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Influence of soundscape and interior design on anxiety and perceived tranquillity of patients in a healthcare setting

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ABSTRACT

Tranquillity characterized by a pleasant but calming environment is often to be found in natural environments where man-made noise is at a low level though natural sounds can be relatively high. Numerous studies have shown a link between such restorative environments and hospital recovery rates, stress reduction, longevity, pain relief and even how the brain processes auditory signals. In hospitals and primary care facilities there is a need to improve patient waiting rooms as current designs are largely based solely on medical need. There are often long waits in such spaces and patients are coping with the stress and anxiety caused by their medical condition. Attention should therefore be given to creating "restorative environment" as a component to their medical treatment. The study describes the effects of introducing natural sounds and large images of natural landscapes into a waiting room in a student health center. Using self reported levels of anxiety and tranquillity it was possible to assess the impact that these targeted auditory and visual interventions had in affecting the quality of the patient experience. Following the changes results show that levels of reported tranquillity were significantly improved but there were smaller change in reported reductions in anxiety.

1. Introduction

Tranquil spaces are often natural environments where man-made sounds are not dominant. Past research has shown that such environments improve hospital recovery rates, reduce stress, improve longevity, reduce pain and can affect how the brain processes auditory signals [1–6]. A useful and comprehensive overview of this area of research has been provided recently [7].

Previous work on elucidating the tranquillity of environments has largely focused on prediction and validation using the Tranquillity Rating Prediction Tool, TRAPT [8–11]. This prediction method includes two important factors: the level of man-made noise and the percentage of natural and contextual features in the visual scene. The percentage of natural features in the landscape includes vegetation, water and geological features e.g. exposed rock outcrops. Contextual features include listed, religious and historic buildings, landmarks, monuments and elements of the landscape such as traditional farm buildings and dry stone walls that directly contribute to the visual context of the natural environment. Examples of excluded elements are: built up areas, energy infrastructure (such as pylons, wind turbines and dams), transportation infrastructure and recreational facilities These human artefacts introduce an element of visual discontinuity within the landscape that can result in a perceived lack of contextual coherence [12].

Based on these factors TRAPT allows the prediction of the tranquillity of a place on a 0–10 scale. It is proposed to extend the model to inform the design of interior spaces and especially in healthcare centers where it is important to reduce stress to facilitate better mood, well being and outcomes of treatment. The method proposed involves intervention research where changes are made in a live setting and evaluations are obtained from users of the facility. Note that the approach adopted here departs from *some* architectural practices in that the proposed study to inform design of restorative spaces is evidence based and certainly does not try to capture the latest trends of fashionable design.

Among other facilities in hospitals and primary care facilities there is a need to improve patient waiting rooms as current designs are largely based solely on medical need. From previous experience there are often long waits in such spaces and patients are coping with the stress and anxiety caused by their medical condition. Attention should therefore be given to creating "restorative environments" as a component to their medical treatment. All too often a lack of understanding of the influence of interior space on

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well being and budget constraints have led to the adoption of "hard" architecture consisting of plain walls and ceilings, little or no wall art, no greenery or flowers and little consideration of the view from the windows, if incorporated. Further the acoustic environment or soundscape is often characterized by consistently high sound levels due to reflections from hard surfaces of noise emitted from people and equipment; such as mobile phones and monitoring apparatus. Almost it frequently appears that little consideration is given to noise reduction strategies despite detailed hospital guidelines on noise control [13]. There are a number of studies that illustrate these problems. For example, in the reception area at the entrance to a hospital emergency department levels of L_{Aeq} ranged from 65 to 73 dB(A) due to the constant flow of patients, doctors, nurses, and moving equipment [14]. However, sound level is only one aspect of the soundscape. In order to improve healthcare environments it is important to understand the role of sound and to determine what may be positive, negative, and the feelings that different soundscapes can evoke [15]. Therefore it should be relatively easy to identify such areas within current designs of many primary care centers and hospitals, though exceptionally some designs may already be informed by such considerations and there may be little room for improvement.

2. Method

2.1. Study area

The Bradford Student Health Service (BSHS) located within walking distance of the University of Bradford campus has a waiting room that fitted well with experimental requirements since it was necessary to treat an area which was reasonably well isolated from the rest of the facilities so that the effects of any environmental "treatments" that are applied as part of the study are not contaminated by sounds or views from outside the study area.

The treatments that was applied to the room was limited by a consideration of the needs of staff, doctors and the Practice Manager, plus the budget available and the time constraints. Obviously the size and quality of the impact of any treatment will depend on the number of improving factors introduced and their scale.

Fig. 1 shows a dimensioned plan (in meters) of the waiting room. Seating was arranged around the edges of the room and there were 4 noticeboards where health related notices were displayed. In a prominent position a monitor screen gave patient prompts as appointments became due. The room has an ordinary shoe box shape with the exception of a reception area. The room volume is approximately 75 m^3 and the average reverberation time measurement (RT60) for the room was 0.55 s. This was the average of three measurements made with B&K 2165 microphone and Nexus amplifier connected to PC running winMLS at 48 kHz sampling rate. The impulse sound source was produced by bursting a balloon. This reverberation time for the waiting room was considered to be within acceptable limits for the use intended. The cushioned seats and sound absorptive ceiling would have contributed to this relatively low value.

2.2. Treatment applied

The following are the adjustments that were made to the room.

Auditory factors: Reduction of disturbance from loud conversations and mobile phone use by posting prominent notices on a low table in the middle of the waiting room and reception counter indicating "Quiet zone".

Introduction of natural sounds such as water sounds. Earlier work has demonstrated that this should be as natural as possible [16] and a low *level* but audible. Good examples would be recordings of a babbling brook or of waves breaking on a beach rather than high powered fountain noise or water falling into a culvert, so the effect is subtle throughout the space. It was decided to use the sound of sea waves on a beach and to facilitate the choice of 12 recordings taken around the coast of Britain (available from the British Library [17], these stimuli were evaluated by 14 volunteers. After a practice session the participants rated the tranquility of each recording on a 0–10 scale of tranquillity. It was found that the differences between sounds were highly significant ($F = 13.66$, $p < 0.0001$). The recording considered on average as most tranquil was the sound described as "gentle waves on sand and shingle", and was the one chosen for the study. This was replayed under the "adjusted" condition through speakers indicated in Fig. 1 spaced to be heard throughout the waiting room. This sound replaced the radio station ("Pulse") playing popular music under the "as is" condition. The comparison of typical sound signals is presented in Fig. 2 which include time histories and spectrograms. The sounds produced from the waves on sand and shingle are showing a well defined modulation with an average period of approximately 3 s and containing higher frequency components compared to the sound of Pulse radio station.

Visual aspects: Changes were made to the visual aspects of the design by introducing large photographs of natural landscapes that completely covered the 4 noticeboards that had previously contained health related posters and leaflets. Twenty high quality natural images of landscapes and seascapes considered tranquil were purchased from the internet [18]. These were then shown to 46 volunteers who were asked to rank them in terms of tranquility. The differences between images were highly significant ($F = 8.90$, $p < 0.0001$). The 4 most highly ranked pictures were then used to prepare large high quality photographs to cover the noticeboards. Fig. 3 shows three of the notice boards before and after the changes were made. Two scenes showed coastal views, one looking across a lake and the fourth showed daffodils in a park with tree blossoms.

The chosen views contained no obvious buildings, infrastructure or people, thus allowing natural elements, such as of water, rock, sand and vegetation to *completely dominate each scene*. In addition to these natural images fresh flowers (potted Chrysanthemums) were placed on ledges and the central table. Under both conditions the view through the windows was through vertical blinds and this was not altered. Some areas of grass and sky were visible as well as a small area of trees in the background.

2.3. Experimental design

The methodology was to introduce these changes sequentially and for each treatment a questionnaire survey of patients was carried out in the waiting room. The proposed design allowed two basic designs to be considered. They were:

Week 1: "as is" – this is the room as found prior to any treatments.
Week 2: With visual and acoustic adjustments termed "adjusted".
Week 3: "as is" – reverse all adjustments.

Two "as is" assessments were included to enable a repeated measures design to be employed.

The two basic designs comprised:

(i) Matched pairs where participants under each condition were matched on age and gender.
(ii) Repeated measures where participants recruited on their first visit to the center agreed to return on other days to complete the questionnaire under each condition but where in each case they were not booked for a medical appointment.