Facades of building significantly modulate EEG signals of brain cortical lobes

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The cognitive approach towards architecture can make communication path between architecture and neuroscience. It concentrates on neuro-architecture researches. This paper investigates the effects of architectural elements of building facades on emotional behavior. We analyzed the effects of those elements in 3 categories: geometries, materials and proportions. The purpose of this paper is to distinguish the effects of building façades elements on lobes & signals of the brain.

I. EXTENDED ABSTRACT

Architectural objects are a part of constituent elements of the environment that significantly affect the emotional behavior of human life. Building facades are an important basic pattern for the structure of buildings and provide an impressive view of cities. This study experimentally investigated the influence of the constituent elements of the building facades on the population brain signals and behavioral reactions of human subjects. EEG signals were collected by g.tec data acquisition (64 channel electrodes) from 18 human subjects (male students; 23 to 26 years old) when the façades of the buildings were presented on the screen located in front of subjects (70 cm). It should be mentioned that the facades appeared on the screen were modeled with 3d max software. The EEG signals were low pass filtered (< 250 Hz) with a fourth-order Butterworth filter, and a fast Fourier transform (FFT function in MATLAB; version 2013) was used to convert the EEG signals into different frequency bands: delta (0.5-3 Hz), theta (3-7.5 Hz), alpha (7.5-13 Hz), beta (13-31 Hz), and gamma (31-100 Hz) frequencies. We also used WICA and a Butterworth notch filter for removing eye-blinking artifacts and the 50 Hz noise, respectively. Finally, the mean power at different frequency bands of EEG signals was studied in different lobes of the brain. We investigated the modulation of human brain activity by showing three categories of building facades including geometries and proportions of windows and materials used in the facades of buildings. The primary results show a significant increase in beta frequency oscillations in occipital and parietal lobes when the pleasant facades of the geometry of windows and materials were shown on the screen ($p<0.001$, t-test) and an inversely significant decrease in beta frequency oscillations when the unpleasant facades were presented ($p<0.001$, t-test). Moreover, the proportion of windows with arcuate and rectangular shapes in a horizontal stretch generated an inversely relation in theta frequency oscillation between small and large proportions. Pleasant and unpleasant expressions of facades were identified according to the subjects responses however the squared windows were perceived as neutral facades.

2. REFERENCES

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3. AUTHOR BIO

Parastou Naghibi Rad is an architecture graduate student. During her MSc studies, she was familiar with ANFA. At that time she started her research in the area of neuroscience and architecture. Therefore she followed her M.S. thesis in neuro-architecture. She began to work in Institute for Research in Fundamental Science after her graduation. She has continued her research in neuro-architecture with neuroscientists, electro physiologists and biomedical engineers. Her research focus is on EEG and visual cortex neural signals in users of urban spaces.