An Exploration of Feasible Approaches to Soundscape and Music Therapy

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Abstract. Stressful and strained workplace settings are becoming more common in modern culture, significantly affecting employees' mental well-being and work productivity. The purpose of this article is to investigate the usage of soundscape in the workplace using music therapy. We will cover the present state of soundscape development in conjunction with music therapy possibilities, as well as merging the good effects of soundscape with music therapy interventions to build a unique emotional intervention program. We will also look at crucial elements and testing methods to consider, as well as how these can be incorporated and examined early in the program design process. Most importantly, our research aims to validate the feasibility of soundscape combined with music therapy methods for workspace applications in the hope of improving working population stress and emotional state through intelligent interventions, thereby improving the overall work environment and employee well-being, enabling employees to better cope with stress, increase productivity, and achieve a balance between work and life.

1 Introduction

Soundscapes are intriguing sound settings that can generate a serene, relaxing, or motivating emotional experience and have a powerful positive effect on mood. Music therapy is a psychotherapy method that uses certain sounds and music to affect the human psyche and cause useful interventions. It has been widely utilized for emotional management and recovery. Sound environment has been extensively researched during the last two decades, and soundscape has emerged as a major academic area. The concept of soundscape was first presented in the late 1960s, with roots in music and acoustic ecology, and it has since been subdivided by scholars studying various types of manifested soundscapes. Schafer claimed that all urban sounds should be studied, treating the acoustic environment as a field of study and defining the soundscape as a resource[1], a definition by which researchers have extended the study of the soundscape to a broader range of disciplines, particularly in areas of concern for human health and public sanitation, rather than simply viewing it as a separate source of noise[2]. Soundscape has shifted from an early emphasis on the physical characteristics of acoustic environments to a focus on human perceptual characteristics, and is based on the "acoustic environment as perceived or experienced and/or understood by a person or people, in context" as proposed by the international standard ISO 12913-1[3]. As a result, soundscape research focuses on understanding the link between humans and the acoustic environment, as well as investigating how individuals react to changes in sound and location.

2 Current Research and Development Status

Previous research has found that soundscape can have an impact on people's mood and health, with the goal of stress reduction for the working population. The current study has a review of studies that have transformed the negative impacts of ambient sound to positive impacts based on soundscape research, and the conclusions proved that positively evaluated soundscape can support recovery and quality of life, which is associated with better self-reported health[4]. Ratcliffe identified that nature sounds are frequently associated with pleasurable and relaxed affective states[5], and that after stress and/or fatigue, nature sounds and soundscapes can lead to subjective and objective improvements in emotional and cognitive performance.

Furthermore, research on soundscapes in many contexts has expanded in various ways, such as investigating the relationship between perception and acoustic aspects of urban soundscapes[6]; investigating the perceptual and emotional reactions to sound aspects[7]; Lindborg focused on the relationship between a restaurant's sound environment and perceptual feature relationship[8]; Solorio suggests using sound in workplaces to improve concentration[9]. Rossetti investigate acoustic settings and music therapy practice in hospitals, presenting the ideas of environmental music therapy (EMT) and musical soundscape interventions

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(MSI)[10], as well as the usefulness of music therapy in lowering stress in humans and relieving anxiety in patients.

We can infer from the studies above that there is currently noise masking of open workspaces to improve the quality of the soundscape, to reduce the loudness noise perceived by the listener[9], and the use of music therapy to contextualize soundscape by ordering and arranging them[10]. We propose combining music psychotherapy approaches with positively evaluated soundscapes to create a new design program that alleviates stress in the workforce by improving the soundscape of the workspace, improves workforce working conditions, and enhances well-being.

3 The Connection between Soundscape and Emotions

The definition of "soundscape" typically refers to all sounds in the region, encompassing both natural (e.g., wind, birdsong, water flow) and urban (e.g., car noise, human voices, machine sounds). According to several studies, conscious and subconscious sound sequences may influence the perception of acoustic settings, and constructing and predicting effective soundscapes results in positive ratings[2]. However, a few researchers have actively constructed and analyzed certain soundscapes to induce and steer human emotions in the design and practice of auditory environments. In reality, eliciting emotions is a fundamental component of soundscapes, hence it is critical to explicitly include emotions in soundscape study[11]. Numerous studies have been conducted on the relationship between music and the human brain and psychology. Music has a substantial impact on human emotions in a regular, organized, and intentionally generated manner, but the acoustic environment has a more subtle and sometimes unnoticed impact on emotions. A substantial corpus of literature exists that describes the neuroscientific basis for music's power to elicit emotion. demonstrating that music has neural mechanisms capable of eliciting emotion, emphasizing the importance of brain regions such as the prefrontal cortex, amygdala, and hippocampus in emotional processing, and pointing to music's ability to reduce stress or alleviate depression and anxiety[12]. As another example, the emotional properties of music (e.g., happiness or sadness) are widely used in neuroscience, with studies showing that the amygdala is associated with the processing of aversive stimuli, and that right parahippocampal activity is associated with unpleasant responses to dissonance[13], Positive emotions are associated with left striatal and insula activation at high arousal levels (surprise, joy)[14]. At the same time, dopamine-related structures in the brain become active during enjoyable listening, which proves that music may be pleasurable due to the release of more dopamine[15].

Koelsch described changes in neural activity in response to music in a similar way[16], demonstrating that music can elicit a wide range of emotions such as pleasure, sadness, excitement, and so on, and that these are realized not only through the various elements of music such as melody, rhythm, harmony, and timbre, but also through the acoustic properties of music. The acoustic properties of music and soundscapes are comparable. For example, roughness arises when the fundamental frequency or its harmonics are near the same critical bandwidth (i.e., too close to be well separated on the basement membrane)[17], and this roughness has been found to be a discordant and unpleasant aspect that causes a shift in emotion[18]. From a structural standpoint, the stability of musical structures such as tonic chords provides a sense of stability, but off-key chords away from the tonal center create tension, resulting in a sense of tension[19], As a result, we can use these features to the study and design of soundscape structures, such as incorporating urban sounds with natural sounds to determine whether the environment creates tension. In addition to research on brain structure and acoustic properties, participants' self-reported intensity of chills in pleasant situations was positively correlated with the degree of autonomic nervous system changes, including heart rate, respiratory rate, body temperature, and galvanic skin responses, characteristics that can better identify emotional and physical changes associated with sound[20].

We may utilize the research method of music's effect on emotion in the above study to explore the effect of soundscape on emotion based on the correlation between music and soundscape, the specific approaches include: 1. subjective assessment, which entails asking people about their emotional reactions to the sound environment, such as the pleasantness, unpleasantness, and excitability of the sound; 2. physiological indices, which physiological indices, such as heart rate, skin electrical activity, and electroencephalography, can be used to track people' physiological responses to specific sound environments. Individuals' physiological responses to various sounds, and these physiological indicators can provide an objective assessment of psychological state because emotion is frequently accompanied by physiological changes; 3. Behavioral observation, which evaluates emotion by studying a person's behavior in specific acoustic settings. Their facial expressions, actions, and voice, for example, can be examined to determine their emotional state. 4. Brain imaging, including functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), can be used in researching the impact of acoustic environments on brain activity and emotion[21]. 5. Dynamic data capture, the employment of perceptual devices to record individuals' emotional responses in various emotional experiences in various sound settings. This involves using voice recording devices, headgear, and smartphone apps to collect emotional data.

The area of soundscape research is currently being actively explored in various fields, including acoustic ecology, psychology, and musicology, and a greater understanding of the emotional impacts caused by soundscapes, as well as their measurability, would be a significant step forward for soundscape research.

4 Soundscape research methodology

The methods of soundscape research usually involve Soundscape Measurements, Soundwalk [22], Questionnaires, Interviews, and so on, and there are some studies that generate Soundmap to label and display the soundscape characteristics of architectural place iconography in the form of sound visualizations [23]. This study evaluates and designs the methodology for the program designed in this paper, as well as the selection of specific research methodologies.

4.1. Questionnaires

Questionnaires are a highly subjective way of assessment that is intimately tied to an individual's background and lifestyle. Researchers have explored the topic of "the emotional impact of high and low noise in an open workspace" using interview-based reports in previous experiments, and post-interview analyses have revealed that motivation to work is lower in a noisy environment[24], or produced a questionnaire based on an assessment of sound levels and acoustic comfort, identification of recognized sounds, and categorization of sound preferences to categorize sounds into wanted and disliked, and interviewed approximately 1,000 people[25]. All the previous trials demonstrate that questionnaires and interviews are viable and feasible methods of conducting soundscape research. Nonetheless, soundscape research technique remains limited in that there is no clear system of standardizing scales. To address this issue, the experiment described in this paper will combine the Music in Mood Regulation scale (MMR)[26] and 30 potentially positive sound factors that humans are exposed to in their daily lives (such as running water, bird calls, wind, and so on) into a questionnaire for subsequent assessment. Music in Mood Regulation (MMR) was chosen because it focuses on changes in mood, stressors or other causes of the original mood, and mood-inducing mechanisms, and it includes elements that maintain and enhance positive moods as well as several ways to deal with stress and negative moods (e.g., distraction, release, and comfort). We designed and evaluated two scales in the questionnaire section: a survey of positive voices, which was used to collect and organize categorization and sorting, and a scale of voice-influenced emotions, which was used to investigate and induce voice-influenced emotions in the population and was used with two scenarios for analysis and control. One is the outcome of participants whose voices influence mood after soundscape therapy, while the other is the outcome of participants whose voices do not have an effect on mood after soundscape treatment.

4.2 Soundscape Measurements

Soundscape measurement is a complex procedure that must be carried out based on human perception of the environment, necessitating the analysis of both physical phenomena and psychoacoustic perception[2] . To examine background sound levels, physical data can be collected with a sound level meter, or continuous measurements can be taken using devices such as multiple Acoustic Recording Units[27]. Current research on soundscape measurements includes one-minute A-weighted Leq (equivalent continuous noise level) measurements of plaza spaces and other microclimate indices[25]. Additionally, investigations have been conducted by extracting one hour of office noise from a multichannel recording, editing, and reproducing it in a test room equipped with eight loudspeakers (two at each wall and one subwoofer) and other microclimate indices set for both high and low noise conditions[24]. Torija et al. used hierarchical cluster analysis with 15 semantic difference attributes and acoustic descriptors (equivalent sound-pressure level, maximum-minimum sound-pressure level, impulsiveness of the sound pressure level, sound-pressure level time course, and spectral composition) to carefully measure and evaluate the impulsiveness of sound-pressure levels, maximum-minimum sound-pressure levels, and acoustic perceptual differences[6]. To make a careful distinction between different soundscape types, we can measure the sound pressure level of the workspace in the subsequent study, aiming to analyze the noise mean value while also discovering and organizing the pressure of the working population in the environment of different sound-pressure levels.

4.3 Physiological Measurements

Physiological measurements can be effective in validating the feasibility study of sound on stress, for example Thoma et al., assessed salivary cortisol and salivary alpha amylase (sAA), heart rate (HR), and respiratory sinus arrhythmia (RSA) in subjects and concluded that sound can influence stress changes[28]. Additional studies have collected data before and after 15 minutes of listening to specific sounds, including muscle tone (EMG), pulse rate, and self-reported stress[29], as well as measuring galvanic skin responses during stimuli exposure combined with verbalization of the participants to measure the effect of sound on mood[7], and we collected physiological data such as heart rate (HR) and respiratory sinus arrhythmia (RSA) and determined that sound can influence stress levels. As a result, our physiological data measurements, such as heart rate, breathing rate, and electrical skin activity, can be efficiently assessed in terms of stress recovery, relaxation, and stress reduction, and the effect of sound on an individual's physiological condition can be measured accordingly[30].

In addition to physiological data measurement, electroencephalographic measurements are frequently used as an important tool, such as the use of electroencephalographs (Nexus10, Mindmedia) to measure indices of deep brain activity levels in comparing the effects of different ambient noises[31], or the use of functional Magnetic Resonance Imaging (fMRI) to explore the impact of listening on the brain at different noise levels, arguing that noisy tones elicit more intense motor and limbic responses than non-noisy

tones[32], as well as further research into the practice of sound-evoked emotional experiences[14].

5 Experimental design for Soundscape integrated Music therapy

The Guided Imagery and Imagination (GIM) approach practiced through music is one of the more effective music therapy approaches to stress relief, and Koelsch suggests that the use of the tension/resolution model of Western tonal music in the Guided Imagery and Music approach to enhance the balance needed for wellness is an important rationale for this paper's study of the integration of music therapy and soundscape approaches[33].

This method has been used in conjunction with soundscape factors to try to demonstrate a correlation between musical structure and the mental images of music produced by specific perceptions[34], which is based on body schema to understand the sensations produced when listening to music, visualizing the sensations of the human experience, of invisibility, and demonstrating that some of the processes involved can be explained in words and images. some of the processes involved[35], and based on this psycho-perceptual transduction, analyze and direct the visitor's status in a specific way. We designed a usable scenario for future research on the combination of soundscapes and music therapy based on this music therapy approach and the proven feasibility of combining it with soundscapes: assessing and categorizing people's preferences for soundscapes through questionnaires, and then asking music therapists to set up an intervention process and a few interventions based on the research results, and then providing specific interventions and services. Specific interventions and analyses were carried out, and changes in stress measures were noted during the intervention period, with the specific processes being as follows:

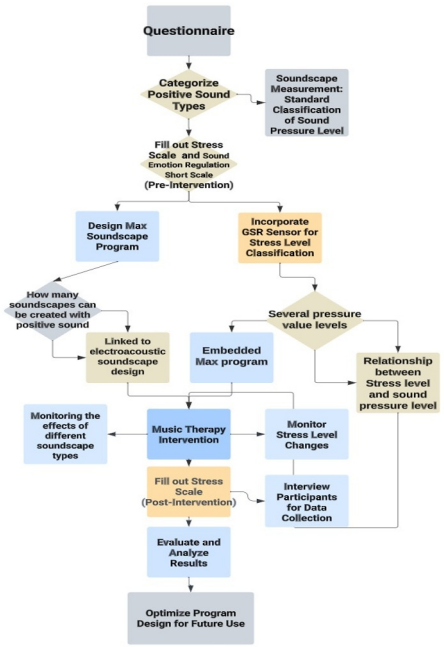

Fig. 1. Project Design Flow chart.

1) A questionnaire survey was conducted and analyzed to determine the target population's age range of 20-40 years old, while actual sound pressure level measurements were taken on the target environment (work scene space), and the soundscape was designed to meet the specific environmental needs based on the soundscape environment assessment results. On the one hand, the soundscape will include many scene variants, and we will record or mime three scenarios (forest, cliff, and beach) to create the core setting. On the other hand, must be designed by integrating the acoustic elements of the soundscape with electroacoustic musical elements to create electroacoustic effects such as granular delays, multichannel diffusion[36], to ensure that it meets the environmental requirements.

2) The type of soundscape and the intervention technique were determined. The soundscape was created using audio equipment or tweaked on-site by a music therapist using the Max/msp design soundscape improvisation tool[37]. The music therapist's assessment of the soundscape should continue by incorporating the noise level of the space and the general psychological state of the space (tense, calm), as well as noting the participant's prominent features, such as body language, gestures, and facial expression[10]. With the non-disturbance principle being followed to improve the ambience. Finally, the intervention was designed to last 30 minutes at a time, three times a week, over a two-month period.

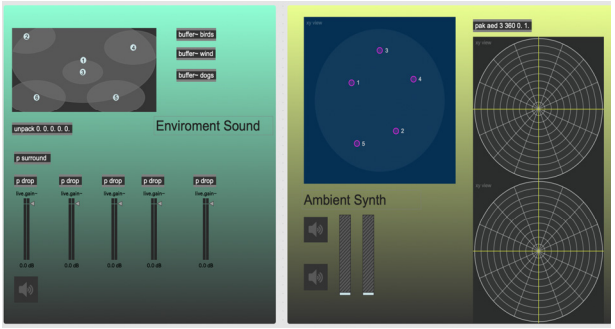

Fig. 2. Surround Sound Effect and Electroacoustic Synthesis Soundscape Creation Illustration: Setting up an ambient soundscape using [nodes]object, creating electroacoustic ambient effects using [ambiencode~] and [ambidecode~] object as well as sound synthesis.

3) The impact of the musical soundscape intervention on the environmental climate and the emotional state of the individuals was looked into in the third step of the intervention, which included data collection methods and physiological measures measuring the galvanic skin response (GSR). The first includes observation, feedback, and surveys, whilst the latter employs sensors and other physiological data from the population's galvanic skin response (GSR)[38] to obtain stress indices for actual assessment. The specific intervention process is as follows:

At first, an Arduino and Grove GSR sensor are used to create a sensor device that obtains the value of the crowd in a normal state (no stress), which is used as the baseline, and then monitor the value of the crowd's stress

in the working environment, which is classified into four states of light, medium, heavy, and no stress as the given value to be passed into the Max program, which provides feedback immediately after obtaining the value, and then arranges and combines the different indices. Max obtains the values and provides immediate feedback, arranges, and combines the sound objects collected from different indices and the pre-questionnaire results that are effective for stress relief, and performs three random combinations of soundscape environments based on different environmental conditions. The program employs a surround sound effect that necessitates the operation and execution of multiple angles of speakers at the same time, while also producing improvised clips based on the electro-acoustic soundscape combined with environmental sound to create an ambient effect, and testing the change of the pressure value in the scene's consciously controlled environment. The program is intended to be carried out primarily since pressure value adjustments and sound arrangement and planning, with the goal of determining whether the soundscape effect can have a practical influence on the psychological strain of the working population. The music therapist evaluated the effects of the given space's soundscape, the dynamic changes in the participants' external characteristics, and the values of the stress data emanating from the Max program during this process and derived a basic evaluation data form to document the impacts of the intervention.

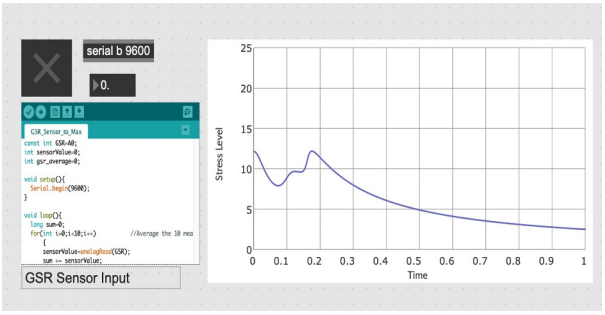

Fig. 3. Graphical representation of the variation of the measured pressure values: This graphical representation uses the GSR Sensor connected to the Arduino to pass the data into the Max program to visualize the pressure values via the [plot~] object.

4) The effects of the intervention were quantified after the intervention, using a stress scale survey such as the Perceived Stress Scale (PSS)[39]. Participants completed the scale twice before and after the intervention to assess changes in their stress levels, and the effects of soundscape stress relief under music therapy were also analyzed based on a combination of physiological data measurements before and after the intervention, as well as the results of the pre-sound affecting mood scale questionnaire. In addition to quantitative data, the working population's free opinions and feedback on the soundscape environment were gathered to capture their subjective impressions.

5) To determine the effectiveness of music therapy with the working population, physiological and psychological data was evaluated. The physiological and psychological data were analyzed to determine the effectiveness of music therapy for the working population, and the emotions associated with the different sound types were identified and represented so that the environmental data could be directly correlated without the intervention of a music therapist later, and the soundscape program could be optimized to be more versatile and efficient in relieving and improving the working population's stress. It is important to mention that this project necessitates a simulated workspace intervention, i.e., an assessment of the effects of the music therapist's soundscape in a recorded workspace to analyze the effects on stress, followed by a soundscape program set up to test the effects of stress in the actual workspace based on the data and results of the intervention.

There are already relevant soundscape settings in work scenarios, such as measuring the effects of water features on attention and pleasure in the workplace[40], as well as the effects of natural ambient sound and music design on attention[9], so we evaluated the physiology and psychology of the participants individually based on the relevant studies with the data actually evaluated by the music therapists to obtain more complete and rich data support for future research.

6 Conclusion

This article studied the idea of combining soundscape and music therapy to decrease workplace stress, with the intention that it can be used in the workplace for more measurement and practice in the future. We can see from researching soundscape and music therapy that, while there are many soundscape reviews currently, there are still many possible circumstances for practical usage in the environment and in life. The design of this program can be combined with artificial intelligence methods after the operation is mature, for example, soundscape intervention through the measurement and accumulation of data can be carried out through the numerical value and the corresponding keywords to the actual intervention, which can not only reduce the intervention cost of the music therapist but also through artificial intelligence to achieve the integration of the intervention effect, in order to seek for the future in a variety of scenarios, space, and multiple perspectives in the application of the actual life of human beings.

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