophysiology of music

Music is capable of evoking exceptionally strong emotions and of reliably affecting the mood of individuals.¹⁵ Koelsch¹⁶ reviewed the functional imaging studies conducted on the investigation of emotion with music. These studies showed involvement of limbic and paralimbic cerebral structures (such as amygdala, hippocampus, parahippocampal gyrus, temporal poles, insula, ventral striatum, orbitofrontal, as well as cingulate cortex) during the processing of music with emotional valence (such as pleasant or unpleasant). These studies imply that music-evoked emotions can modulate activity in virtually all limbic and paralimbic brain structures. These structures are crucially involved in the initiation, generation, detection, maintenance, regulation and termination of emotions that have survival value for the individual and the species.

Menon and Levitin¹⁷ used functional magnetic resonance imaging and functional/effective connectivity analyses to show that listening to music strongly modulates activity in a network of mesolimbic structures involved in reward processing including the nucleus accumbens (NAc) and the ventral tegmental area (VTA), as well as the hypothalamus and insula, which are thought to be involved in regulating autonomic and physiological responses to rewarding and emotional stimuli. Responses in the NAc and the VTA were strongly correlated pointing to an association between dopamine release and NAc response to music. Responses in the NAc and the hypothalamus were also strongly correlated across subjects, suggesting a mechanism by which listening to pleasant music evokes physiological reactions. Findings showed significant VTA-mediated interaction of the NAc with the hypothalamus, insula, and orbitofrontal cortex.

Physiological effect of music on healthy subjects

Knight and Rickard¹⁸ demonstrated that relaxing music prevents stress-induced increases in subjective anxiety, systolic blood pressure, and heart rate in healthy subjects. Undergraduate students were exposed to a cognitive stressor task involving preparation for an oral presentation either in the presence of music, or in silence. Measures of subjective anxiety, heart rate, blood pressure, cortisol, and salivary IgA were obtained during rest and after presentation of the stressor. The stressor caused significant increases in subjective anxiety, heart rate, and systolic blood pressure in male and female controls. These stress-induced increases were each prevented by exposure to music. Music also enhanced baseline salivary IgA levels in the absence of any stress-induced effects. These findings provide experimental support for claims that music is an effective anxiolytic treatment. Miller et al¹⁹ evaluated the extent to which music may affect endothelial function. Endothelial function was assessed by brachial artery flow-mediated dilation (FMD). Self-selected joyful music was associated with increased FMD to a magnitude previously observed with aerobic activity or statin therapy. The authors concluded that listening to joyful music may be an adjunctive life-style intervention for the promotion of vascular health.

Anxiolytic effect of music in clinical scenarios

Coronary heart disease

White²⁰ examined the effects of relaxing music on elevated state anxiety in patients with a confirmed medical diagnosis of acute myocardial infarction. Statistically significant reduction in heart rate, respiratory rate, and state anxiety scores were found in the group that listened to relaxing music. Elliott²¹ conducted a randomized, controlled trial to test the efficacy of music and muscle relaxation techniques in reducing the anxiety of patients admitted to a coronary care unit with unstable angina pectoris or acute myocardial infarction. No significant reductions in anxiety were achieved for patients using music or muscle relaxation interventions when compared with the control group. Barnason²² studied the effects of music interventions on anxiety in the patient after coronary artery bypass grafting. No significant differences were reported for anxiety ratings. There were significant effects over time for heart rate and systolic and diastolic blood pressure, which indicated a generalized physiologic relaxation response.

A recent Cochrane review⁶ concluded that music listening may have a beneficial effect on blood pressure, heart rate, respiratory rate, anxiety, and pain in persons with coronary heart disease. This review stated that the quality of the evidence is not strong and the clinical significance unclear.

Perioperative scenarios

Several researchers have studied the role of music in the control of patients' anxiety in perioperative scenarios. Music can reduce the anxiety and stress of patients in the surgical holding area.²³ Augustin and Hains²⁴ demonstrated that music can be more beneficial than preoperative instruction alone in reducing ambulatory surgery patients' preoperative anxiety. Patients who listened to their choice of music before surgery in addition to receiving preoperative instruction had significantly lower heart rates than patients in the control group who received

only preoperative instruction. Differences in experimental and control group patients' blood pressure measurements and respiratory rates approached significance. In a controlled study²⁵, it was observed that music produced a significant reduction in anxiety and respiratory rates of women awaiting breast biopsy. Wang et al²⁶ evaluated the role of music in the management of preoperative anxiety through a randomized, controlled study. Patients who listened to music before surgery reported lower levels of state anxiety. Physiological outcomes (electrodermal activity, blood pressure, heart rate, cortisol, and catecholamine data) did not differ, however, between the study groups. A recent randomized controlled trial²⁷ demonstrated that exposure to music resulted in a statistically significant reduction of preoperative anxiety in patients undergoing day surgery.

Patients who listened to their choice of music during surgery with local anaesthesia experience significantly lower anxiety levels, heart rates, and blood pressure than patients who did not listen to music.²⁸ Allred et al²⁹ studied the effect of music on postoperative pain and anxiety following total knee arthroplasty. The music group's decrease in pain and anxiety was not significantly different from the comparison rest group's decrease in pain or anxiety. However, statistical findings within groups indicated that the sample had a statistically significant decrease in pain and anxiety over time. In a systematic review of 42 randomized controlled trials of the effects of music interventions in perioperative settings³⁰, it was observed that music intervention had positive effects on reducing patients' anxiety and pain in approximately half of the reviewed studies. The authors of this review stated that further research into music therapy is warranted in light of the low cost of implementation and the potential ability of music to reduce perioperative patient distress.

Ventilatory assistance

Chlan³¹ noted that a single music therapy session was found to be effective for decreasing anxiety and promoting relaxation, as indicated by decreases in heart rate and respiratory rate, in patients receiving ventilatory assistance. Wong et

al³² studied the effects of music therapy on anxiety in ventilator-dependent patients. Findings indicated that music therapy was more effective in decreasing state anxiety than was an uninterrupted rest period. However, blood pressure and respiratory rate showed no significant differences in the 2 conditions over time. A randomized controlled trial³³ indicated that patients on mechanical ventilation who listened to a single 30-minute session of music appeared to show greater relaxation as manifested by a decrease in physiological indices and an increase in comfortable resting behaviours. Recently, Han et al³⁴ confirmed that short-term therapeutic effects of music listening results in substantial reduction in physiological stress responses arising from anxiety, in mechanically ventilated patients.

Clinical procedures

Colt et al³⁵ observed that relaxation music administered through headphones to patients during flexible bronchoscopy does not decrease procedure-related state anxiety. Kotwal et al³⁶ demonstrated that the background Indian classical music is efficacious in reducing psychological distress during a gastroscopic examination. Smolen et al³⁷ examined the effects of music therapy on self-reported and physiological signs of anxiety among ambulatory patients undergoing colonoscopy. Their findings indicate that music therapy has the potential to reduce physiological indicators of anxiety and the need for sedation among individuals undergoing a colonoscopy. Listening to music during ambulatory colonoscopies decreases the level of anxiety that is inherent to the process without other anxiolytic methods³⁸.

Studies on the anxiolytic effects of music in the context of cardiac catheterization have yielded mixed results. Hamel³⁹ observed that patients waiting for their cardiac catheterization benefit from music therapy. Anxiety and the heightened physiological values elicited by the stress response are reduced. In contrast, Taylor-Piliae and Chair⁴⁰ demonstrated that the use of music therapy or sensory information did not significantly reduce anxiety, improve mood state, decrease heart or respiratory rate among subjects undergoing cardiac catheterization. Music therapy results in a statistically significant reduction in

anxiety scores in patients undergoing angiography procedures.⁴¹⁻⁴³

Obstetrics & Gynaecology

A randomized controlled study⁴⁴ has demonstrated that exposure to music resulted in significantly less pain and lower anxiety during colposcopy examination. A controlled trial by Chang et al⁴⁵ provides evidence that two-week music therapy during pregnancy provides quantifiable psychological benefits. Carefully selected music that incorporates a patient's own preferences may offer an inexpensive and effective method to reduce anxiety for antepartum women with high risk pregnancies who have been prescribed bedrest.⁴⁶ A recent randomized controlled trial⁴⁷ provides good evidence for the use of music as an empirically based intervention of women for labour pain and anxiety during the latent phase of labour.

Music therapy can reduce anxiety and create a more satisfying experience for women undergoing caesarean delivery.⁴⁸ Postoperative use of patient-selected music in caesarean section surgery alleviates pain and reduces the need for other analgesics, thus improving the recovery and early contact of mothers with their children.⁴⁹ A recent study by Tseng et al⁵⁰ does not provide evidence that preselected designer music reduced stress and anxiety levels among postpartum women.

Dementia

Results of studies on the impact of music on patients with dementia are controversial. According to Sung et al⁵¹, preferred music listening has a positive impact by reducing the level of anxiety in older adults with dementia. In contrast, Cooke et al⁵² have demonstrated that music does not significantly affect agitation and anxiety in older people with dementia.

Dental procedures

Soothing music reduces anxiety in patients undergoing root canal treatment.⁵³ Newton⁵⁴ demonstrated that relaxing music administered through headphones to subjects during root canal treatment decreased the procedure-related anxiety of the patients, but does not significantly

affect blood pressure and heart rate over the procedure.

Miscellaneous scenarios

Music has been shown to be effective in reducing anxiety and dyspnoea along with physiologic measures such as systolic BP, pulse rate and respiratory rate in COPD patients hospitalized with exacerbation.¹⁴ Guetin et al⁵⁵ confirmed the usefulness of music therapy in the treatment of anxiety-depression and mood in patients with traumatic brain injury.

The role of music as a therapeutic intervention for anxiety in patients receiving radiation therapy was studied by Smith et al.⁵⁶ No significant difference existed between the music group and control groups to suggest that music moderated the level of anxiety during radiotherapy. However, post-hoc analyses identified changes and trends in state anxiety scores, suggesting a possible benefit of music therapy during radiotherapy. Yilmaz et al⁵⁷ have demonstrated that music decreases anxiety and provides sedation in patients undergoing extracorporeal shock wave lithotripsy. Ferrer⁵⁸ investigated the effects of familiar music on the anxiety levels of patients undergoing chemotherapy treatment. Results of the study showed statistically significant improvement for the experimental group on the measures of anxiety, fear, fatigue, relaxation, and diastolic blood pressure. No significant differences between groups were found for heart rate and systolic blood pressure. Shabanloei et al⁵⁹ demonstrated positive effects of music therapy on pain and anxiety in patients undergoing bone marrow biopsy and aspiration. Music therapy significantly decreases the acute procedural pain, anxiety, and muscle tension levels associated with daily burn dressing changes.⁶⁰ Music can improve depression, anxiety, and relationships in psychiatric patients.⁶¹

Clinical implications of anxiety, elevated heart rate and blood pressure

Evidence suggests that people with anxiety disorders are at greater risk for developing a number of chronic medical conditions.⁶² Anxiety has now been implicated in several chronic physical

illnesses, including heart disease, chronic respiratory disorders, and gastrointestinal conditions.⁶²

Anxiety can produce disturbances in GI function.³ Research indicates an association between high anxiety levels and the development of IBS following a bowel infection.⁶² A high level of anxiety symptoms raises the risk of further coronary events in patients after MI by two to five times that for non-anxious comparison patients.³ High anxiety levels are associated with a tripling of risk of sudden cardiac death.³ In asthmatic individuals, high levels of anxiety are associated with increased rates of hospitalization and asthma-associated mortality.³

Elevated resting heart rate is a known, independent cardiovascular risk factor in healthy men and women.^{63;64} Epidemiological studies have reported that a high heart rate is associated with a higher risk of all-cause mortality and cardiovascular events.⁶⁵ Resting heart rate and BP proportionally raise the risk for type-2 diabetes mellitus.⁶⁶ Blood pressure of young individuals shows a significant association with cardiovascular risk variables and the occurrence of metabolic syndrome in young adult life.⁶⁷ Studies have demonstrated a continuous and graded relationship between 'normal' systolic blood pressure (SBP) and cardiovascular disease.⁶⁸ There is a linear relationship between normotensive SBP and risk of heart failure.⁶⁸

Conclusions

Music-evoked emotions modulate activity in the limbic system and hypothalamus, and can thus have a profound impact on autonomic and physiological responses. The anxiolytic effect of music in various clinical scenarios has been documented by several researchers. However, results are inconsistent across studies. Some studies on the anxiolytic effect of music in clinical settings have indicated dissociation between changes in the psychological and peripheral correlates of anxiety in response to music. Research on the impact of music on physiological processes in healthy individuals is not as abundant as research data on the therapeutic effects on music in the context of illness. Research on the role of music in disease prevention, health

promotion, and positive psychology is meagre. There is a definite shortage of published Indian research on the physiological effects of music. There are a number of individual and sociocultural factors that influence responses to music. Existing research data pertaining to the impact of music on health needs to be systematically replicated in the Indian context.

Recommendations for research

Rigorous randomized controlled trials need to be conducted on large samples to clarify and establish the role of music in disease prevention, health promotion, and positive psychology, in the Indian context. Existing research data pertaining to the therapeutic role of music in various clinical settings needs to be systematically replicated in Indian subjects, through randomized controlled trials. Prospective, controlled, follow-up studies are essential to test the long-term impact of music on health. Controlled trials are needed to compare the therapeutic efficacy of patient-preferred music with researcher-selected music. Future research on music therapy needs to specifically address issues such as music preference of the subjects, subjects' personal associations with the music, musical background ("musicality") of the subjects, and sociocultural variables. Studies on the anxiolytic or stress-relieving effects of music should routinely include objective biochemical measures of stress-induced autonomic arousal such as neuroendocrine variables. Functional neuroimaging studies on the neurophysiology of music need to be reproduced on a larger scale. Such studies would serve to elucidate and establish the neural pathways that mediate the impact of music on health.

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