Being of Sound Mind: Predicting Emotional Responses to Noise

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ABSTRACT
Experiments have shown that neural activity of listeners during noise events can be measured using an electroencephalograph (EEG)[2]. This is anticipated to correlate well with a listener's emotional response to different noise sources. This poster is based on experiments to investigate the correlation between sounds we experience and the moods we feel using both qualitative and quantitative collected data; perceived versus neural response. With this data, planners and designers can assess or 'tune' an environment to optimize the health benefits in terms of noise. The model can answer design questions like 'what is the optimal building arrangement for a development to maximize an external, tranquil space?'.

KEYWORDS
Acoustics, applied mathematics, health science, EEG.

1 INTRODUCTION
Environmental noise has documented effects upon health, wellbeing, and quality of life. Whether listening to an orchestra or running from a siren, we are typically aware of how different sounds make us feel. With increasing pressure on the resources of health service providers and more patients than ever before, creating an environment conducive to good health and recovery is of upmost importance. Perceived annoyance is often measured through surveys to understand the quantity of noise effects, but a gap in knowledge remains in determining whether there are neural markers that also describe noise effects to an accurate degree.

Our study involved 35 participant whom were asked to listen to a series of first-order ambisonic recordings of urban environmental soundscapes while EEG data was gathered through wearing a specialist headset. The stimuli were played back through an ambisonic loud-speaker array at calibrated sound levels within the Arup SoundLab™ facility in Manchester to give an aural experience similar in level to the original sounds as recorded outside the laboratory environment [1]. Perceived annoyance was also gathered using the ISO 15666 scale to later compare the EEG results to a more qualitive response [2]. From the initial survey, we can look at the mathematical quantities through computational process that relate emotion to sound frequencies

2 PROPOSED SYSTEM
Focusing on specific levels of the data gathered meant that we are more likely to gain a desirable outcome, namely homing in on the alpha and beta levels in the EEG (Figure 1) separated over two-second time intervals. These much smaller segments allowed us to analyse specific patterns in the frequencies received from the numerical values. A measure of loudness, sharpness and MFCC was then also conducted to see the effects and filtering out based on the results so that a smaller spectrum of sound features can be analysed.

Once the filtering of data is complete, work began on training a regression model with weighted vectors for EEG activity, acoustics features and self-reported annoyance to demonstrate how such vectors can correlate together.

The model shone light on what was a factor in causing an emotional response from noise and allowed us to use other noise sources to compare results that were not initially measured. There was a clear indication the frequencies broken down into their subcategories do have a certain acoustics correlation regarding people's perception of noise, thus later allowing for a wide use of applications in consultation between built environment and the public's health.

3 FURTHER WORK AND APPLCATION
While some level of certainty in our hypothesis was achieved, the lack of quantitative data in responses compared to qualitative data (based on the processible data versus the opinions of participants at the time of recording) meant that the accuracy of each predictive measure from the overall experiment was lower than desired and more data needed to be gathered to be conclusive in the early stages.

From the data we collected, using a microphone using raspberry pi, we can predict a listener's likely EEG response to any sound based on the acoustic measures and general correlation observed in this study. This response can be plotted in terms of alpha and beta band power on an output display.

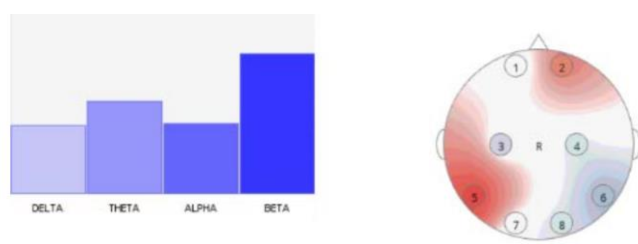

Figure 1 Spatial distribution of activity and bandpower analysis from participant #35

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