

# Urban Planning, Neurosciences and Contemplation for improving well-being in our cities

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**ABSTRACT:** This paper presents the results of a pilot experiment which is a part of research attempting to prove that specific space-design strategies can induce contemplative states, as indexed by neurophysiologic measures of mindfulness. This study establishes an important dialogue between artistic and scientific disciplines: landscape architecture, urban studies, neurosciences and traditions of meditation, for finding methods that will enable improvement of well-being in cities by urban green open space design. The innovative part of the investigation is usage of EEG (electroencephalography) laboratory methods for evaluation of impacts of designed urban landscape settings on brain and mental states. This interdisciplinary approach is to create a tool for contemplative space design. It shows how to implement these findings in a design practice by highlighting the importance of particular, so called "contemplative design", and for creating restorative landscapes in our cities. Finding the right design techniques can provide a significant contribution to green space design with inclusion of stress reduction and mental health improvement strategies. The pilot experiment is a proof of concept and showed that the applied framework can serve well for further experiments. It also managed to establish a new reliable method of contemplative landscapes evaluation.

**KEYWORDS:** urban planning, landscape architecture, neurosciences, EEG (electroencephalography), contemplation, mindfulness

## 1.0 INTRODUCTION

Architecture, as well as landscape architecture, is a design discipline that even though borrowing from various scientific areas, still bases itself on artistic expression with its incomprehensible, immeasurable, metaphysical aspects. This brings forth many questions and doubts such as: What is the link between the human and his environment? How does one perceive the designed space? What is the impact of that space on one's mental health and well-being?

One scientific discipline that seems to be able to provide the answers for those questions is neuropsychophysiology with its methods of brain scanning. In the end, it is the brain that processes all the sensory stimuli as well as interpretation of them and emotional response. We believe that establishing the link between the visual *outer* space with the *inner-self* (inner space), that can be represented by the specific brainwave pattern, can provide interesting answers to previously mentioned questions.

There is no doubt that architects and landscape architects should design with people in mind; and that being the case, their designs should prioritize people's health and well-being.

The percentage of the population of the More Developed World living in urbanized areas is now 78,7% and still growing (Champion, 2001). Since one of the biggest challenges facing contemporary metropolises is mental health, and one of the biggest problems of developed societies is psychological imbalance and distress leading to various mental disorders (W.H.O. 2005), this would be a target problem to resolve using joined forces of scientific and artistic disciplines.

Researchers from such areas as landscape architecture, environmental psychology, and medicine have agreed that contact with natural settings and greenery has a positive influence on our health and well-being (Kaplan and Kaplan, 1989).

The aim of this study is to go one step further by explaining which kinds of greenery and landscape types have those therapeutic powers; because not every attribute of space design will have the same impact on the observer just as not every piece of art brings up the same types of emotions in each individual.

Based on the existing concepts, scales and measures for different mental states and healing processes we have designed a relatively simple experiment that aims to prove that some specific design strategies in urban parks and gardens can induce the brain activity patterns associated with restorative states of mind, such as mindfulness.

## 1.2 Central concepts:

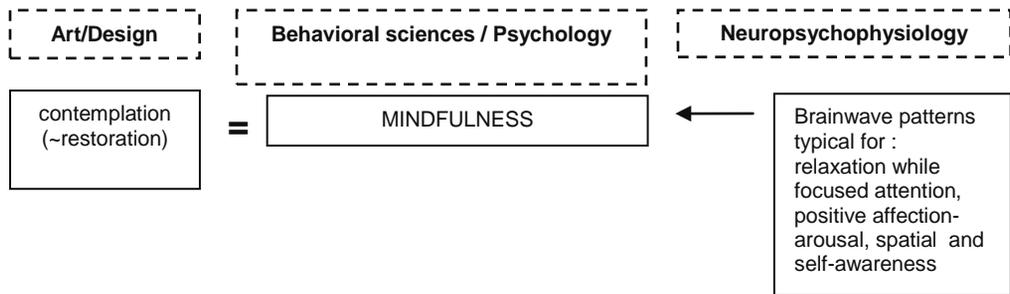
**Contemplative landscapes/spaces** – this concept is used in various artistic disciplines; contemplative values of the nature, space or art has been described by poets writers. Nevertheless there isn't any set of rules for creating landscapes of contemplation. What we know about those kinds of spaces is that they stimulate contemplation.

**Contemplation-** The word contemplation is commonly used as an attentive watching and/or perceiving of some phenomena. It can be induced by some landscape setting, leading to stress reduction and relaxation, which is connected with the concept of the healing power of nature. It focuses on the elimination of thought, benefiting body and mind, giving a sense of wellbeing, contributing to psychological, intellectual and spiritual development, and stimulating creativity and stress reduction mechanisms (Kaplan, Kaplan, 1989).

Contemplation can sometimes be misunderstood as an activity; however it is rather a state of *being not doing*. This state could be compared with a trance, but not every type of trance provides contemplation. *“Television, modern culture’s peculiar contemplative shrine, supplies a contemplative trance to millions of people, for hours on end day after day year in and year out.”* But this kind of trance very often is a cause of reinforcement of sensory dissatisfaction, imprinting anger and violence, confusion, construction and maintenance of the delusion of materialism (Thurman, 1994). In general, we are all involved in contemplation on a daily basis and we assume that contemplative states are associated with specific therapeutic benefits (mental restoration), and expressed by particular brainwave patterns.

The term contemplation has often been used across the artistic disciplines because it involves some kind of object, phenomena, piece of art or landscape: we contemplate something – the painting, the sculpture or the beautiful landscape. The concept of contemplation doesn't have a rigorous scientific character.

**Mindfulness** - What artists want to understand as contemplation is well described and scientifically measured as mindfulness under the umbrella of psychology. And then, neuroscience developed specific tools and scales to measure what is called mindfulness. Therefore, it makes the concept of mindfulness an important inter-disciplinary bridge. The relation between disciplines is shown by the graph below (Fig.1).



**Figure 1. Inter-disciplinary relations between central concepts of the research**

Unlike transcendental meditation (mantra), mindfulness meditation focuses on the present moment and surrounding realm. Mindfulness refers to the process of bringing one's attention, in a nonjudgmental manner, to the internal and external experiences that exist in the present moment. Those external experiences can be, for example, the visual stimuli received from the landscape setting. Typically, mindfulness includes awareness of: sensations, thoughts, bodily states, consciousness, and the environment, while simultaneously encouraging openness, curiosity, and acceptance towards them (Bishop, 2004).

Mindfulness is increasingly being employed in Western psychology to mitigate a variety of mental and physical conditions for it is believed that it improves well-being. The popularization of mindfulness studies is visible by the number of scientific publications that is growing almost geometrically (1 publication in 1989; 477 in 2012, (Black , 2013)).

The mechanisms of mindfulness include changes in neural networks underlying emotion regulation (Holzel et al., 2008); changes in self-processing (Vago and Silbersweig, 2012) which effects in strong relation between mindfulness and mental health improvement, stress defense, anxiety, depressive states reduction (Kabat-Zinn, 1982; Shapiro, et al. 1998) learning and memory processes, emotion regulation, self-referential processing, and perspective taking (Baer, 2003).

Despite the fact that mindfulness is generally reachable through education and training (typically retreat-oriented), we believe the brainwave patterns associated with the state of mindfulness can be induced or stimulated by outer stimuli such as specific landscape setting; also without the subject even realizing.

### 1.2 Hypothesis and aim of the Pilot Experiment

The presented pilot experiment is a part of initial stage of the project entitled '*Contemplative values of urban parks and gardens*' that aims to prove that there are certain characteristics of urban parks and gardens that can induce in the visitor the pattern of brain activity that is associated with contemplative or meditative states (mindfulness).

The goal of the pilot experiment was to revise the methods, evaluate feasibility, time, cost, adverse events, effect size and getting familiar with methods and equipment that allows predicting an appropriate sample size and improving the experiment design before a full-scale one.

All the steps taken across the framework process have been evaluated and tested. However the interpretation of results and explanatory effort has not been undertaken regarding to the EEG-Lab method, because the aim of this pilot is not proof of the hypothesis but the proof of concept and preparation for a full scale experiment.

The output of the Pilot was to observe the typical brainwave power spectra for the landscape settings that are considered to be contemplative, and attempt to track the tendency, if existant before the further experiments. There was no control groups included in the pilot, as it's goal is purely methodical, and the eeg data obtain shall mean nothing regarding the proof of our hypothesis.

Nevertheless the questionnaire-based part of the framework is supposed to provide rigorous results that can be interpreted and used in forthcoming experiments.

## 2.0 METHODOLOGY

The applied method consisted of two major parts: (1) questionnaire-based and (2) laboratory-based.

In the first part we developed a questionnaire of contemplative attributes and attempted to evaluate a set of selected design landscapes in terms of those attributes. - The second part was intended to study brainwave patterns induced by the landscapes with higher contemplative attributes. The questionnaire-based part helped to select the proper material for the laboratory experiment, and the laboratory data delivered the empirical evidences concerning the effects of the selected landscapes on the brain. Both parts together contribute to the final explanatory effort.

### 2.1 Questionnaire / Checklist

After a deep study of the respected contemporary literature of architecture, landscape architecture and design in its broad meaning, all possible contemplative attributes of the landscapes were listed. As a 'respected contemporary literature' we consider books and papers that have been published during the last 20 years, in peer-reviewed journals and also books by recognized scientists (Smardon, F. Palmer, Felleman ;1986; Hermann, 2005; Krinke R. 2005 ; William J. 1992; Zelanski&Fisher,1996 Treib M, 2005;). These publications deal with the contemplative aspect in space design, and are usually the only source of knowledge about those aspects in the design of spaces. We understand the term 'contemplative attributes of the landscapes' as those characteristics of space that are intended to inducing contemplative states of mind in the visitors.

All of the listed contemplative attributes of the space were studied and divided into groups. We have distinguished 5 groups of attributes:

- 1) *physical attributes*, that are connected to the spatial composition and visual values (i.e. long distance views or geometrization of natural elements);
- 2) *psychological attributes* – how the space potentially makes us feel (i.e. 'sense of reorientation from', 'sense of solitude');
- 3) *archetypal elements* existing in the setting – those based on the findings of Carl Gustav Jung and his study on collective subconsciousness (Jung, 1991), such as *path, clearing or single old tree*;
- 4) *art&bio* characteristics that can be more of less intense such as *character of peace and silence* or level of *biodiversity*, and
- 5) the last group of attributes consists of classical division of the landscape's composition into six main types: *canopied, enclosed, feature, focal, ephemeral and panoramic* (Smardon, 1986).

A 52-item checklist based on that list was created and organized in five parts including all of the contemplative characteristics found in the literature (Table 1).

**Table 1 Checklist specification including division into parts, response scheme; number of items and the reliability expressed by the percent of overall agreement for each part (21%-40% - fair agreement, 41%-60% - moderate agreement, 61%-80% - substantial agreement, 81%-100%-almost perfect agreement (Fleiss,1981))**

|               | <i>Group</i>             | <i>Response scheme</i> | <i>Nr of items</i> | <i>Percent of overall agreement</i> |
|---------------|--------------------------|------------------------|--------------------|-------------------------------------|
| <i>Part A</i> | Physical attributes      | Nominal (Y/N)          | 23                 | 70%                                 |
| <i>Part B</i> | Archetypal elements      | Nominal (Y/N)          | 12                 | 90%                                 |
| <i>Part C</i> | Art & Bio attributes     | Likert scale (1-5)     | 4                  | 40%                                 |
| <i>Part D</i> | Psychological attributes | Likert scale (1-5)     | 12                 | 30%                                 |
| <i>Part E</i> | Landscape type           | Nominal (a-f)          | 1                  | 60%                                 |
|               | <b>Total</b>             |                        | <b>52</b>          | <b>60%</b>                          |

We have selected three urban parks that have been built during past 50 years and provide biggest possible number of various settings. (Parque de Cidade, Serralves (Porto/Portugal) Parc Andre Citroen (Paris/France). However the selection of parks isn't most relevant as we evaluate settings, not parks. During several site visits we established a big photographs collection of random photos taken during a regular walk in the park. We tried to take a photo everywhere accessible for the visitors, and all the settings and views were included. We made sure the light conditions are equalized on each photo, therefore, we took photographs with a white-sky weather conditions. After removing photographs with a repeated content we had the collection of 50 photographs, that were then forwarded for further evaluation of the Jury panel.

Selected landscape settings were evaluated by four independent experts, representing the space design profession. They were instructed to give the most objective answers to 50 selected photographs, according to their professional experience and knowledge. Photographs were displayed to them on the PC screen, there was no time limit for the procedure.

## 2.2 EEG-Laboratory

The second part of the study consisted of a laboratory-based EEG passive task, one condition data collection. Nine healthy subjects, 4 females, age ranging from 25 to 35 years old, were tested with an Emotiv EPOC, 14-channel headset (researcher version). All participants provided informed consent.

The experiment took place in a closed dark room<sup>1</sup>. The 15 photos of landscape settings rated highest by the panel of experts in terms of contemplative attributes were displayed to the subjects, for 8 seconds each; in a 21 inch computer screen, placed 70 cm in front of the place where they were sitting. Subjects were instructed to relax, focus on the setting and imagine that they were there.

The EEG recordings were performed in a laptop computer running MAT-lab EEG acquisition software in Windows 7; Raw EEG data was processed and analyzed with the *EEG-lab* toolbox, then the signal was de-trended and offline-filtered. Average scalp maps for different power bands across all subjects were obtained and, because of a small number of subjects, scalp maps of different power bands for each subject were also analyzed. Finally, EEG asymmetry was explored through the average powers across all subjects for frontal electrodes (electrodes F3, F7 for left and electrodes F4nF8 for right hemisphere), and subtracting left from right alpha-power.

<sup>1</sup> Indoor environment of the experiment helped avoiding serious noise-contamination of the eeg signal.

Theoretically, the used equipment allows taking it outdoors, due to its wireless function, so it may seem a better solution because of the "full perception" of the landscape. Nevertheless, the noise ratio recorded by Emotiv outdoors is very high and seriously contaminates the record. Secondly, the number and intensity of the stimuli occurring outdoors would not be controllable during the experiment. The study is dealing with the design strategies and only visual attributes of the space, therefore the indoors character should not be considered as a limitation.

### 3.0 RESULTS

The results are separate for each part of the study, and only after compared in the stage of conclusions and explanation.

#### 3.1 Questionnaire results

As a result we obtained the ranking list of 50 evaluated landscape setting according to their contemplative values. The highest score was 55% , and the lowest was 27,5%. We also obtained 50 files of datasets, one for each photo, with a detailed description of its contemplative values, and attributes. Examples of those datasets are presented by Figure 2.

We were then able to select 15 most contemplative and 15 least contemplative settings out of the ranking, for further study with the EEG methods (identifying the brainwave response between the block of most contemplative compared with the block of least contemplative settings).

The checklist showed a substantial inter-examiner reliability rate measured with the percent of overall agreement of the jury panel ( $P = 0.61$ ) (Fleiss 1981) (Table 1). The reliability was also measured for each of the five parts of the checklist (Table 2). Selected 15 settings from the top and from the bottom of the ranking, showed a statistical difference  $t(28) = 22.9, p < 0.00001$ . It means that photos evaluated as most contemplative are statistically proved to be different from ones evaluated as least contemplative.

#### Example 1



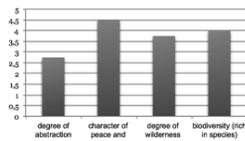
##### Part A (physical attributes)

long distance view, universalism in design, large empty space, smooth land form, natural asymmetry, contrast with surrounding urban landscape, openings and closings of the views, explicit spatial order, physical and visual relations are worked out, warm color location, stimulation to look up towards the sky, simplification of form, visibility of shade movements along the daily cycle, seasonally changing vegetation

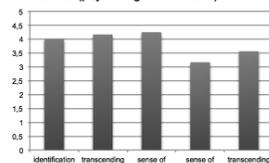
##### Part B (archetypes)

clearing, forest

##### Part C (art&bio attributes)



##### Part D (psychological attributes)



##### Part E (landscape type)

Panoramic

#### Example 2



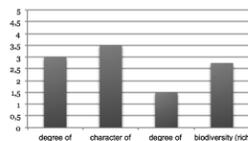
##### Part A (physical attributes)

Long distance view, universalism in design, signage elements in the hierarchical relation to each other, geometrical use of some natural elements, contrast with surrounding urban landscape, opening and closings of views, explicit spatial order, physical and spatial relations are worked out, warm color tonation, simplification of forms, repetition, seasonally changing vegetation, space enclosed

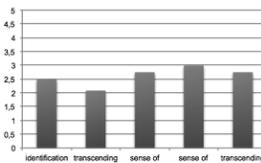
##### Part B (archetypes)

path

##### Part C (art&bio attributes)



##### Part D (psychological attributes)



##### Part E (landscape type)

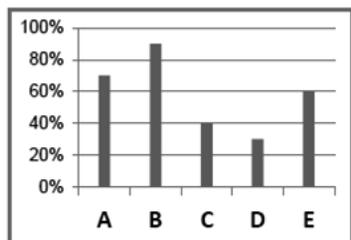
Focal

**Figure 2. Evaluation of landscape settings based on the results of the checklist (2 examples out of 50; contemplative attributes-oriented datasets)**

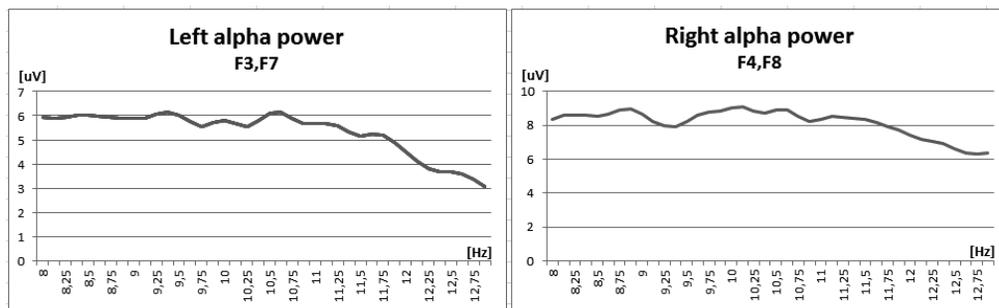
#### 3.2 EEG-lab results

In figure 3, we show the average (across all 9 subjects) scalp maps for all power bands (delta, theta, alpha and beta). These maps clearly show hemispheric asymmetry, with higher power in the right frontal lobes. Also, we can notice that the average maximal power of alpha brainwaves (10,8  $\mu\text{V}$ ) is higher than beta brainwaves (6,5  $\mu\text{V}$ ) (see figure 2).

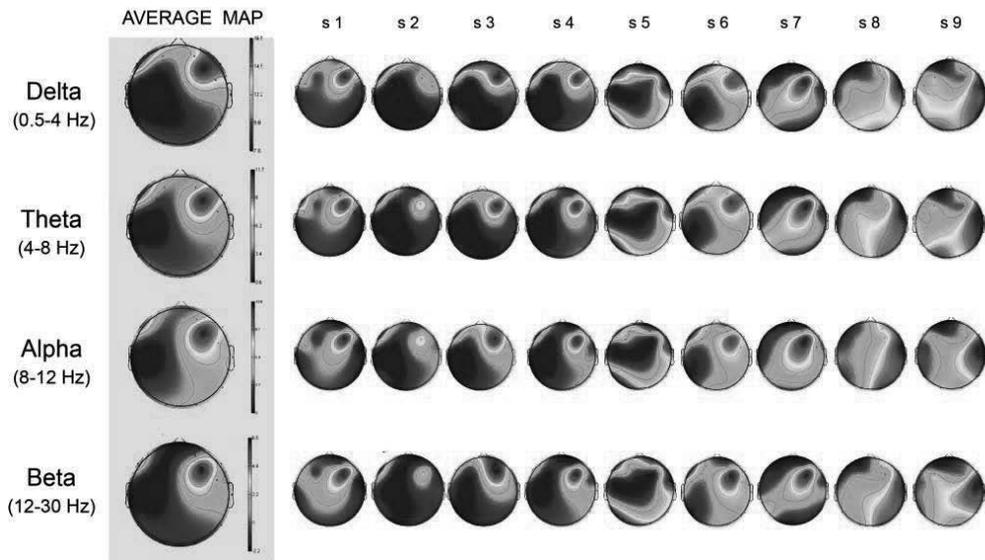
The alpha power spectra for left and right frontal lobe electrodes across all subjects, while observing the landscapes show lower alpha power in the left hemisphere (approx. range 3  $\mu\text{V}$  - 6  $\mu\text{V}$ ) than in right hemisphere (approx. range 6  $\mu\text{V}$ -9  $\mu\text{V}$ ) (see figure 3).



**Table 2.** Percent of overall agreement [%] for each part of the checklist (A,B,C,D,E)



**Figure 3.** Alpha power spectra for left (F3 and F7) and right (F4 and F8) frontal



## electrodes

**Figure 4. Scalp maps for different power bands (alpha, beta, delta and theta) , average maps across all nine subjects and specific maps for each subjects, contributing to the average. Each scalp map is an average across all displayed photos.**

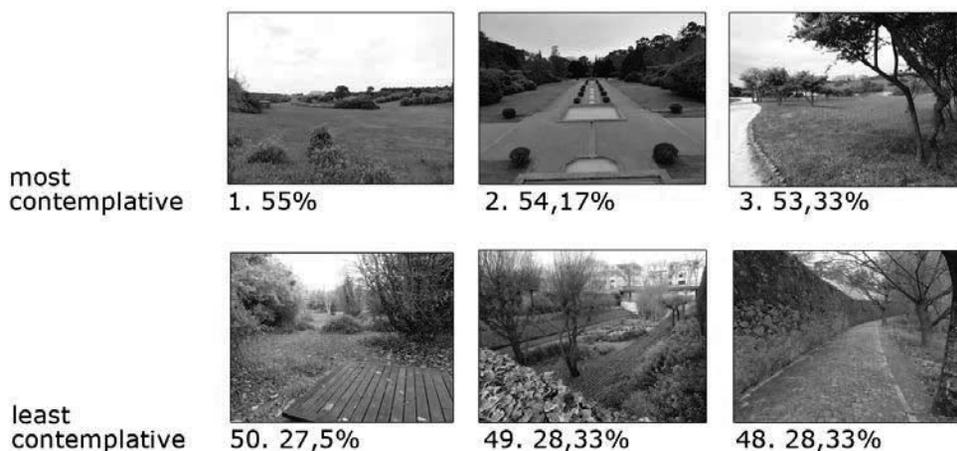
## 4.0 DISCUSSION:

The first part of the study (questionnaire based) provided us with the data describing 50 selected photographs of urban parks and gardens in terms of contemplative attributes of spatial design. Thanks to the applied scoring system we were able to rank them in terms of contemplative values. The primary gain of the first part of the study was the ranking of landscape settings and the checklist-framework that showed substantial reliability and therefore can be used in further experiments.

Showing 15 top-ranked photographs to the subjects, recording their EEG signal, analyzing it and comparing to the existing scales and measures of mindfulness led us to the finding that there is a similar response to all of the photos across the subjects.

The ranking of landscape settings shows, that the common attributes for 10 settings evaluated as mostly contemplative are those characterized by: long distance view (more than 400m), large empty space, smooth landform, natural asymmetry, contrasting with an urban type of landscape, openings and closings of views were worked out, stimulation to look up to the sky, simplification of forms, and seasonally changing vegetation. Their main archetypal element is clearing. They are all characterized by a high character of peace and silence and biodiversity, and low degree of abstraction and wilderness. They represent panoramic or focal type of landscape.

On the other hand the least contemplative settings are usually lacking most of the physical attributes of the contemplative space, the main present archetypal element is a path. The character of peace and silence as well as biodiversity is lower, but degree of abstraction is higher. They usually represent an enclosed type of landscape composition. Three most contemplative settings and three least contemplative settings are presented below, Figure 5.



**Figure 5.** Most and least contemplative settings, with a number in the ranking and scoring based on the contemplative attributes.

Once again we want to underline, that the experimental part results will not be interpreted and explained on this stage of research, because of the pilot character of the experiment, and too many limitations, the explanatory effort would not be accurate. Nevertheless, the experiment carried out proved the concept, and can be repeated with bigger sample size and number of conditions. The success of the pilot is to find out that we are actually able to produce a measurable and explicable data through applied framework. Further research on the mindfulness will bring answers on how to interpret the data, and what to look for in the EEG brainwave recordings.

#### 4.1 Main limitations

Most of the limitations are mainly due to the initial stage of the study which involved only 9 subjects (while a regular experiment should involve around 30 subjects). Also, the performed experiment had only one condition (‘most-contemplative landscapes’ condition), while it should be compared with ‘least-contemplative landscapes’ condition). The limitations of the undertaken method are also increased by the used equipment which is a 14-channel headset excluding midline electrodes and reported by some experts as registering high noise frequencies leading to low clinical reliability (Duvina et al., 2013).

The one limitation of the questionnaire-based part lays on the *psychological attributes* part of the checklist, which performed the fair reliability rate (30%), and in the further experiments should have the form of an on-site questionnaire with at least 40 respondents.

#### 4.2 Main contributions

The presented experiment is an innovative initiative joining together the insights of landscape architecture and design disciplines with neurosciences and the traditions of mindfulness meditation. The development of the performed experiments can prove that there truly exist design strategies that can help induce the brainwave patterns typical for mindfulness in the visitors (city inhabitants), which, in further perspective, can influence the improvement of their mental health and well-being. The results of the research can contribute to better understanding of spatial perception and its influence on people, promoting mindfulness, as well as re-defining the term *genius-loci* and demystification of design practice.

#### 4.3 Conclusions:

Even though our study is on initial point (pilot experiment stage), our findings differ from what we know as a “landscape preference” (Kaplan&Kaplan, 1998).

Nevertheless, our aim is to remain independent from already known methods of landscape evaluation by “do you like this landscape?”-surveys. Restorative or mindfulness mechanisms in

our brains are unconscious (unless we are meditation practitioners); this is why the subjective response might be misleading for the landscape evaluation. Also, number of respondents do not really know what they feel about some certain landscape; their more or less extended knowledge about photography or composition can be misleading too. Finally, we do not procure the landscape settings that are likeable, but ones that can have a particular influence on our brainwave patterns, and therefore provide a design tool contributing to improvement of quality of living in the cities, and improvement of health and well being.

Further experiments following the checklist-based part, should be conducted with extended number of independent experts, and in a laboratory environment. Finding out the brainwave patterns associated with mindfulness present during observing the contemplative settings, and finding how it differs from response to non-contemplative landscapes, can significantly contribute to this research as well as scientific evolution of design disciplines.

Effects of our study can be part of the innovative space design policy, having in mind the mental health improvement in the city environments, and designing spaces in order to reduce stress and mental fatigue of people. Confirmation of our hypothesis will also give artists and designers an important tool – scientific confirmation of beneficial influence of art on our lives.

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