Sonic therapy for anxiety management in clinical settings

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Abstract
Traditionally, healthcare facilities have been designed from a practical standpoint providing efficient spaces for laboratories and increased numbers of rooms to accommodate beds for patients. Such an approach has often led to facilities that "function effectively" but can indirectly create an atmosphere that is stressful, undermining the psychological needs of patients. This research uses an interdisciplinary approach combining immersive environmental sounds constructed as auditory journeys and biofeedback to help manage anxiety and stress in clinical settings. A study was designed exposing 55 patients experiencing anxiety and stress to the auditory journeys. Physiological measurements of skin conductance level (SCL) was used to index parasympathetic activation. Heart rate (HR), and heart rate variability (HF HRV and LF HRV) were used to index sympathetic activation. Although HR, HF HRV, and LF HRV showed no significant effects, the results from SCL were highly significant, suggesting that auditory journeys may assist patients with anxiety management.

Author Keywords
Clinical settings; anxiety; biofeedback; physiology; immersion; environmental sounds.

Research Inspiration

The inspiration for this research came about from the extensive work conducted at Simon Fraser University by researchers from the World Soundscape Project (WSP), in conjunction with the possibilities from emerging technological approaches such as biofeedback and virtual reality (VR). VR especially is of interest because of the level, or depth, of immersion, one can experience through creating a perceptual change in environment. The goal is to produce a similar result – a dramatic change in perception – through the act of listening, but without the aid of visuals or head mounted display (HMD). The justification of explicitly using sound is to reduce the complexity (including cost, and ease of use) of implementing a non-invasive approach for anxiety reduction in a clinical environment.

ACM Classification Keywords

H5.2 Auditory Feedback, User-centered design, Theory and methods

Introduction

For over a hundred years, sound therapy devices have been used for the purpose of distraction and healing. Some people feel that using sound enrichment can bring about physiological changes in sensitivity in the hearing parts of the brain, while others believe it acts as a mental distraction or an aid to relaxation [1]. In clinical environments, research has shown that patients recover faster when looking at natural settings through a window [2]. Furthermore, while some have reported greater restorative experiences when exposed to natural environments, research exposing patients while waiting in clinical settings to environmental sounds via immersive auditory journeys is limited.

Clinical Environments

One of the goals for promoting wellness includes the creation of a "psychologically supportive" environment [3]. While the effects of incorporating such supportive design may fast-track the healing process, the scientific research on psychologically supportive health design remains limited. A study has shown that a well-designed healthcare facility may increase positive emotions, which may improve the patients' health and wellbeing [4]. Although doctors and other healthcare providers are aware of this problem, implementing a system that is easy, affordable, and non-disruptive to the pattern of healthcare can be very challenging [5]. In addition, designing a system that is user-friendly and provides affordance to patients who vary in age, medical symptoms and exposure to technology can be extremely challenging. We therefore must look to other disciplines and theories that may help address this limitation.

Therefore, the present study explores the therapeutic potential of using immersive auditory journeys as a therapeutic intervention to improve patient recovery from anxiety and stress.

Anxiety & Stress

The level of anxiety we experience, whether acute or chronic, can take a toll on the brain. Allostatic load or overload refers to the damage caused by stress, or it can refer to it as the wear and tear on the body and brain that results from constantly having to maintain balance or allostasis [6].

Anxiety brought upon by long wait times and noise in clinical environments can produce additional side effects for patients. One important element is that time perception can change according to the level of anxiety experienced by patients. For example, those with higher levels of anxiety give longer estimates of wait times and find intellectual tasks such as completion of diagnostic assessment forms challenging and time consuming [7]. However, if anxiety levels are controlled, then shorter estimations of time are perceived and patients may experience reduced allostatic load [8]. As the perception of waiting time increases, customer satisfaction tends to decrease [9, 10]. Due to the number of outpatient visits and capacity of hospitals and clinics, it may not be possible to reduce time for patients. However, this research may provide an opportunity to positively influence the experience of patients through anxiety management.

	State Score	SD
Female	42.21	10.06
Male	44.51	8.74
	Trait Score	SD
Female	45.44	11.08
Male	43.05	10.92

Table 1 Results of the STAT score for female and male participants.

Based on the means, both female and male participants were experiencing a moderately high level of anxiety prior to the listening phase.

Physiological Measure	Paired samples *t* test	P Value
HR	t(54)= -1.965	.055
HRV (HF)	t(54)= -.785	.436
HRV (LF)	t(54)= -1.920	.060
SCL	t(54)= -4.922	.000

Table 1 Results of the paired samples *t* tests for the physiological measures.

Designing Immersive Sonic Journeys

In this research, we use the theory of acoustic communication developed by Barry Truax as the underlying mechanism for creating distraction and immersion to help improve the psychological experience of patients waiting in clinical environments. Attentive listening is required and this level of engagement causes an arousal of central cognitive and motivational processes. The act of listening allows the patient to be distracted from their current state of pain and anxiety similar to virtual reality-based interventions and mindfulness meditation techniques [11, 12].

Specifically, binaural audio recordings of environments are recorded and facilitated to patients via headphones. The goal is to create a perceptual change using these recordings in the environment that the patient is situated in while waiting to see the doctor.

To verify this anticipated outcome, medical grade biofeedback sensors are used to measure the physiological changes associated with anxiety and stress while the patients listen to soundscape compositions.

Participants

For this study, participants were recruited from three locations: Fraser Health Chronic Pain Clinic, St. Paul's Hospital Gastroenterology (GI) Clinic, and a private complex pain clinic located in Vancouver, Canada. These patients were situated in a designated room waiting to see their doctor or nurse.

Fifty-five patients participated in this experiment (34 women and 21 men, mean age = 49.8 years).

Experimental Design

The experiment was broken into three phases: (1) A pre-listening background questionnaire, (2) a 5-minute auditory journey listening session, and (3) a follow-up post-questionnaire phase bringing the total time for the experiment to approximately 20 minutes.

Pre-Listening Phase

In the pre-listening phase, participants were asked to complete a State-Trait Anxiety Inventory (STAI), commonly used in clinical settings to measure and diagnose trait and state anxiety [13]. The scale has 20 items that assesses trait anxiety which is a general long-term quality of experiencing stress and 20 for state anxiety which is a temporary condition of feeling stress. The completion of the pre-listening phase was estimated to take 10 minutes per participant.

Listening Phase

Patients were administered five environmental recordings to test how the compositional structure of each auditory journey may affect the listening experience, anxiety, and physiological responses. Each recording varied from calm and serene environments to more active and hyper-mediated environmental sounds with the inclusion of meditative drone sounds. In a previous, study, we had concluded that the use of headphones with no sound (playback of auditory journey) did not influence the patient's experience [14].

Post-Listening Phase

In this experiment, we measured the subjective experience of participants in the post-listening phase by creating an immersion questionnaire that includes

questions specific to immersion, flow, presence, and cognitive absorption.

Physiological measurement

Skin conductance level (SCL) and the skin conductance response (SCR) was used to measure sympathetic activity. Heart Rate (HR) and Heart Rate Variability of a high frequency (HRV HF) was used to detect parasympathetic changes. Lastly, the low frequency of HRV is sometimes used to measure both sympathetic and parasympathetic activities [15].

Thought Technology medical grade biofeedback equipment was used to capture and record the physiological data at 1000 Hz. Statistical analyses were conducted in SPSS 20.

Results

Based on the data captured, a statistically significant change of SCL was identified suggesting that patients can experience anxiety reduction via activation of the sympathetic nervous system. We analyzed the time difference by computing the mean of the first minute (seconds 0-60 of the baseline period) and the mean of the last minute (240-300 seconds of the x period). The results revealed a significant reduction in the SCR based on the first minute (m=1.55, SD=1.49) and last minute (m=1.10, SD= 1.25), $t(54)=-4.922$, p=.000. In addition, the qualitative responses support the physiological data of participants feeling more relaxed after listening.

The results also showed heart rate and heart rate variability were unaffected, and therefore parasympathetic activation may not be affected by listening during stress recovery (see Table 1). Since parasympathetic responses are meant to control homeostasis and control the body's response while at rest, it may be useful to test the relationship between parasympathetic activation and listening to the auditory journeys in a post-surgery scenario.

We also identified that there was no statistically significant difference among the journey types. One reason may be that a larger group size is required for each journey type to show a clearer distinction in the physiological data and the qualitative reporting.

In addition to measuring physiological changes, we wanted to investigate the role of immersion and other similar perceptual experiences such as flow, presence, and cognitive absorption. Nineteen perceptual questions were created based on previous studies [16]. Included was a single question to measure for immersion (e.g. rate how immersed you felt from 0–10) and a mixture of questions combining aspects of flow, cognitive absorption, and presence.

Through our questionnaire, we were able to obtain a result that showed the experience of immersion does occur while listening to these specific recordings (see tables 3&4). The mean results from the single immersion question show that overall the participants felt immersed listening to the various recordings (m = 7.16, SD = 2.15). Personality traits and cultural attachment to sounds may also impact the level of immersion. Participants who had an openness to experience listening to such immersive recordings reported were able to visualize themselves walking in the forest and hear specific sonic details of the environment.

Experience of Immersion (0-10)	Mean & SD
Journey 1	7.5 (2.32)
Journey 2	8 (1.47)
Journey 3	6.6 (1.95)
Journey 4	7 (1.51)
Journey 5	6.5 (3.14)

Table 3 Mean values for each journey related to immersion question.

Combined response (0-5)	Mean and SD
Presence	3.5(SD=1.33)
Flow	3.51(SD=1.32)
Cognitive Absorption	3.22(SD=0.85)

Table 4 Combined mean values for Presence, Flow, and Cognitive Absorption.

Conclusion

The results of this experiment revealed that the patients may experience anxiety reduction while waiting in a clinical environment by providing a method of distraction using immersive audio recordings. In addition, this research could provide an opportunity for healthcare practitioners and institutions to provide an easy non-invasive system to patients to help with anxiety and stress management while waiting in a clinic or hospital.

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