

## Does views to nature and the design of spaces matter?

### *A pain stress experiment*

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The Academy of Neuroscience for Architecture

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# Urban Attractors, Physical Proximity and States of Mind: Measuring Dynamic Experiences in Varying Typologies of the Built Environment

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## ABSTRACT:

The presented research work attempts to offer new insights on the human responses to the public space through quantifying the impact of varying qualities of the built environment to the individual experience [1]. The objective is to afford architects and urban designers with novel metrics on spatial cognition and emotional states for supporting design intuition and better informing urban interventions [2]. The research methodology includes the measuring of the spatial experience and psychological transactions of test subjects while navigating and exploring the urban environment, leveraging the emerging technological opportunities of mobile wearable sensing tools. Two research experiments are discussed, exploring the relationship between (a) urban attractors and user attention in walking tasks, and (b) urban proxemics and psychological states through different modes of transportation.

The first study addresses the influence of specific elements in the urban environment on people's mental maps of a place, reinterpreting studies on city "imageability" [3,4]. Drawing correlations between visual perception and physical characteristics of the public space, this experiment employs the use of sensor data from a wearable eye-tracker to analyze human attention patterns while exploring the actual environment [5,6] – as opposed to more conventional studies of screen images in indoor settings [7]. By mapping the eye gaze of 15 test subjects as they walk along a familiar route in Cambridge, MA, this experiment correlates gaze duration/intensity and different qualities of the viewed elements (pavement, entrances, corners, etc.). The juxtaposition of the eye-tracking results with a post-walk map-drawing task also allows to make comparisons between the portion of existing information that is taken in through the eye and what is remembered or processed into memory.

The second experiment investigates the emotional impact of varying typologies of the public space while navigating the environment through four modes of transport: walking, cycling, driving, and riding the subway. This research draws on precursory Psychogeography studies [8] and recent investigations on mobile cognitive measurements [9,10], as well as on proxemics theories that sets a hierarchy of physical proximity – from the body space, through the personal and social space, to the public space [11]. In the study, a test subject followed a specific route in Boston travelling through three unique neighborhoods, each time using a different mode of transit. Proxemics was studied with a set of proximity sensors directed at the four corners, whereas a wearable EEG brain scanner allowed to track brain activity [12] throughout the experiment and against proximity. The analysis of the readings and spatial scenarios are reinterpreted for the creation of a taxonomy of urban compositions that juxtaposes the spatial condition, proximity, and state of mind of the 99 cases observed.

Future studies will expand this lexicon of experimented urban situations, inviting for a critical engagement with the neuroscience towards a deeper understanding of how the spatial morphology, the dynamic activities, and the subtle varying conditions of places affect people's perception and behavior in urban contexts. This framework might eventually foster enhanced design methods in which the human experience – and even emotions – are placed at the forefront of design decisions towards more engaging, pleasant, and responsive built environments.

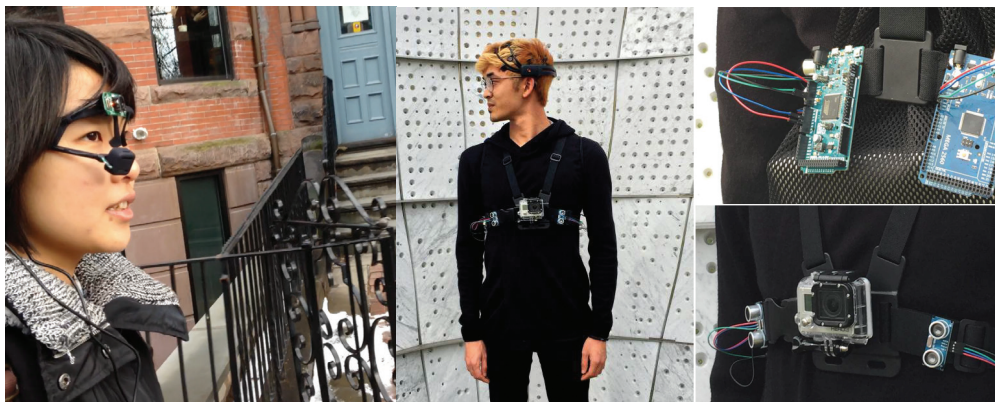


Fig. 1 Test subject wearing an eye tracker in the public space (left) and measurement of the test subject's emotional states and proxemics values through a mobile EEG scanner and proximity sensors (right).

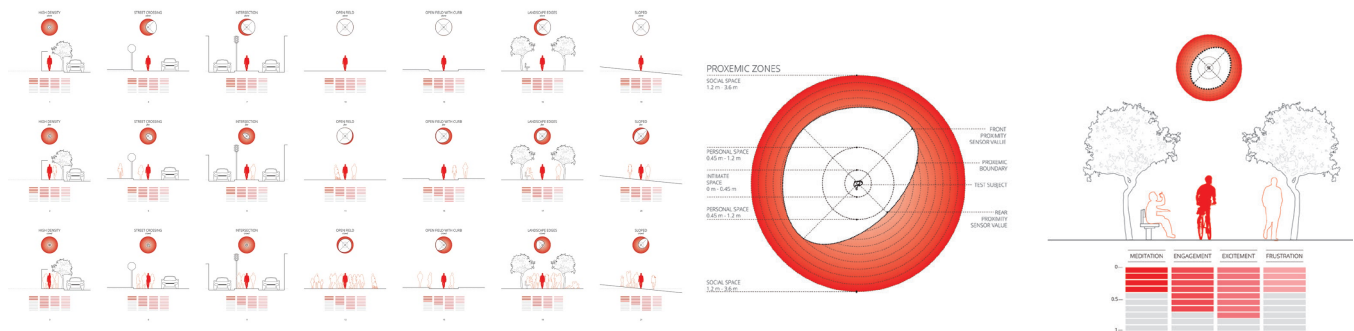


Fig. 2 Analysis and visualization of proximity data and EEG readings in relation to varying typologies of urban environments and modes of transport.

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# Theoretical Paradigm Adapted for School Design for Children with Autism Spectrum Disorder

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## ABSTRACT:

There are many school design guidelines available to support 21st century educational demands. However, these guidelines offer little information about educational interventions for children with Autism Spectrum Disorder (ASD) because most of these children have abnormal reactions to sensory stimuli (Kaufman, 2014). Many researchers and architects believe that architectural interventions do influence educational outcomes of children with ASD and have suggested design guidelines for ASD school environments (Beaver, 2011; Mostafa, 2008; Scott, 2009). However, the relation between sensory stimuli and a wide range of sensory profiles of ASD in an educational setting is unclear.

This research proposes a theoretical framework that describes the relation between environmental stimuli and autistic sensory profiles that support clinical intervention. The framework is based on an atmospherics theory Ahn (2016) proposed that describes the theoretical relation between store stimuli and the emotional responses that induce consumer behaviors. Ahn's theory integrates three environmental theories, the SOR Paradigm (Donovan and Rossiter, 1982), Aesthetic Theory (Berlyne, 1971) and Preference Theory (Kaplan and Kaplan, 1982). Ahn's theory can be adapted for this study because it offers architects/designers a useful tool for design developments by enabling them to understand the relations in the environmental stimuli-human experience holistically.

The framework proposed suggests that the twin concepts of "comfort" and "arousal" can be used to determine/measure the perceived environmental quality of a school environment. Comfort is a physiologically and/or mentally amenable condition that supports the activities intended. Arousal is the feeling that subjects experience and the degree to which they are aware of environmental stimuli. The framework addresses hyper- and hypo-sensory conditions of children with ASD and explains the way a designer/architect can achieve appropriate comfort and arousal levels to support an artistic child's individual needs, and therefore, optimize architectural conditions of a classroom to support clinical interventions. A case study of the framework's implications in four existing classroom environments will be used to explain the way this framework can be used in design analysis to determine the way classrooms function to meet the individual needs of children with ASD.

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## **LEARNING OBJECTIVES:**

1. To understand architectural interventions' effects on sensory issues of children with ASD.
2. To understand autistic sensory conditions (hyper vs. hypo) in relation to architectural stimuli.
3. To develop a theoretical paradigm that describes the relation between the environment and autistic behavior that can be useful in design.

# Applicable Biophilic Principles on Hospitals Retrofitting

## The Case Study of Turkish Public Hospitals

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### ABSTRACT:

The UNEP's reports are seeking to promote the isolated relationship of human and nature in health care's architectural spaces due to their emerged social and environmental sustainability challenges in recent years. Chief of it is reviewed and proved low satisfaction level from hospitals architectural spaces being low thermal, visual, lighting and acoustic comfort levels. Nowadays architectures of health care services by integrating architectural spaces with nature, in any possible way, have succeeded to improve a large part of these problems from following the bionic principles to generating healthy, productive and therapeutic spaces. Accordingly, this research project by focusing on built health centers and surveying and analyzing their social problems, as a novel project, will present bionic-based retrofitting solutions. One possibility is applying Biophilic principles. Biophilic is an innovative and growing design method of architectural spaces within which we live, work, learn, and heal up. Specifically this research project explores the novel ideas in favor of revitalizing built public health centers incorporating Biophilic design patterns. This paper presents the part of an executive research project and will consist in: 1) a literature review of two similar projects which have been composed by Biophilic principles and 2) presenting applicable solutions in order to optimize the comfort levels in healthcare centers in Turkey. The mentioned literature review will highlight the outcomes of Biophilic principles on both financiers and users. The Khoo Teck Puat Hospital (KTPH) in Singapore and the modern Altunizade Acibadem Hospital of Istanbul are case studies which have been selected using General Morphological Analysis (GMA) and will be analyzed by applying WELL building standards and using Multi-Criteria Decision Making methodology. Then, research team by presenting design solutions will specify the Biophilic method's 14 principles of which can be effective while optimizing built hospitals sustainability.

**KEYWORDS:** Biophilic Design, Existing hospitals, Turkey, WELL Building Standard.

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I have five years progressive on-site and off-site experience in numerous project including electrical installations, executive supervisor, and/or architectural-design team leader for several companies in Iran and Turkey from 2011 to 2016.

I was an architectural advisor for Mahan International Commercial Real Estate from 2014 to 2016.

While earning master's in architectural technology, I worked on Islamic patterns as well as a project to optimize university-student satisfaction publishing my research projects at Iranian conferences including "The Relationship Between Leisure Time and Satisfaction Level of Students, Iran, Tourism and Urban Identity".

I am currently doing my doctoral research in hospital façades and intelligent materials.

### **BEHNAZ AKRAMI**

I have recently graduated with my master degree in architectural design from Istanbul Technical University, Istanbul, Turkey.

I did my bachelor project about hospital design and then, I have improved my research study about sustainable healthcare architecture in higher education and have submitted papers about impacts of sustainable hospital design on patient's treatment processes and also publishing my research project at Istanbul conference including "Investigating the Methods for Using Sustainable Architecture in Hospital Design in Istanbul; Eco-Friendly Cities for Everyone book". Hence, during that time, I was familiar with Biophilic design, Neurobiophilia terms and doing my master thesis in relating healing environment and biophilic design in healthcare architecture.

From 2014 to 2017, I had a variety of experiences in diverse projects as an interior designer, executive supervisor in several companies in Istanbul. Also, I worked for two years in Azerbaijan municipality as an architectural-design team leader in Iran from 2011 to 2014.



# From Neural Space to Physical Space: Giving a “Brain” to a Building

Michael Arbib, Tricia Ngoon, and Eric Janes

## Introduction

We explore the integration of two ways in which neuroscience (which we extend to include the study of cognitive science as well as brain mechanisms) may impact architecture.

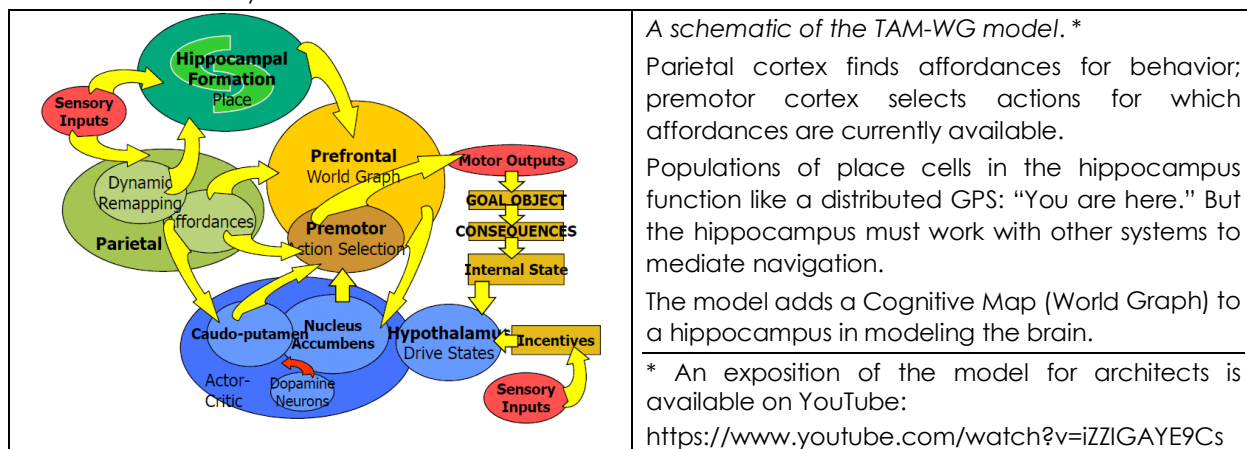
- *Neuromorphic architecture*: Studying neuroethology (the neuroscience of animal behavior) in search of systems whose mechanisms can inform future developments in smart architecture. A key notion is that of “neural space,” the network of sensors, effectors, and computations embedded in the building, analyzed in terms of their functionality rather than their placement in 3D space.
- *Neuroscience of the experience of architecture*: Assessing the ways in which different populations of people explore, experience and interact with the built environment, in search of lessons relevant to the design process.

*We propose that careful attention to the “neural space” of a building may yield innovative designs that enrich the physical “building space” through constraint satisfaction between the physical and neural dimensions of the building.*

## Neuroscience of the experience of architecture

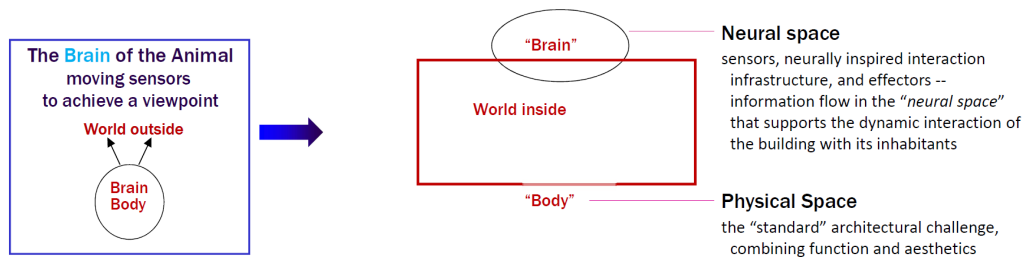
A key notion from neuroscience is that a human (or animal) is engaged in a continual cycle of action and perception (APC) with its environment, with sensors providing the input for perception and effectors providing the means to carry out actions – but perception is based in part on the human’s current goals and needs as well as memory based on prior experience, with actions serving both to gather more information and to effect changes in the environment. An important feature of the APC is the social interaction of people with each other, as the plans and behavior of each actor change with their perception of the actions and intentions of others. The neuroscience of the experience of architecture applies findings and methods of neuroscience (and cognitive science more generally) to assess the behavior and experience of a person within or in proximity to a building (or architected space) in terms of these concepts, seeking to understand how changes in the building may constrain or enrich that behavior. Conversely, we seek to engage neuroscientists in extending studies from the laboratory to the built environment.

**Example:** Multi-sensory integration plays a key role in human experience of buildings, but much behavior makes especial use of vision both to locate objects and to navigate despite the possible variations in the placement of obstacles. How does that change when vision is absent? Folska (2012) had blind participants sketch maps of a routine route at the Colorado Center for the Blind. All participants exhibited a preference for relying on touch rather than audition for extracting environmental information. Passini and Proulx (1988) found that the blind made more decisions in navigating complex spaces and required more information access points than those who navigated sighted, but blind participants were still able to navigate novel, complex spaces. This suggests the need to provide diverse tactile cues in designing for the blind. Similar considerations apply to aiding memory formation and recall, both providing means to help blind newcomers to the building orient themselves, and supplementing the resident’s working memory of where objects are to be found. We have analyzed this in terms of the TAM-WG model (Guazzelli, Corbacho, Bota, & Arbib, 1998) which explains the integration of a cognitive map with available affordances in locomotion, showing how the unavailability of visual affordances requires a greater density of established “via points” if navigation is to be conducted efficiently.



## Neuromorphic architecture

Viewing a building as an “inside-out” animal which contains the environment in which it interacts with human occupants, *neuromorphic architecture* proposes that the future evolution of architecture will endow many buildings with appropriate variations on sensors, effectors and *interaction infrastructure* (“brain”) studied in neuroethology to support the adaptive interaction of each building with its inhabitants (Arbib, 2012). The “neural space” of a building then provides the abstract network linking the sensors, effectors and “brain” to achieve a key set of functionalities, such as supporting navigation, memory and the performance of key functions.



## A Proposal

*The design of the interaction infrastructure (“neural space”) should lead the design of the physical layout (“building space”), although each will constrain development of the other as design proceeds.*

Rather than rooting the initial design stage in large-scale site planning and massing models, we begin with the neural space: What actions is the building to perform to benefit specific occupants in specific ways? What sensors are needed to gather the necessary data? What effectors will implement the actions? How will the interaction infrastructure be designed to link them, using new neuroscience data to develop complex information structures such as that of the TAM-WG model? With an initial design completed for the neural space (where “space” is used here in the abstract sense of elastic relationships, with no prior commitment to placement of its elements in space in the conventional 3D sense), design of the physical layout can proceed, incorporating the placement of the design elements of the neural space in the unfolding integrated design.

## A Case Study

*The poster at ANFA 2018 will provide a worked-out example, an apartment for a blind resident* whose design exemplifies this strategy. We will use the above data on the importance of the tactile sense as a guiding principle for the physical layout, while adding a specific exercise in neuromorphic architecture – the design of the interaction infrastructure (“brain”) of the kitchen which integrates sensors and effectors to supplement the resident’s working memory of where items are located and the sequencing and timing of a recipe while cooking. Supplementing the blind resident’s command of a great deal of verbal and spatial memory, the interactive kitchen uses technological tools and audio cues to offload this memory and assist in cooking tasks. A key point for debate is the extent to which neuroscience can add to the growing impact of artificial intelligence in the design of interactive architectures.

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Arbib wrote the book on “Brains, Machines and Mathematics” and is an expert in computational neuroscience and the evolution of the language-ready brain. He pioneered the notion of “neuromorphic architecture” in the sense of designing a building with a “brain.” Having served as ANFA vice-president, he is currently coordinator for the ANFA Advisory Council. His UCSD lectures (and other talks) linking neuroscience and architecture are available on YouTube.

**Tricia Ngoon.** Ph.D. Student in Cognitive Science, UCSD, [tngoos@ucsd.edu](mailto:tngoos@ucsd.edu)

Ngoon is a Ph.D. student in Cognitive Science advised by Dr. Scott Klemmer. Her research examines how to support relational thinking and creativity in learning. This paper is based in part on her project in Michael Arbib’s 2017 course at UCSD on the interaction between neuroscience and architecture.

**Eric Janes.** Designer. San Diego, [janeseric@gmail.com](mailto:janeseric@gmail.com)

Janes is an architectural designer with a keen interest in the biological reasons behind how we, as humans, experience tectonic space. He believes that design is an evolution of work produced along a meandering path of discovery and learning.

# Architecture, Light and Emotion: The Brennand Chapel by Paulo Mendes da Rocha, in Recife, Brazil

Rafaela Paes de Andrade Arcoverde & Fernando Diniz Moreira

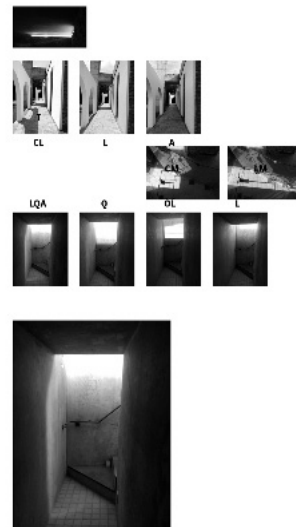
## ABSTRACT:

The manipulation of space by the architect can generate empathy and creative sensibilities in man, engendered by the invocation of the so-called "atmospheres". According to Mallgrave (2015), one of the main tasks of architecture is the creation of empathy. In this way, this paper explores the relationship between natural light and matter in religious spaces and their human emotional responses. In what ways light and matter are interrelated in order to create these architectural atmospheres (conscious or otherwise)?

Designed by Paulo Mendes da Rocha, one of the most distinguished Brazilian architects, in Recife-PE between 2004 and 2006, the Chapel of Our Lady of the Conception, also known as the Brennand Chapel, is an exemplary case for analyzing these atmospheres. Mendes da Rocha reused the ruins of an existing old building, restoring it, inserting new symbolic elements and exploring new natural light sources. The dialogue he promoted between stone, concrete, glass and light provokes sensations to the user. The interaction between the hardness of matter and the lightness of light is a crucial factor for the architectural experience of man.

These aspects can be discussed with the support of phenomenology and neuroscience, associating the records of forms and types of light effects inside the chapel, as well as the capture of the emotions aroused by the spatial and sensorial experience of the religious space. For this, we have applied methodologies based on Moustakas (1994), McCarter and Pallasmaa (2012), which maintain that the experience is the most complete way of expressing the sensorial dimension, since these sensations can only be perceived in their integrity when personally experienced by the passerby. Authors such as Holl (2006), Plummer (2009) and Millet (1996) were also instrumental in understanding the effects of light in space.

**Keywords:** Natural Light, Neuroscience, Phenomenology, Architecture, Paulo Mendes da Rocha.



Photographs by Rafaela Paes

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# Applying Neuroscience Research to Boost Creativity

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## ABSTRACT:

Many organizations, public and private, link the success of their endeavors to the creative performance of their members. Neuroscientists have learned a lot about the design of spaces in which people, individually and in groups, are most likely to think and act creatively, and their insights can be applied to develop workplaces where individuals and teams charged with creative tasks perform to their full potential. Neuroscientists have tied enhanced creative performance to design elements at a variety of scales, from room to city level. Systematic research has linked specific surface colors (green; Lichtenfeld, Elliot, Maier, and Pekrun, 2012), light colors (3000 Kelvin; Weitbrecht, Barwolff, Lischke, and Junger, 2015), and the presence of leafy plants (Studente, Seppala and Sadowska, 2016) to more creative thinking, for example. Similarly, certain other visual, olfactory, acoustic, and haptic experiences, as well as psychosocial conditions, have been associated with enhanced creative achievement. Individual elements combine in networks that elevate users' creative problem solving capabilities and collectively establish the mental conditions/framework needed to support creative thinking (Schifferstein and Desmet, 2008). Creativity-relevant design-related science has been effectively applied in practice in a diverse set of real world settings via scientist-designer collaborations and obstacles to implementation have been overcome. Designers and other people developing and using environments where complex issues need to be resolved must be familiar with research linking design and enhanced creative thinking—resources are limited and, in many important contexts, we don't have time for "do-overs."

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# Re-Scripting Urban Interactions Through Architecture: Correlations of Brain Function and the Built Environment

Sarah d'Auriol

## **ABSTRACT:**

This thesis applies recent research in neuroscience and behavioral studies to rethink and implement cognitive architecture within the re-design of Place des Fête, Paris—a historical city square turned post-modernist concrete jungle; housing a metro station, monstrous housing complexes, a police station, and commercial establishments—to address urban and cultural isolation to create a community base, which harbors the social interaction of diverse citizens. In order to create urban spaces, which can improve the human experience; it is critical to understand brain function. Valuing the intrinsic human need for nature and the immense influence of biophilic design on human health is a key factor of positive urban experiences. From chemical process to physical and emotional responses, the built environment causes many reactions in the body, both subconsciously and consciously. In urban environments full of negative sensory stimuli, it is important to provide positive architectural experience, which includes spaces encouraging leisure, rest, community enhancement, self-expression, respect, productivity, and growth. The urban re-design of Place des Fêtes is an intervention that maximizes human wellbeing and cross-cultural collaboration through physical experiences.

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SARAH D'AURIOL

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# Supporting Recovery Through Design: A Translational Application of the Neuroscience of Eating Disorders to a Treatment Facility

Meredith Banasiak, EDAC, Assoc. AIA, Mark Blaser, AIA, Kathleen Reeves, MS, LPC

## **ABSTRACT:**

Recent advances in neuroscience research have begun to unravel neural correlates of eating disorders. Findings suggest functional and anatomical differences in processing and anatomy resulting in perceptual, affective, physiological and cognitive distinctions-- many of which have environmental correlates with respect to how persons with eating disorders experience their surroundings. This unique set of experiences can inform the design of specialized behavioral health facilities programmed for treating eating disorders. This poster will 1) review findings in eating disorder research across key themes associated with restorative care as a critical first step to developing research informed goals and translational design considerations for environmental interventions in eating disorder service settings, 2) share research conducted with patients and staff to capture the eating disorder patient experience, and 3) describe how evidence was applied to guide the programming and design of a new residential treatment center, Eating Recovery Center in Denver, Colorado.

A former NIMH director called anorexia nervosa the most fatal mental disorder (Insel 2012) given that it has the highest mortality rate of any mental illness, 10% (Arcelus 2011). A review of eating disorder literature elucidates distinct characteristics of persons with eating disorders and the therapy they are receiving as unique from other behavioral health classifications. Evidence suggests that eating disorders are complex conditions which present discrete differences in neural anatomy and processing often in response to environmental correlates which affects how a person with eating disorder relates to an environment. For example, because the circadian rhythms of food intake in persons with eating disorders are abnormal, optimized light can aid regular eating to synchronize circadian rhythms influencing hunger and temperature (Yamamotova 2008) whereas low light, diurnal and seasonal, can undermine self-regulatory control resulting in the disinhibited eating in persons with bulimia (Kasof 2001). In addition, research suggests that associated over/under sensory modulation issues characteristic of certain eating disorders may result in proprioceptive impairment affecting spatial cognition (Brand-Gothelf et al 2016, Chieffi et al 2015).

Given the limited evidence examining interactions between the environment and eating disorders, mining the patient perspective was essential to developing hypotheses around environmental impacts on delivery of care and recovery. Because functional aspects of eating disorders tend to heighten a patient's dissatisfaction and ambivalence (Swain Campbell 2001) conventional instruments such as patient satisfaction questionnaires do not accurately assess the experience of persons with eating disorders nor the success of the facility design in supporting recovery. Thus, we structured this data collection as an exploratory study by applying grounded theory (Patton 1990) to uncover themes related to patient outcomes using the methods described by Trzpac et al 2016 as precedent. We will share this research approach to capturing patient experience through the development of an experience-based questionnaire and simulated empathetic observations.

Findings from this literature review and data collection will be summarized as associated key design goals and research-informed design strategies, linked with specific attributes of eating disorders. The translational application of such strategies will be illustrated in the dining spaces and community spaces and art selection at Eating Recovery Center's newest residential facility.

This interdisciplinary team continues to build on this initial research effort as new Eating Recovery Center facilities are being built at locations across the country. Future work will include examining patient outcomes associated with lighting and facility geographic locations.

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Design Researcher, Boulder Associates Architects

As design researcher for Boulder Associates Architects, Meredith promotes the firm's commitment to person-centered design by cultivating research partnerships with healthcare clients, exploring innovative methods of conducting research, and gathering and translating evidence with designers. Having been a faculty member in architecture and environmental design programs for over ten years, Meredith brings to Boulder Associates experience in health-design research and pedagogy supporting the transformational shift in practice towards an evidence-based culture. She was an original Research Associate with the Academy of Neuroscience for Architecture (ANFA) and remains an active Advisory Council member.

### **Mark Blaser, AIA**

Associate, Boulder Associates Architects

Mark Blaser has over ten years of healthcare design experience with Boulder Associates.

### **Kathleen Reeves, MS, LPC**

Vice President of Operations and Development, Eating Recovery Center

As Vice President of Operations and Development at Eating Recovery Center, Kathleen Reeves brings over 25 years of healthcare experience, ranging from the direct delivery of patient care as a clinical clinician to the provision of administrative oversight in various director- and executive-level positions. In her current role, Kathleen is tasked with operational strategy development, planning and execution for Eating Recovery Center's facilities, including facility development and expansion, accreditation/licensing, patient housing, transportation and other ancillary services.



# CREATION OF NEURO-ARCHITECTURE STUDY GUIDE, FACING THE ARCHITECT, WITH INTERNATIONAL APPLICATION

BENCKE, PRISCILLA  
MOURA, SANDRA MARLISE CESCON DE  
PLECH, REBECA CALHEIROS DE NOVAIS  
ROSA, YASMINE

## 1. ABSTRACT

First voluntary movement of architecture professionals, started in 2018 in Brazil, to the development of a study guide about Neuro-architecture, which is divided in two parts: Theoretical, through a group of studies and Practical, through social actions in public spaces.



Figure 1 - Flowchart

records and reduce the amount of painkillers that are consumed. We are looking for sponsors to perform the interventions to enable the practice.

## STUDY GUIDE

The study guide will be divided by semester, to allow the entry of new participants along the year. Each meeting will have a specific subject to be approached with previously defined bibliography, based on reading recommendation disclosed on ANFA website (Academy of Neuroscience and

### GOALS OF THE GROUP OF STUDIES (Theoretical Part):

We aim to reunite people who are interested in Neuro-architecture, creating a support network and voluntary collaboration, in order to share and improve contents about the subject, also developing a more humane view of the ambiances.

Through this movement we also reach to encourage the development of researches with Teaching Institutions, spreading the subject, providing knowledge exchange between different groups and applicability of the guide in any part of the world.

### GOALS OF THE GROUP OF STUDIES (Practical Part):

The social actions will allow to put into practice and validate the Neuro-architecture knowledge, applying strategies in public spaces, with the possibility of measuring and registration of the results, applying technique known by Evidence-Based Design, taking Neuro-architecture benefits to needy community.

After studies made by the group, it was found a huge lack of humanization in hospital areas. Therefore, we will start our practice in hospitals. The first intervention to be performed will be in a hospital room, through application of wallpapers or paintings on the walls and roofs. We established this way of intervention to avoid any change or damage to the place. This action will be performed in small scale aiming to accomplish accompaniment and to obtain results in the year of 2018. The way to make feasible this practice will be through the search of assistance of local medical staff, so that we can follow and assess the benefits of the action.

With the practice, we aim to reduce the time of permanence of the patients in the hospital, physiological



Figure 2 – Some Photos

Architecture). At the end of each meeting, it must be registered the knowledge that was discussed in order to be shared with other groups of studies. Each meeting must have a voluntary organizer who will be in charge of the logistics, as well as the registration of the knowledge that will be shared.

#### EXPECTED RESULTS BY THE GROUP OF STUDIES AND SOCIAL ACTIONS:

Attendant	Date	Content
Priscilla Bencke, Yasmine Rosa, Rebeca Calheiros	18/1/4	Groups formation meeting and general definitions/application of schedule
Priscilla Bencke, Yasmine Rosa, Rebeca Calheiros	2018/29/01	Development of Guide of Presencial Study Groups and development of material to apply for the selection and to show poster to Anfa Conference
Priscilla Bencke, Yasmine Rosa, Sandra Cescon de Moura, Rebeca Calheiros	2018/20/03	How the built environment shapes our lives
Priscilla Bencke, Yasmine Rosa, Rebeca Calheiros	18/4/12	Introduction: Brain, behavior and emotions (Architecture can change the brain)
Priscilla Bencke, Sandra Cescon de Moura, Mander Damasio, Marcio Bartilotti, Bia Rafaeli, Stela Gudolite Ortiz	2018/24/05	Analysis and Discussion about research summary/articles already existent about Neuroarchitecture
Priscilla Bencke, Sandra Cescon de Moura, Mander Damasio, Marcio Bartilotti, Bia Rafaeli, Paula Zampiva	2018/19/06	Analysis of articles about projects of Neuro-architecture applied in hospitals around the world
	18/7/4	Technical visit to the Health institution where the intervention will be performed
	2018/24/07	Definition of the theme to intervention in hospitals with the person in charge
	2018/21/08	Discussion about neuroscience with a Neuroscientist
	2018/25/09	Presentation of summaries shown in Anfa 2018
	2018/23/10	Analysis of the interventions performed so far with a neuroscientist and a psychologist
	2018/20/11	Conclusion of the social action/ practical activity and preparation to presentation of results in the final meeting of December - results of social actions
	18/12/7	Conclusion - National Meeting of Neuro-architecture

Figure 3 – Studies Schedule

To the professionals of projects, we hope the application of a way to design based on neuroscientific evidences, stimulating a more humane view of the ambiances and that cause an impact on physical and emotional well-being of the users.

To the community, we hope to allow the access and experience to Neuro-architecture, promoting a better impact of the ambiances in people's lives, also measuring its influence.

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Yasmine Rosa, Architecture and Urbanism, Specialist in Residential Architecture. Owner of Studio A1 Arquitetura, Imbé – RS, Brasil, develops residential projects focused on comfort and well-being through Neuroarchitecture studies.

# Personality and Location Decision Making: Mapping the Distribution of Big Five Personality Traits Inside Built Designs

Kevin Bennett, Ph.D., Pennsylvania State University, Beaver Campus

## ABSTRACT:

Personality psychology seeks both to understand individual differences in behavior, emotion, and decision making and to identify the underlying causes of traits. The discipline is organized around the pursuit of three principle questions concerning human activity: First, how do individuals differ from one another? Second, how can we explain these differences? And third, what are the consequences of these differences? The emergence of the Five-Factor Model (FFM) or "Big Five" – five general dimensions of character – has allowed the field to move beyond basic issues of taxonomy toward an understanding of the consequences of trait differences. Big Five factors are reliably associated with a number of behavioral outcomes in academic, occupational, relationship, and health settings (Ozer & Benet-Martinez, 2006). Although the consequences of personality differences have been studied in numerous areas, few studies have focused on the link between personality traits and location decision making (LDM) in the context of architectural design. This study presents findings that relate the psychological functioning of personality traits to LDM inside built environments by explicitly mapping out individual personality data. This approach provides a bird's eye view of the distribution of personality traits, thus adding layers of information to overall LDM patterns. Across multiple semesters, seat locations were freely chosen by college students (N=209) in an interior auditorium (11 total rows and a seating capacity of 20 seats per row). The 60-item NEO-Five Factor Inventory (NEO-FFI) – developed as a short form of the NEO PI-R (Costa & McCrae, 1989) – was administered as a measure of five domains of personality: Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness. Presented as detailed psychological maps of interior spaces, results reveal important associations between dimensions of personality and LDM. Discussion centers on how to best translate

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## **AUTHOR BIO:**

KEVIN BENNETT is Director of the Personality and Human Performance Lab (PHPL), winner of the Faculty Excellence in Teaching Award, and Assistant Teaching Professor in Psychology at the Pennsylvania State University, Beaver Campus. He currently serves as psychology program coordinator at the Beaver campus and delivers an array of courses including social, personality, evolutionary, human factors, quantitative, and introductory psychology. Bennett earned degrees from City, University of London UK (Ph.D, Psychology), University of New Mexico (M.S., Experimental Psychology), and University of Michigan (BA, Psychology). In a broad sense, Bennett's research examines (1) how we think about and engage with physical space (the actual world as well as virtual, augmented, and mixed realities); (2) how we make choices about geographic locations - from large landscapes and regions to small interiors and built designs.

## Revisiting Behaviorism: New Approaches to Understanding City Life

Andrew Brown, Associate Director of Research, Van Alen Institute

David van der Leer, Executive Director, Van Alen Institute

### **ABSTRACT:**

At Van Alen Institute, we believe that, too often, investment choices and design decisions are made in cities without sufficient appreciation of how minds and bodies respond to urban environments. The increased sophistication and accessibility of technology to observe human behavior, and the willingness of designers to experiment with those tools, signal meaningful progress toward a more human-centered urban future. However, in light of the behaviorism of the 1970s, and its limited influence on design fields beyond that period, we are reminded that research often requires considerable support to reach practitioners, inform better policies and practices, and achieve real impact.

Through our initiatives, Van Alen hopes to expand the body of knowledge showing how urban settings affect people, and empower designers and citymakers by making that knowledge more accessible. Van Alen has developed a variety of multidisciplinary projects that investigate the relationship between mind, body and city at ground-level, translate knowledge across disciplines, engage communities, and address the gaps between scientists, designers, city dwellers and city leaders. Based on studies and lessons learned from Van Alen's larger body of work, and interspersed with historical anecdotes from behaviorism's past, this presentation shares a fresh approach to exploring human behavior in the city, and advances a vision for behaviorism that can truly drive design fields and citymakers. The presentation will feature the following Van Alen projects:

#### I. The Brain and the City: Brooklyn, NY (2015)

Van Alen collaborated with neuroscientists from Columbia University GSAPP's Cloud Lab on a citizen-science experiment using brain-computer interfaces (BCI) to record brainwaves as participants explored Brooklyn's DUMBO neighborhood. Data from the experiment was aggregated into a spectacular visualization by Cloud Lab and later presented at an interactive public event of BCI research projects. The experiment and event deepened our understanding of how people relate to place and helped reshape the conversation about urban design and its potential to affect the human experience.

#### II. Shore to Core: West Palm Beach, FL (2017)

Van Alen and the City of West Palm Beach launched the design and research competition, Shore to Core, to create healthier spaces along the city's waterfront promenade. The winning research team, Happier by Design, created a tactical intervention to study the impact of the site on well-being. The result was the promotion of psychological restoration and human engagement on the waterfront, and the development of tools for policy makers to determine the success of West Palm Beach's new masterplan by measuring the links between design and wellbeing.

#### III. Ecologies of Addiction: London, UK (2018)

Van Alen and Imperial College London's Sustainable Society Network+ launched Ecologies of Addiction to explore the complex relationship between cities and addictive behaviors. The research team - neuroscience researchers from King's College London, landscape architects, and the art foundation Nomad Projects - developed a smartphone app that collected data from study participants in real time, and encouraged participants to share surrounding audio and images on social media. The study's findings suggest that even brief encounters with nature in cities can boost one's mental well-being for hours afterward, and the effects appear to be particularly beneficial for individuals at greater risk of addiction disorders.

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## AUTHOR BIOS:

### David van der Leer

David van der Leer, Executive Director of Van Alen Institute, develops projects that explore the nuanced relationship between the built environment and the human being. Under his leadership, Van Alen focuses on the ways our minds and bodies are impacted by the cities we live in, and how we in turn impact the environment.

### Andrew Brown

Andrew Brown is a researcher trained in empirical analysis of programs and public policy. At Van Alen, Andrew oversees projects that explore the relationship between mental well-being and cities, and develops activities that convene stakeholders to design strategies to urgent problems.

## AIA Credit - Learning objectives:

- Trends in the future of community engagement and fostering trust between citizens and public officials
- Trends in technologies used to observe/analyze human behavior in the built environment
- Trends in translating research in human behavior to urban development and public policy.



# Neuroscience for Biophilic Design

William Browning, Partner, Terrapin Bright Green

## ABSTRACT:

Biophilia is the innate human connection to nature (Wilson, 1984). Biophilic design brings the outdoors in and brings experiences of nature into the built environment. These experiences have been found to lower stress, improve cognitive function, and enhance preference. Theories on how these psychological and physiological changes occur have been around for several decades, and additional recent studies in neuroscience have been used to further our understanding of some of the underlying mechanisms.

Some of the earliest research on biophilic design was focused on the impact of a view to nature on surgical recovery periods (Ulrich, 1984 and Ulrich et.al., 1993). These studies examined the effect of both real and representational views of nature, which then led to questions about the differential responses to real vs simulated nature (Kahn et.al. 2008, and Spangler et.al. unpublished). Additional research explored visual preference, and where different images are processed in the brain (Biederman & Vessel, 2006).

New technology and imaging techniques allow us to see and track real-time changes in the brain. One well-researched impact of biophilic design, improvements in cognitive performance, has been attributed to the mechanism of Attention Restoration Theory (Kaplan & Kaplan, 1989). Recent work using fMRI has shown that the shift in cognitive processing can occur within 40 seconds (Lee et.al., 2015). Proposed research using a new technique, neural cartography, may allow in the field confirmation of responses to biophilic environments that had been recorded in observational study. It allows us to see the significant impact that our environment has on us.

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## **AUTHOR BIO:**

WILLIAM BROWNING, BED Colorado University, MSRED MIT, Hon. AIA, LEED AP., is one of the green building and real estate industry's foremost thinkers and strategists, and an advocate for sustainable design solutions at all levels of business, government, and civil society. Early in his career, Bill built Buckminster Fuller's last experimental structure. In 2006, he co-founded Terrapin Bright Green is an environmental strategies research and consulting firm. Browning's clients include Disney, New Songdo City, Lucasfilm, Google, Bank of America, the White House, and the Sydney 2000 Olympic Village. Browning is a founding board member of the USGBC. In addition to consulting, William writes and lectures widely on sustainable design and building practices. He is a co-author of Green Development: Integrating Ecology and Real Estate; A Primer on Sustainable Building; Greening the Building and the Bottom Line; Biophilic Design; The Economics of Biophilia; Midcentury (un)Modern; and 14 Patterns of Biophilic Design.

## **LEARNING OBJECTIVES:**

1. Understanding the basics of the science of biophilia and biophilic design.
2. Learning how design elements can support Attention Restoration response.
3. Discussing new techniques for in-the-field measurement of brain response.

# Behavior-aided Design: A Translational Approach to Persuasive Architecture

Richard Buday, FAIA, Archimage, Inc. Houston, Texas

Tom Baranowski, PhD, Baylor College of Medicine Houston, Texas

## ABSTRACT:

Architects are adept at designing functional and fashionable buildings, but they face improbable odds against issues outside their traditional skills—such as anticipating how users respond to architecture. This is important because the world's most pressing design problems are manmade. [1] Poverty, hunger, and illiteracy, for example, are the result of resource distribution, not lack of resources. Half of all accidents, many diseases, and most wars, crime, intolerance, and injustices are similarly behaviorally preventable. Architects are ethically [2] and legally obliged to protect the public's health, safety, and welfare, but as neither neuroscientists nor psychologists, they are ill equipped. Thus, sustainable, resilient, affordable housing, safe neighborhoods, productive workspaces, engaging schools, healing hospitals, and livable cities are a challenge to produce.

Human behavior is a complex process and resistant to change. Science provides insight into factors influencing what people do, but architects have little opportunity to test design ideas against psychosocial and neuroscience theories of behavior.

A combination of ancient and modern technologies offers a possible solution. Narrative immersion has been used to shape what people think and do since the dawn of man. Story-based video games have been successful educating, training, and changing people's behavior. [3] Storied game worlds are virtual environments that simulate urban, architectural, and interior settings within first-person narratives. Like real-world building users, players' game experiences can include interactions with artificially intelligent non-player characters representing different cultures, genders, ages, and physical abilities.

Architects' computer model tools are compatible with video game engines. As differences between physically constructed and virtually built environments shrink, storied video games become ideal sandboxes for architects to study a proposed building's behavioral performance with a target population.

Based on twenty years' experience creating video game interventions, we explore opportunities translating video games into architectural behavioral simulators. Qualitative and quantitative research on story immersion for promoting new behaviors, [4,5] emotional responses to simulated worlds, [6] training behaviors through video games, prose action as narrative companions to virtual environments, [7] and adapting behavior-change worlds to target population needs is presented. [8]

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# Through The Eyes of The User: Understanding Architectural Design for Users with Disabilities

Yousef Bushehris

## **ABSTRACT:**

### OBJECTIVE:

This article presents a case study that employed a user-centered methodology (functional scenarios method 1,2,3) for evaluating and quantifying multi-unit residential building designs based on the needs of the primary users. To use the assessment tool, functional-needs of a user-group are identified to determine architectural metrics and criteria for evaluation.

### BACKGROUND:

Research indicates that there are few housing options<sup>4</sup> that meet or support the social and activity needs of young adults with disabilities who are transitioning from their parents' homes into independent living in the community<sup>5,6</sup>.

### METHODS:

A survey was administered to 22 individuals with physical disabilities that asked them to indicate how they performed activities (e.g. level of independence/assistance) and how much their quality of life is impacted by that activity. The survey items were determined based on interviews, component tasks of ADLs, and the available literature on unmet needs<sup>5,6,7</sup>. 32 activities were identified for the survey in 4 main categories (bathroom-related, eating-related, ambulation-related, and interaction-related activities). Quantitative architectural elements that are associated to each of the component-tasks were determined to establish a method for assessing building designs and determining how successful they will be in meeting the users' needs.

### RESULTS:

17 activities were identified as being important for achieving a high quality of life and the focus of the architectural evaluation.

### CONCLUSION:

Based on the results, 4 architectural metrics were identified (distance, clearance, connectivity, and visibility) to assess how well social and activity needs will be met in a building design. Each of the activity categories has specific metrics associated with them (clearance for bathroom and eating activities; clearance and distance for ambulation activities; connectivity and visibility for interaction activities) and each metric is measurable (CAD software for distance and clearance, DepthMapX space syntax for connectivity and visibility). Criteria and thresholds for successfully meeting each of the important needs should be identified so that a design can be assessed based on the needs and abilities of the user group

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**AUTHOR BIO:**

YUSEF BUSHEHRI is a Ph.D. student at the Georgia Institute of Technology investigating how the design of the built environment affects human health outcomes. His research interest is at the intersection of spatial design, aging, and psychology. The focus of Yousef's doctoral studies is evidence-based design and he is working on developing methods of analyzing and quantifying spatial experiences and the impact of design elements on the various needs of its users, which can help develop future guidelines. Before Georgia Tech, Yousef had been practicing architecture in Kuwait, and was an artist in residence for 89plus at the Google Cultural Institute at Google, Paris.

Yousef Holds a BS.Arch (2011) and M.Arch (2013) from the Catholic University of America and an MS.Arch (2016) from Georgia Tech.



# Analyzing Users' Experience of an Intensive Care Unit (ICU)

Laura Cambra-Rufino, Ph.D. Student Architect  
 José León Paniagua-Caparrós, Ph.D. Architect

## ABSTRACT:

The aim of this abstract is to share the research work on the environmental conditions (both quantitative and qualitative) in an ICU of an acute hospital.

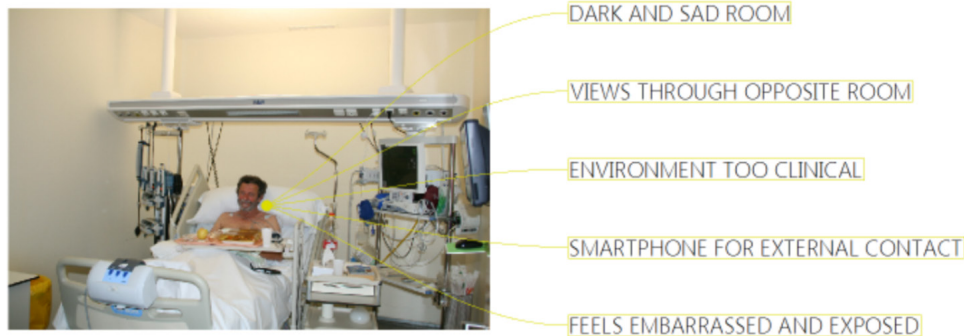
This project is a small part of a Ph.D. thesis in progress at Escuela Técnica Superior de Arquitectura de Madrid (Universidad Politécnica de Madrid, Spain) funded by "Ayudas para la formación de profesorado universitario FPU, Ministerio de Educación Cultura y Deporte de España".

The method used for analyzing users' experience consisted of a three-month placement at Hospital Marina Salud de Dénia (Alicante, Spain) sponsored by "Beca DKV Arte y Salud". During that time, we used a three-step ethnographic strategy:

- Firstly we studied and observed users' behavior in the ICU environment.
- Secondly, we carried out walking interviews to members of staff (nurses and anesthesiologists), patients and companions. In these interviews we asked them for their everyday routines and took notes about their comments on the interaction between their activities and the built environment.
- Thirdly, we drew users' flow on the ICU plan and wrote down the conclusions about their functional and emotional needs .

The overall purpose of this analysis was to identify and enlist specific users' requirements that should be considered on the design process of an intensive care unit.

Figure:



*Patient's comment on the ICU room. Written informed consent.*

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Laura graduated from Architecture at Universitat Politècnica de València in 2012.

After finishing her MArch, she got a job at the Vertical Transportation team at Arup London where she worked for almost three years. Since September 2015 she has been working on her Ph.D. at Universidad Politécnica de Madrid which focuses on the influence of the built environment on people's health. To understand hospital performance from its user perspective she has spent a large amount of time in hospitals: a three-month hospital placement and several study trips to reference hospitals in Spain. In March 2018 she moved to Sweden for a three-month placement at the "Centre for Healthcare Architecture" Chalmers University of Technology.

For more information, please visit <https://arqppmed.wordpress.com/>

JOSÉ LEÓN PANIAGUA-CAPARRÓS, Ph.D. Architect

Biographical narrative: José León Paniagua-Caparrós is a Dr. Architect with over thirty years of experience in healthcare architecture. Working as a civil servant since 1980, he has been instrumental in the design, planning and execution stages of many Spanish hospitals. He currently works as the infrastructure's manager for "Instituto de Salud Carlos III (ISCIII)" which is the main Public Research Entity that funds, manages and carries out biomedical research in Spain.

# Neurocosmos: The Emotional and Cognitive Correlates of Architectural Atmospheres

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Laura Avanzino: M.D., Ph.D.<sup>[2]</sup> - Giovanna Lagravinese: Ph.D.<sup>[3]</sup> - Anna Fassio: Ph.D.<sup>[4]</sup> - Valter Scelsi: M.Arch.<sup>[5]</sup>

## ABSTRACT:

Through its inherent spatial presence, the architectural action instills an emotional potential in the physical environment, shaping the ground for the architectural atmospheric perception<sup>[1]</sup>. The term “atmosphere” defines a state of resonance and identification (sensorimotor, emotive and cognitive) between an individual and his surrounding built space. Human subjects can feel empathy for inanimate rooms when they interiorly establish an embodied simulation<sup>[2]</sup> of some architectural features as form, proportions, rhythm, materials, light and shade, temperature, sounds (that is the so- called “generators of atmosphere”<sup>[3]-[4]</sup>).

Performing an experimental test, we propose to verify the existence of an empathic reactivity<sup>[5]</sup> in subjects put into contact with architectural settings, loaded by variable arrangements of atmospheric tension. The goal is to determine which architectural features ignite the atmospheric perception, based on emotional sensitivity, and if this supposed empathic performance is shared among subjects and gradable as model in architectural theory, according to the scientific principle of objectivity and replicability.

The test is based on observation of reproductions of architectural settings designed about their atmospheric skills. These settings, modeled in VR, are showed to engaged subjects, who have to draft a self-assessment questionnaire, aimed at analyze the multicomponential nature (emotive and cognitive) of the architectural atmospheric perception. The sample is founded on 205 individuals, of mixed sex, aged 20-35 and collected from the same sociocultural milieu. Their dispositional empathy is preliminarily examined by a brief form of the Interpersonal Reactivity Index (B-IRI)<sup>[6]</sup>. Every experimental session employs 21 digital settings, composed by a standard element and 20 variations on the theme. The case study is the spatial unit of corridor<sup>[7]</sup>, inflected with five categories of design parameters. In the questionnaire the first questions rate the subjective measure of the atmospheric emotive component, using a self-report visual analogue scale (VAS), based on arousal and hedonic valence. Following questions explore the cognitive dimension, asking the participants to describe with an adjective the emotional experience lived, extracting a tag from a prearranged set of “atmospheric features” (emotive qualities)<sup>[8]</sup> and “objective features” (physical and geometrical properties).

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## FIGURES: (clockwise, starting from the top left):

Standard element: typical corridor in private residential buildings (width: 1,20 m; height: 2,70 m), with smooth finished concrete walls, floor and ceiling.

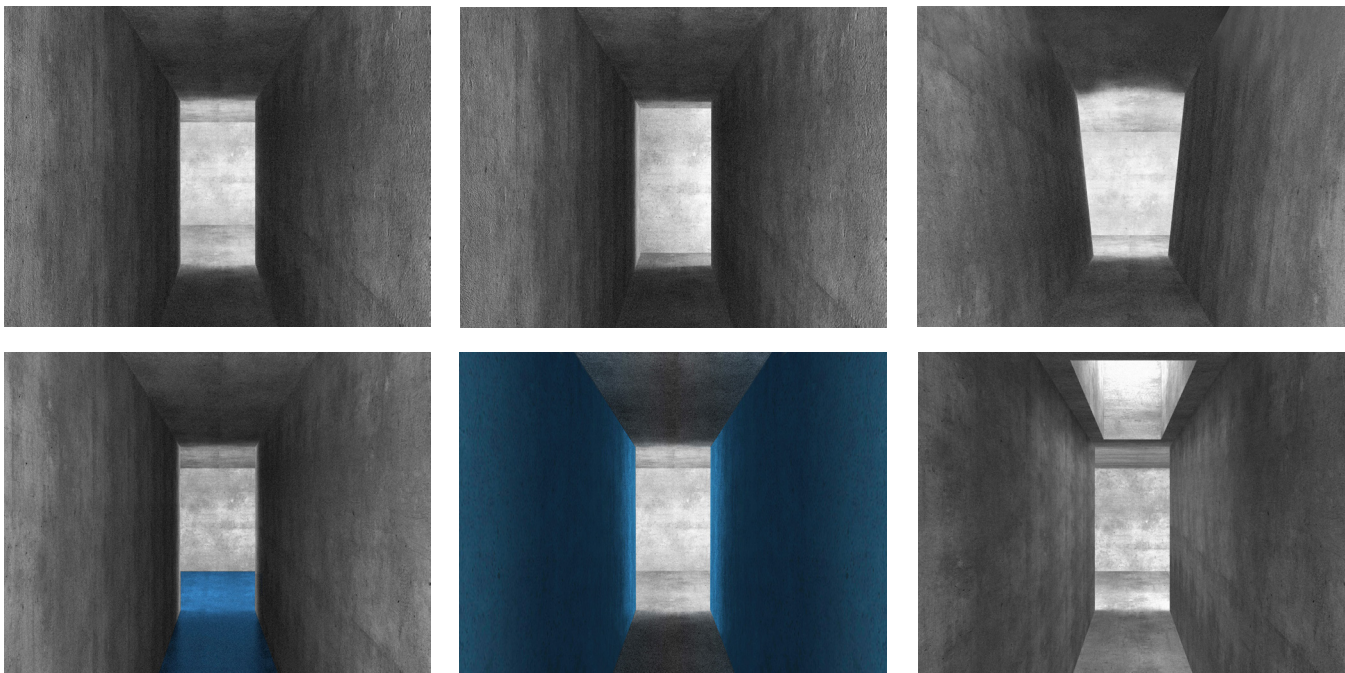
Case no. 1.2 - Variation of plan layout: "L" layout with right-turn.

Case no. 2.4 - Variation of section: trapezoidal section with sloped walls.

Case no. 5.1 - Variation of horizontal surface treatment: colored flooring (blue).

Case no. 6.1 - Variation of vertical surface treatment: colored walls (blue).

Case no. 7.1 - Variation of light and shade layout: zenithal and scattered lighting



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# PERCEIVED INTEREST AND HEART RATE RESPONSE TO FAÇADE AND DAYLIGHT PATTERNS IN VIRTUAL REALITY

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## ASBTRACT:

### SUMMARY

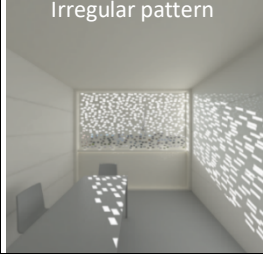
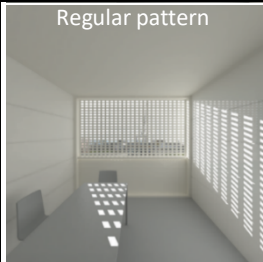

This contribution introduces an experimental study aiming to provide concrete evidence on how façade and daylight pattern geometry can affect the emotional responses triggered by a space. The study was conducted in Virtual Reality (VR) where participants were exposed to 360° scenes of an interior space with three different façade patterns. Their subjective evaluations and heart rate were recorded. The results show a statistically significant effect of façade on the perception of space, as well as the mean heart rate change. Specifically, during exposure to a façade with an irregular pattern, participants rated the space as more interesting and their mean heart rate was lower, resulting to a greater mean heart rate change compared to the resting state, providing quantifiable measures of the impact of façade characteristics on human perception and physiological behavior.

### METHODOLOGY AND RESULTS

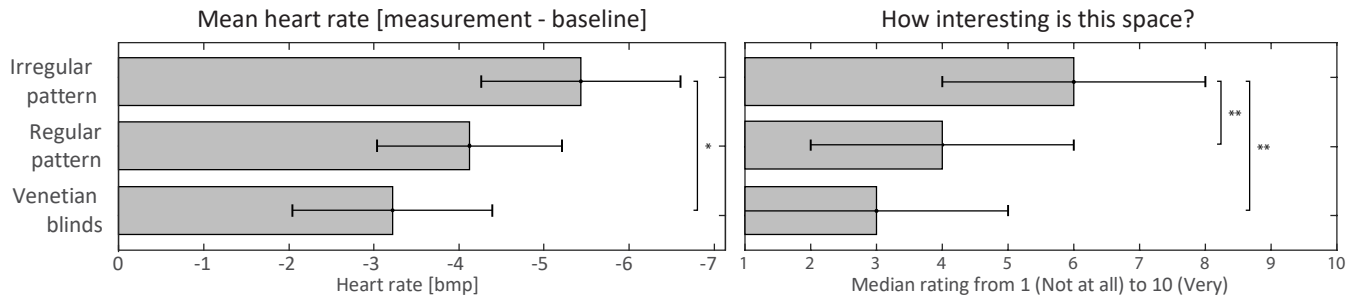
The profound impact of daylight on the subjective experience of a space has been widely acknowledged in the field of architecture (Pallasmaa, 2012; Zumthor, 2006). Current design practices tend to limit sunlight penetration in favor of visual comfort and energy efficiency, which has been criticized as leading to a monotonous light landscape (Corrodi and Spechtenhauser, 2008). Although various studies have highlighted the importance of contrast and luminance variability for the creation of interest (Parpaire et al., 2002; Rockcastle et al., 2016; Wymelenberg et al., 2010), we have limited knowledge on how the façade geometry and the resulting distribution of daylight patterns affect the experience of a space. Previous research has shown the importance of perceived order and complexity of the façade (Omidfar et al., 2015) and the irregularity in the distribution of openings on a façade (Chamilothoni et al., 2016) based on evaluations with rating scales. Although this is an important step in uncovering the perceptual effects of façade geometry, the validity of rating scales in quantifying the perception of a lit environment has been questioned (Houser and Tiller, 2003). A two-step approach, combining subjective evaluations with an objective measure, has been suggested instead (Tiller and Rea, 1992).

Following this approach, the authors conducted a within-subject experiment where participants were immersed in VR scenes with different façade geometries, investigating the relation between façade patterns and emotion responses through subjective evaluations, but also measures of heart rate and skin conductance (Felnhofer et al., 2015; Izso et al., 2009; Lang et al., 1993). Three variations of façade patterns were investigated, with, as shared attributes, the façade material and the ratio of aperture (open to total façade surface), and as varied attributes, pattern regularity and geometry of aperture (**Table 1**). The variations were developed following the workflow described in Chamilothoni et al. (2016) and were projected in VR, which has been shown to accurately convey the perception of real spaces lit with daylight (Chamilothoni et al., 2018). The three scenes were presented in random order to 72 participants (36 men and 36 women), however 16 were excluded after visual inspection of the physiological data due to anomalies or technical problems. The participants verbally evaluated how pleasant, interesting, and exciting the space was perceived (subjective response), while their heart rate and skin conductance were simultaneously recorded with the Empatica 4 wristband (McCarthy et al., 2016). For the sake of brevity, we discuss here solely the results regarding the

**Table 1.** The studied façades and the shared (✓) and unique (X) attributes between them.

Front view of interior scenes in virtual reality	Ratio of aperture	Clarity (Material)	Aperture geometry	Pattern regularity
Irregular pattern 	✓	✓	✓	X
Regular pattern 	✓	✓	✓	✓
	✓	✓	X	✓

perceived interest and the heart rate. A Friedman's ANOVA for the three façade types showed statistically significant differences of pattern geometry on both subjective and objective responses (perceived interest:  $\chi^2 = 40.86$ ,  $p < .001$ , mean heart rate change:  $\chi^2 = 6.99$ ,  $p < .05$ ). Specifically, during exposure to the irregular pattern, participants rated the interest of the space higher, and had a stronger decrease in heart rate (**Fig. 2**), which may witness coherent orienting effect (Laumann et al., 2003) toward this pattern. Pair-wise analysis with a Wilcoxon Signed-Ranks Matched-Pairs test showed significant differences between the irregular pattern and i) the venetian blinds ( $W = 101.5$ ,  $p < .001$ , effect size  $r = 0.69$ ) as well as ii) the regular pattern ( $W = 60.5$ ,  $p < .001$ ,  $r = 0.63$ ) on the perceived interest, and only between the irregular pattern and the venetian blinds ( $W = 1111$ ,  $p < .05$ ,  $r = 0.34$ ) on the heart rate change. The calculation of Spearman's rho showed a statistically significant negative correlation between mean heart rate change and interest ( $\rho = -0.24$ ,  $p < .05$ ).



**Fig. 2.** Mean heart rate change and standard error of the mean for a 28s response window after event onset, measured with a frequency of 1Hz (left), and median reported interest and median absolute deviation (right) during exposure to different façades in VR. The paired comparisons with statistically significant differences are marked as follows: \* =  $p < .05$ , \*\* =  $p < .001$ .

#### FUTURE WORK

Our results confirm that the effect of architectural façade elements on human experience is quantifiable and highlight the need for further studies on the perceptual and physiological effects of built environments. This study is part of a wider experimental investigation of the effect of façade characteristics on human perception and physiological behavior.

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# Psychological Responses to Natural Patterns in Architecture

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Marc G. Berman<sup>ii</sup>

<sup>i</sup>University of Cambridge; <sup>ii</sup>University of Chicago; <sup>iii</sup>New Mexico State University; <sup>iv</sup>University of Pennsylvania

## ABSTRACT:

Exposure to natural environments has been shown to enhance mood, cognitive functioning, and mental health. Nature-like design features can also be found in "biophilic" architectural spaces. It has been proposed that organic architectural patterns are innately preferred over synthetic forms, and that exposure to naturalistic architectural spaces may confer similar psychological benefits as interacting with nature itself. In this study, we examined whether subjective perceptions of naturalness in architecture are driven by objective visual patterns, and we investigated whether nature-like patterns are robust predictors of similarity and preference ratings of architectural scenes.

In Experiment 1, participants (n=100) rated images of interior (n=120) and exterior (n=120) architectural scenes on their perceived degree of naturalness. Ratings were then regressed on eight low-level spatial and color features of the images, which explained 64% and 49% of the variance in naturalness ratings of interior and exterior scenes, respectively. Scaling and contrast-related features drove the majority of variance in naturalness ratings, supporting the hypothesis that people associate these patterns with more natural-looking architectural scenes.

In Experiment 2, participants (n=167) assessed the similarity of the architectural scenes in an image arrangement task. We applied multidimensional scaling analysis (MDS) on these similarity data to identify the underlying aesthetic dimensions that drove participants' grouping decisions. MDS Dimension 1 weights were then regressed on subjective naturalness ratings, which explained over half of the variance in Dimension 1 weights for interior scenes and over two-thirds of variance in Dimension 1 weights for exterior scenes. These results suggest that people may unconsciously "see" naturalistic patterns in architectural images, even when they are not prompted to do so in any way.

In the final experiment, participants (n=100) were asked to make aesthetic preference ratings on the architectural scenes. These ratings were then regressed on naturalness scores modeled by low-level visual features, which explained 53% of variance in preference ratings for interiors and 35% of variance in preference ratings for exteriors. Nature-like scaling and contrast patterns accounted for most of this variance in each image set. These findings suggest that biophilic visual patterns, particularly patterns of scaling and contrast, may play an important role in generating aesthetic pleasure when people view architectural scenes. This work paves the way for future researchers to explore how naturalistic visual patterns in architecture influence restoration and wellbeing.

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<sup>1</sup> Berman et al., "Interacting with Nature Improves Cognition and Affect for Individuals with Depression"; Berman, Jonides, and Kaplan, "The Cognitive Benefits of Interacting with Nature"; Berto, "Exposure to Restorative Environments Helps Restore Attentional Capacity"; Bratman et al., "The Benefits of Nature Experience"; Bratman, Hamilton, and Daily, "The Impacts of Nature Experience on Human Cognitive Function and Mental Health"; Bratman et al., "Nature Experience Reduces Rumination and Subgenual Prefrontal Cortex Activation"; Kaplan, "The Restorative Benefits of Nature."

<sup>2</sup> Alexander, *The Phenomenon of Life*; Goldberger, "Fractals and the Birth of Gothic"; Joye, "Architectural Lessons from Environmental Psychology"; Salingaros, "The Sensory Value of Ornament"; Solomon, "New Building Systems Mimic Nature and Return to a Biocentric Approach to Design."

<sup>3</sup> Alexander, *The Phenomenon of Life*.

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ALEX COBURN is a PhD student in Architecture at the University of Cambridge. His research focuses on psychological responses to visual patterns in architecture, with a focus on the psychological benefits of biophilic design. Over the past two years he has been collaborating with Dr. Anjan Chatterjee at the Center for Cognitive Neuroscience, University of Pennsylvania, and with Dr. Marc Berman at the Environmental Neuroscience Laboratory, University of Chicago. He can be reached at alexcoburn11@gmail.com or (617) 306-1134.

# Architecture of Effortless Attention

Jana Masset Collatz, Erin Cuevas, and Nancy Etcoff, PhD

## **ABSTRACT:**

Capturing effortless attention—a psychologically restorative state during which investing more attention in an activity or environment is experienced as requiring fewer cognitive resources—has the potential to serve at least two cultural functions through architecture. First, by promoting a conscious engagement with one's physical environment, architecture can inspire interest in the activities and people it hosts. Second, by allowing people to rest their more consuming directed attention, architectural spaces that capture effortless attention can provide cognitive rest and restoration.

Extensive empirical evidence shows that contact with nature supports the experience of effortless attention. Why then do we not produce more built environments that promote the human needs fulfilled by effortless attention? For example, it has been posited that environments with a quality of mystery, suggesting that there is more information to be acquired through further exploration, inherently inspire curiosity and therefore engage effortless attention. Because the human brain is tuned to detect novel information in the environment, novelty inherently attracts effortless attention as well.

"Architecture of Effortless Attention" is an ongoing research project with two goals: (1) to identify specific spatial conditions that promote the mentally engaged restorative state of effortless attention and (2) to generate an evolving catalog of architectural design strategies to produce such conditions. The research is grounded in a review of literature across the fields of neuroscience, psychology, consumer marketing, industrial design, and architecture.

Drawing on this research and experimenting with it in practice, the authors are currently developing "Expansiveness," a design implementation of the theories developed in "Architecture of Effortless Attention" that employs qualities of mystery and novelty— attractors of effortless attention—to promote psychological wellness. Inspired by installation artists such as Yayoi Kusama ("Infinity Mirrored Room") and James Turrell ("Breathing Light"), "Expansiveness" draws on case study analysis to investigate means and methods for generating perceived expansiveness within a confined architectural enclosure. The resulting methods can be applied to solve architectural problems beyond the scope of art and installation; for example in confined urban dwellings, adaptive reuse, and pop-up projects where expanding the perception of an enclosed space is a valuable design strategy.

**AUTHOR BIOS:****JANA MASSET COLLATZ**

Jana Masset Collatz is an architect whose design research investigates the intersection of human perception and material composition. Together with Erin Cuevas, she co-founded a Los Angeles-based design firm with a vision to bring the subjects of their curiosities—nature, neuroaesthetics, performance art, industrial design, and social media—into design realities that actively engage the mind and emotions. Her design process is strongly influenced by interdisciplinary collaboration. Jana received a post-professional Master of Architecture from Harvard University in 2016, in addition to a Bachelor and Master of Architecture from Tulane University in 2009 (summa cum laude, AIA medal recipient) and a Master of Preservation Studies in 2010. From 2009 until 2014, she worked as an associate for Ammar Eloueini Digit-all Studio. Her work has been published online and in print, as well as exhibited at the AIA New Orleans Center for Design and the fortyK gallery

**ERIN CUEVAS**

Erin Cuevas is the co-founder of Curious Minds Los Angeles, an interdisciplinary architecture office focusing on sensory and immersive environments. She holds a graduate degree with distinction from the Harvard Graduate School of Design, and a bachelor's degree from the University of Southern California, where she currently holds a position as a design instructor.

Erin is committed to addressing our increasingly media-centric world by challenging the intersection of culture, digital behavior and architecture. Her work has been published in print and online, as well as on public display, including at Harvard University and the Architektur Galerie Berlin. Supplementing her visual arts studies, Erin has participated in dance and choreography through involvement with several dance companies in Southern California, including Team Millennia, USC Dance Repertory Company, and Evoke Dance Company. Erin founded Project XYZ, a production company composed of dancers, architects, and film-makers, to explore her interest in the delicate relationship between the human body and its surrounding environment.

**NANCY ETCOFF, PH.D.**

Nancy Etcoff is an Assistant Clinical Professor at the Harvard Medical School, a faculty member of the Harvard University Mind/Brain/ Behavior Initiative, a Research Affiliate at the Center for Health and Happiness at the Harvard School of Public Health, and a psychologist and researcher at the Massachusetts General Hospital Department of Psychiatry where she is the Director of the Program in Aesthetics and Well Being.

Dr. Nancy Etcoff conducts ground breaking and highly cited scientific investigations in the psychology and neuroscience of emotion, and the psychology and biology of beauty and aesthetics. Her research has culminated in numerous awards, and her book, *Survival of the Prettiest: The Science of Beauty* (Doubleday, 1999; Anchor, 2000) has been published in over a dozen languages, and is

the subject of a one-hour Discovery Channel documentary.

Nancy Etcoff has appeared as a keynote speaker at numerous international, national and local conferences. Her 2004 TED talk on happiness and its surprises has been viewed by over 1,400,000 people and was recently cited by TED curator, Chris Anderson as one of the 5 talks he learned the most from. Finally, she has been sought out by corporations and non-profits as a consultant & global advisor.

# Building Façades as Neurocognition Stimuli

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## ABSTRACT:

This paper reports the first stage<sup>1</sup> of an ongoing research which suggests a methodology to catalog building façades for further measuring of its in situ influence (if any) on subjects' physiological responses through the use of portable and/or wearable devices such as skin conductivity bracelets, electroencephalogram helmets and georeferencing by the use of global positioning systems. Previous studies<sup>2</sup> on this matter proved effective to point out built environment does affect both psychological and physiological states on passersby. This study aims to pinpoint usual building façade types to gather on-site physiological data.

The suggested method of cataloging building façades is expected to surpass type description by treating it as interface, i.e., transition between closed private systems, (buildings and its boundaries), and open public ones, (streets and its openness). Both connect at the street level affecting each others patterns of movement. This is Space Syntax Theory primary premise and how it tackles architecture: as connected systems ordering space. The omni urban landscape around us within cities is given shape to a certain society at given time and place conveying individual flux from origin to destination - building to building - through the streets. Hence, spatial form, spatial configuration, is of main relevance to this study as it pertains attributes to control movement on the ground: streets, pathways, gardens, fences, railings, multiple entrances (etc.) - inviting or repelling pedestrians. This categorization will help build a broader concept of façades than description alone.

Recent research crossing Neuroscience and Architecture have indicated subject responses to built environment comparing controlled stimuli such as geometric surfaces and organic surfaces, or green spaces and arid settlements (here roughly described as such for better understanding). Regarding results show clear preference, it's fair to analyze architectural space decoding it into listed elements regularly found in cityscapes and commonly used to induce the relation between pedestrians and buildings. There is a chance these elements are related to city planning mechanisms such as zoning regulation: setbacks and sidewalks width, for instance. Any land use legal instrument promoting a pattern of urban development which might affect pedestrian preferences and therefore routes. Put into another words, planners programming the city to be either friendly or excludent to pedestrians behind empirical logic - which might not reflect overall well-being of those who live in the cities.

The suggested cleavage areas for initial testing of this devise methodology are two commercial sectors less than a mile apart from each other in Brasília, capital of Brazil. Separated by the Monumental Axis, South and North commercial areas are within same zoning, same size but former was built about 25 years later than the latter. This time frame results in two unique urban samples, being South representative of modernist ideals [figure 1] and North of sectarian postmodernism [figure 2] - local conditions which allow individual performances analysis and later clashing of both data regarding not only influence of a façade type, but immediate collection of façades, Brasília's Pilot Plan urban planning per se, as perceived by pedestrians.





[figure 1] South commercial sector building - view from a block corner  
(Photo by the authors)



[figure 2] North commercial sector building - view from a block corner  
(Photo by the authors)

## ACKNOWLEDGMENTS:

Research funded by own resources.

## NOTES:

1. Research consist in three phases, being: [1] building cataloging; [2] choice of representative façade types and field arrangements; [3] field experiments on subjects. Next cities to host this research are New York City (US) and Recife (Brazil).

2. Testing, Testing! A psychological study on city spaces and how they affect our bodies and minds. In: <http://www.bmwguggenheimlab.org/>.

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# Implementation of Neurofeedback Paradigms to the Generation of Design & Architectural Features

Pierre Cutellic, PhD Fellow

## ABSTRACT:

This project explores linkages between biophilia, neuroscience, and the built environment to develop evidence-based design. One can see how deeply linked are the developments of artificial with natural (or non-artificial) aspects of intelligence in currently encoding the world and developing models of understanding it. A classical separation between both forms of intelligence may only serve here as a foreword to introduce the complementary use of Machine Learning (ML) models with human cognition in the hereafter described research. Looking within the research and development Molds of Brain-Computer Interfaces (BCI), implemented ML models from data acquisition to classification tasks in general are a great example of complementary loops of inference together in response with the neurofeedback of a user for re-capacitation of motor or other cognitive skills in medical applications such as neuroprosthetics for example. But aside medical research and among the abundant literature and initiatives to bring BCI Out-Of-The-Lab (OOTL) and to other disciplines for research and application purposes, it has been quite rare so far to find architectural or design research contributing in investigating or repurposing such technologies, despite their accessibility. Yet architectural potentials and consequences, and more precisely in the case of Computer-Aided Architectural Design (CAAD) for the scope of this research, should be considered, at least, of the same importance than for construction technologies, material engineering or even environmental data-science; once considered for a broader understanding, reachability and impact on the world in which one operates. This paper describes an ongoing research on generating design and architectural features through the exploitation of discriminative neural patterns such as Event-Related Potentials (ERP) and by the implementation of neurofeedbacks, gained through a visual EEG-based brain computer interface (BCI), for the active modulation of implemented ML models. While the built environment is indisputably aggregating and modulating so many stimuli from the world, It necessarily participates to infer on physiological and psychological states. This paper will first describe empirical experiments in the scope of inverting the concern and ask what can such states provide in modulating design and architecture. Then hypotheses will be proposed following the trivial model of an inference loop and project potential contributions to architecture.

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Pierre is currently PhD Fellow at the CAAD chair of ETH ITA Zürich since October 2016. His research focuses on the integration of peculiar neuro- and other bio-signals together with machine learning in decision-making and learning automation of design processes. Pierre graduated in Architecture at E.N.S.A.Paris- Malaquais in 2007. He joined Gehry Technologies in Europe in 2008 as a Project Consultant and worked until 2012 on EU and UAE projects, as the Qatar National Museum (Doha) or the Luma Foundation (Arles), while being involved with renowned design firms and general contractors such as Gehry Partners, Zaha Hadid Architects, Ateliers Jean Nouvel, Coop Himmelb(l)au, Oger International, Bouygues Construction and Hyundai Construction. Between 2010 and 2015, Pierre became adjunct-assistant professor and taught integrative design and production, human computation and algorithmics at the Digital Knowledge Dept. of Paris-Malaquais. In 2013, Pierre co-founded his first innovative company in neuroscience and computational design. His past professional experience and collaborations have been frequently published and exhibited in US and EU since 2010. Before joining ETH, he was since 2014 lecturer in innovations and computation for the building industry at CNPA Laboratory of EPF Lausanne.

# Incentive Architecture: Neural Correlates of Spatial Affordances During Transition in Architectural Settings

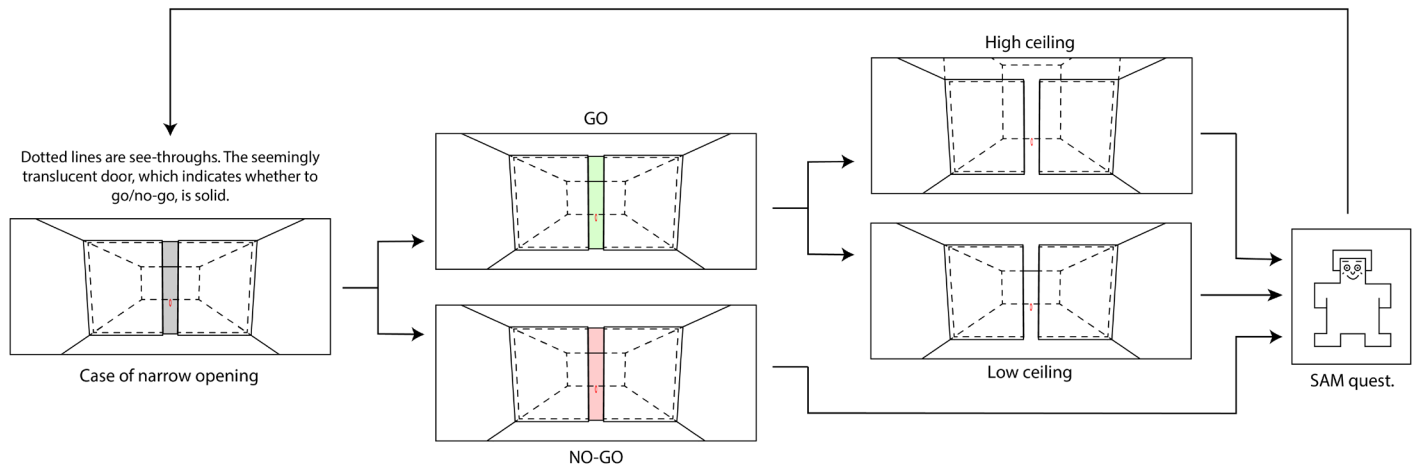
Zakaria Djebbara

## ABSTRACT:

Transitions from one space to another are defined by two spaces and a delineating threshold between them. The threshold itself can manifest in different architectural forms and has impact on the perception and affective evaluation of the connected spaces (Moretti, Bucci, Mulazzani, & DeConciliis, 2002). Changing spatial proportions in sequences is an architectural illusion exploited since the Egyptians (ca. 2100 BCE). Prior spaces seem to affect later spaces and the threshold itself might have an affective influence. Here, we investigated transitions in the form of openings, to gain a deeper understanding of the perceived affordance of crossing the openings and how this impacts evaluation of the space. Embedded in a broader investigation of cognitive predictive mechanisms to better understand architectural transitions, the aim of the current study was to investigate whether the physical passing, referring to affordances (Gibson, 1977) and active inference (Bruineberg, Kiverstein, & Rietveld, 2016; Friston, Mattout, & Kilner, 2011), co-vary with the motor-related cortical potentials (MRCPs; Bozzacchi, Giusti, Pitzalis, Spinelli, & Russo, 2012) as measured with the electroencephalogram (EEG). We hypothesized to find more positive MRCP activity in pre-frontal and parietal areas prior to action in spaces that provide better affordances, compared to spaces that hinder the agent (Bozzacchi, Spinelli, Pitzalis, Giusti, & Di Russo, 2015). We further investigate whether the ceiling height of the second space has an emotional influence, and how the MRCPs may influence the introspective decisions. Using a Mobile Brain/Body Imaging (MoBI) approach (Gramann et al., 2011; Gramann, Jung, Ferris, Lin, & Makeig, 2014; Makeig, Gramann, Jung, Sejnowski, & Poizner, 2009) we combined head-mounted virtual reality with mobile EEG, to investigate transition through different openings. Participants were asked to transition between two spaces passing openings with low versus high affordance, i.e., openings that were too narrow to pass versus openings that were easily passable. The task entailed an action-dependent transit (50% of trials), with the final goal to reach a red circle (Figure 1). This study investigates the neural dynamics underlying action and cognition as predictive mechanisms revealing first insights into the affective influences of transitions on spatial perception of sequentially experienced spaces.

Figure 1: <https://i.imgur.com/C6LpqFG.png>

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# Multimer: Human Signals for Improved Spatial Design

Arlene Ducao and Ilias Koen

## **ABSTRACT:**

Sensor technology, particularly biosensor technology, has become widely, cheaply available and portable. In 2018, than a third of the world's population is expected to own a geo- locatable smartphone, devices that can pair with biosensors so that, for better or worse, we can track ourselves in all kinds of ways, in all kinds of settings, and learn new things about ourselves and our environments. Call it the Era of the Spatially Quantified Self.

To explore how biometric sensors can help us understand the role of infrastructural networks in the collective socio-cognitive life of city residents, a group of researchers from MIT and NYU developed Multimer, a location analytics system that is among the first to examine crowd-sourced, quantified biometric data in a spatial, temporal, social, and environmental context. It also provides experiential data about populations at large spatial scales, with the aim of improving spatial design through quantified, uniformly and passively collected human signals. Multimer data, which includes brainwave, heart rate, pedometer, and GPS information, has been collected and analyzed for a range of applications, from measuring perceptions of danger and safety in Manhattan traffic to quantifying what "immersion" is for users of virtual reality. Multimer data has also been collected in other places including London, Glasgow, Nairobi, Manila, Milwaukee, Kuala Lumpur, and San Francisco. In this paper, we will discuss the system components, the analysis findings, challenges, and next steps for this technology.

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ILIAS KOEN, CTO of Multimer; Research Akliate, NYU

<http://multimerdata.com>





# Exploring the Phenomenological Perception of the Architectural Spatial Experience

## *Bibliotheca Alexandrina as a case study*

Sara Ebrahem

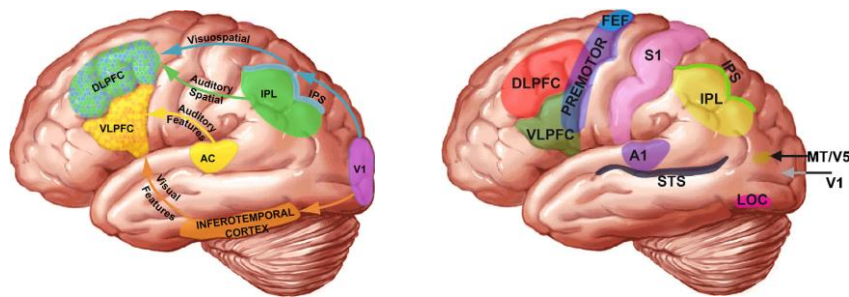
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### Abstract

Phenomenology of perception is the interpreter of the architectural spatial environment. It translates the swilling forces of spatial physical energy into an architectural experience happening in the brain. The senses act as gate ways, in which the spatial environment channels through into the user's psyche. Neuroscientists assures upon studying images of the brain in action that the five senses are the fuel of emotions. Major advances in neuroscientific multi-sensory interaction studies, show that multisensory regions account for sensory spatiotemporal integration, sensory substitution accruing, supramodality, crossmodality, emotional and behavioral response, showing that most, if not all neural processes are in some form multisensory. However, guided by the visually-biased nature of architectural practice, architects attempt to creates better architectural experience relying on their intuitive best judgment, ignoring the phenomenological multi-sensory nature of user's perception and its potentials. Therefore, on an interdisciplinary common ground between architecture and neuroscience, the research takes a speculative method, aiming to empirically determine the extents to which phenomenological perceptions allow users to experience architectural spaces, overcoming the intellectual cognitive blindness through channeling the selective attention of the brain mechanism. The entry spaces Bibliotheca Alexandrina are taken as a pilot case study, verified by a subsequent case study. Following a predetermined procedure based on neuroscientific-architectural findings, users are navigated through the spaces in interactive walkthroughs. The empirical experiment resulted in the verification of the multi-sensory phenomenological nature of the architectural experience, giving intriguing indicator on the extend of impact of each sense and its ability to create emotional inclusive and sensory substitutive experience, speculatively identifying the senses that are most responsible for creating the imaginary volumetric architectural spatial shape in the brain, aiming finally for proposing phenomenological method to be specifically included in the architectural design process and education.

*Keywords: Phenomenology of perception ; Multi-sensory experience ; Sensory emparical experiment; Architectural sensory substitution.*

### Multi-sensory interaction reporting to PFC (DLPFC & VLPFC) of behavioural response and spatial memory



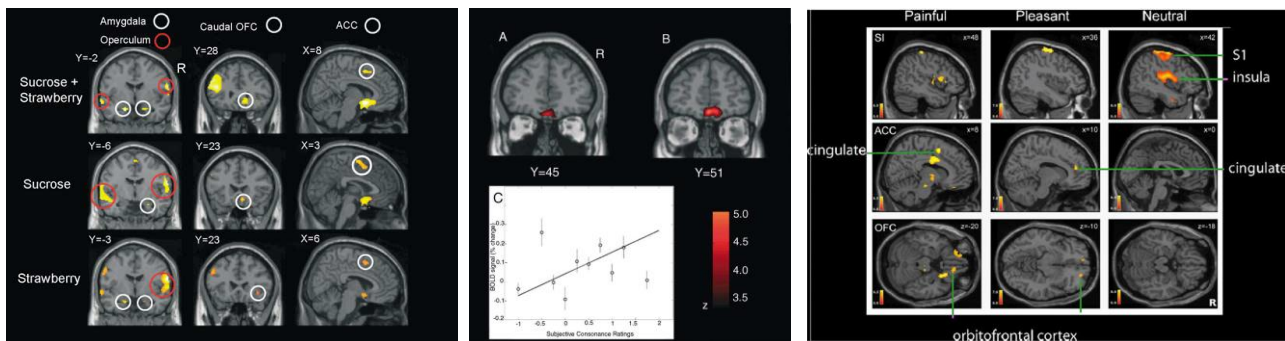
**Fig. 1.** Left: A depiction study of the flow of information from different sensory modalities to each other and to the PFC area in the brain, which is divided to main parts. Right: A neuroscientific review of a Multisensory cortical brain areas, showing a direct relation between multi-sensory interaction and spatial perception motion, behaviour responsible areas. Source: (Klemen & Chambers, 2012)

### *Multi-sensory and emotional response*

Orbitofrontal cortex OFC stimulation: mediating between sensory inputs, emotions, behaviour and The PFC area in the brain

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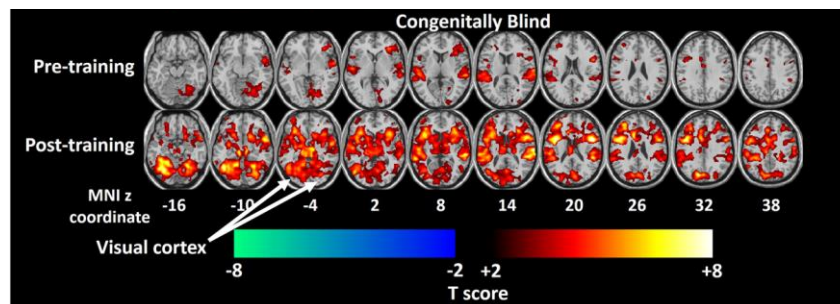
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**Fig 2:** Left: shows the activation of four different brain regions in the brain to odour-tasteless solutions. Middle: shows the activation of specific brain areas due to activation of (taste-odour) stimulus. (A) the medial part of the anterior OFC. (B) in nearby medial part of the anterior OFC. Source: (Araujo, Rolls, Bach, McGlone, & Philips, 2003). Right: fMRI Brain activation of ACC and OFC. Source: (Rolls, 2010)

## Sensory substitution (Phenomenonpathic response)

The potential of the architectural multi-sensory spatial environment to act as a sensory substitution device



**Fig. 2.** Audio visual sensory substitution due to various tasks conducted using sighted, blind and congenitally blind subjects in two situations pre- training and post training. Source: (Murphy, et al., 2016)

## Multi-sensory empirical experiment at the Bibliotheca Alexandrina



**Fig.3.** Part of the Bibliotheca alexandrine empirical experiment including participants following predetermined procedure, based on neuroscience and architectural review.

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# Clinicians for Design: A Convergence of Expertise to Enhance Cognition and Healthcare Design

Eve Edelstein\*, Diana Anderson, Thomas Grey, Desmond O'Neill

## ABSTRACT:

### Background:

Increasingly, clinicians are asking not only for the architect's perspective, but to develop a design skill-set and knowledge-base that will allow them to help shape the future of hospitals, medicine, and healthcare.

### Purpose/Objectives:

Clinicians for Design is an international network of clinicians and researchers with a vision to inspire and accelerate the design of environments that enhance health outcomes through innovations in healthcare spaces, technologies, care delivery systems and policies (1).

The inaugural Clinicians for Design workshop was hosted at the Royal College of Physicians, during the European Healthcare Design conference, London, UK in June, 2017. Thereafter, workshops and research activities with hospitals and academic medical centers are exploring key lessons learned from the clinicians, healthcare system leaders, and medical researchers. Specific objectives include the application of research to improve practice, meetings to increase clinician understanding of the architectural process, and integration of clinical expertise with design-thinking.

### Methods/Results:

As 'neuro-architectural' research converges with clinically-informed design, it has inspired the emergence of new models of practice for dementia care. A network of like-minded clinicians, neuroscientists, and a team of geriatricians and designers have formed an alliance to enable a deeper understanding of the elements which contribute to dementia-inclusive design in healthcare facilities.

A leading cause of institutionalization for those with dementia is often spatial disorientation (2). Absence of cognitive mapping in dementia can be partially compensated for by using other forms of orientation strategies (3). Therefore, the design of healthcare facilities can significantly influence one's spatial orientation and wayfinding abilities (4). This grant-funded study aims to develop a 'Design Audit Tool' in line with Dementia-Inclusive Design Guidelines, ensuring equality across healthcare users (5). The goal is for inclusive, accessible, and easily understood environmental design for people with dementia, based on neurological and architectural research.

### Implications:

Clinicians and designers discuss their progress in identifying dementia care pathways and research outcomes using a transdisciplinary approach. The advances towards a dementia inclusive healthcare audit tool is described, including the role of experts and emerging professionals in medicine, research, and design who seek an enduring connection between clinical practice and architecture.

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**Dr. Eve Edelstein** directs the Perkins+Will Hx Lab that explores human experience of design. Dr. Edelstein translates research into brain-based design solutions that address clinical, psychological and behavioral needs. Eve's degrees include a Ph.D. in neuroscience (Institute of Neurology, University College London), a professional Master of Architecture (NewSchool Architecture & Design) and Anthropology (University California, Berkeley). Dr. Edelstein is co-founder of Clinicians for Design, an international group formulating design solutions at the healthcare interface; a Board member of the Academy of Neuroscience for Architecture; member of the AIA Design+Health Research Consortium, and faculty of the Neuro-Architecture intensive course at NewSchool of Architecture for Design. Eve's research includes: hearing neuroscience (Harvard / MIT lab); circadian impact on EEG and HRV (AIA College of Fellows Latrobe Prize with Ohio State University, University California, Berkeley and San Diego); EEG and perceptual responses to virtual reality visual and sonic simulations (University California San Diego); Neuro-Universal impact of architecture on able and disabled users (Berkeley Teaching Prize); digital modeling of multi-circadian stimuli (HxLab); and the impact of design features on workplace behavior (HxLab and University California Berkeley). Dr. Edelstein publishes and presents internationally, including TEDx and keynote addresses the American Institute of Architects and the American Academy for the Advancement of Science.

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# How does visibility in urban settings change human perception on urban design?

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## ABSTRACT:

Urban population keeps growing with a projected estimate of 70% of population living in cities within the next couple decades (United Nations, 2014). Previous studies on urban design show that urban form has considerable impact on human mobility and path selection (Hillier and Lida 2005, Meilinger 2008). Visibility has long been argued by urban planners and designers and visibility in urban settings play a critical role in perception of urban environments (Fisher- Gewirtzman, 2018). Understanding how visibility in urban settings change human perception of urban design provide opportunities for improving design of future cities. The objective of this research study is to define the correlations between visibility level in urban settings and human perception under variant urban configurations (e.g., walkways, greenery, tall/short buildings, with/out sky view). A set of experiments has been performed using biometric sensors and visual stimuli, which simulate movement along variant pedestrian paths from pedestrians' eye point of view. Results show visible sky view in a low urban settings walking along a center path without greenery was more influential for human relaxation than being exposed to greenery. Similarly configurations of urban design with low buildings with 50% sky-view exposure with trees where pedestrians were walking along the sidewalks resulted in more relaxation in people than without trees. Collected data from 35 participants are currently being analyzed statistically to understand the correlation between visibility scores and human experience.

## REFERENCES:

'World Urbanization Prospects', United Nations, New York, 2014

"Globally, more people live in urban areas than in rural areas, with 54 per cent of the world's population residing in urban areas in 2014. In 1950, 30 per cent of the world's population was urban, and by 2050, 66 per cent of the world's population is projected to be urban".





# Exploring Garden Design Composition and Its Effect on Psychophysiological and Behavioral Responses

Martha Espinoza, Rui-Min Wang, Keiji Iramina

## **ABSTRACT:**

Our daily experiences produced by the physical environment have an active role in our health and wellbeing. Experimental researchers have been studying the benefits of exposure to natural environments, finding that natural surroundings cause more calming responses than urban surroundings; such as a reduction in physiological stress, improved recovery from mental fatigue, and the enhancement of positive emotions. This is well-known in literature as the restorative effect.

However, it is still unclear what specific forms or structures in nature provide an environment that is more in tune with our health. In this work, we will compare two different garden designs to explore which characteristics play an active role in enhancing our health restoration.

The results aim to contribute to the improvement in design of gardens and natural landscapes that can be integrated into urban environments like hospitals, care facilities, and workplaces among others to reduce stress in our everyday life, enhance the recovery process of patients, and improved cognitive functions, mood, and creativity.

## **METHOD:**

This experiment will be conducted in Fukuoka city, Japan, in May when the average temperature is 22 degrees Celsius. The studies will record behavioral and psychophysiological responses of participants ( $n > 12$ ) while viewing to three different spaces for 15 minutes; a) Japanese style gardens, b) urban garden and c) urban area (control condition). Physiological responses of electroencephalography (EEG) and heart rate variability (HVR) will be measured during the viewing time of each space to assess the stress level. After completion, the experiment participants will perform a reaction-time (RT) task to determine the behavioral effects. Self-report questionnaires Positive and Negative Affect Schedule (PANAS) and Perceived Arousal Scale (PAS) will be conducted to investigate the emotional state of participants.

This research will be supported by a specialist in the field of architect and landscape design to better the elements of garden composition and how critically analyzed each criteria.

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KEIJI IRAMINA received the B.E. degree in electronics engineering in 1986 and the M.E. degree in electronics engineering from Kyushu University in 1988, and the Dr.Eng. in biomagnetism from Kyushu University, Japan, in 1991. He was a Research Associate with Kyushu University 1991. He became an Associate Professor with the Faculty of Engineering, Kyushu University in 1994. He joined as an Associate Professor with the Research Institute of Biomedical Engineering, University of Tokyo, in 1996. He was a Professor with the Graduate School of Information Science and Electrical Engineering, Kyushu University, in 2004. His main research interest lies on biomedical engineering and functional imaging of the brain.

# Sensory Design Lab: Studying the Brain and Building Within Real Life Settings

Jonathan Essary, Upali Nanda, PhD, Jon Bailey, and Giyoung Park, PhD, AIA

## ABSTRACT:

In 2017, our HKS research team developed the Sensory Design Lab (SDL) within a new lab and makerspace. The SDL is an adaptable and deployable structure used for testing materials and spatial conditions, while recording environmental and biometric data. Funded through the American Society of Interior Designers, and in partnership with the Dallas Independent School District, the team installed the SDL inside a Dallas high school whose curriculum focuses on personalized learning. The intent was to better understand how space is utilized, and how it might be reconfigured to assist personalized learning through the study of the relationships between furniture selection and arrangement, ambient environment, human behavior, learning achievement, anxiety levels and heart rate.

An array of in-house sensors were created to capture environmental light levels, temperature, humidity and sound levels. Biometric sensors, such as heart rate monitors and thermal cameras, were utilized to capture human responses to various furniture configurations. Behavioral coding and analysis of thermal camera footage identified usage of space, and entry/exit surveys completed the dataset for analysis. Statistical analysis shows higher sound levels were associated with a greater reduction in anxiety levels and with greater subjective achievement. A higher heart rate was only linked to higher temperature. The frequency of changing interfaces (e.g., laptop to whiteboard) was marginally associated with a reduction in anxiety, but with lower self-reported achievement.

The SDL is currently installed in the 2000 square foot lab in HKS' headquarters. Current and future use will further explore the relationship between the built environment and human neurophysiology. Advances in neuroscience could shift designing for the "human," to designing for the "human brain." A deeper understanding of the phenomenological connections between people and our habitats, at the cognitive scale, provides insight for what we build for healthier communities and societal stability. Architects and designers will soon be using the SDL to test their design hypotheses with an expanded set of devices including VR/AR headsets, Microsoft Kinect, EEG and GSR sensors. We hope the SDL serves as a nexus for collaboration with neuroscience researchers, moving the needle for brain and building in our profession.

## Figures:

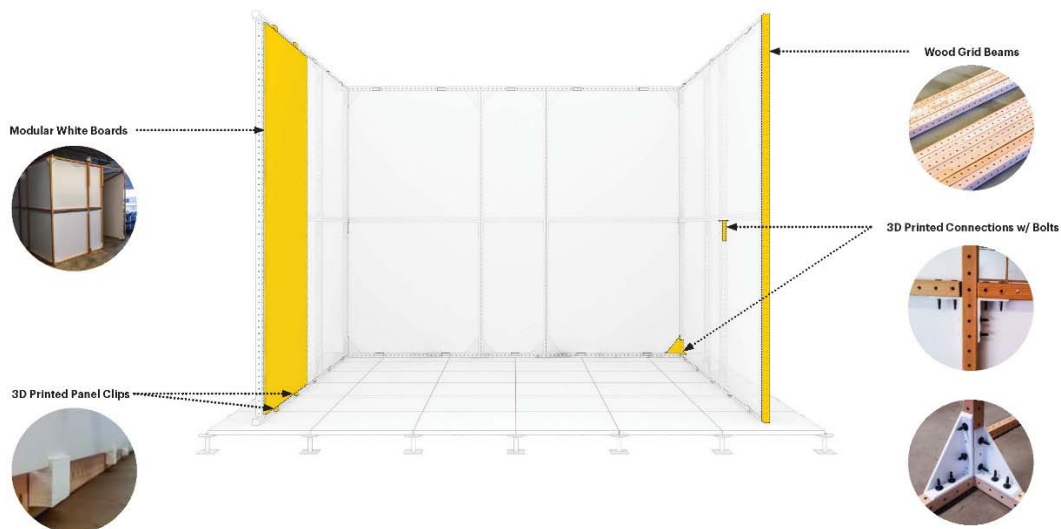


Figure 1 - Diagram of Sensory Design Lab structure, custom brackets, surface material, and flooring system.

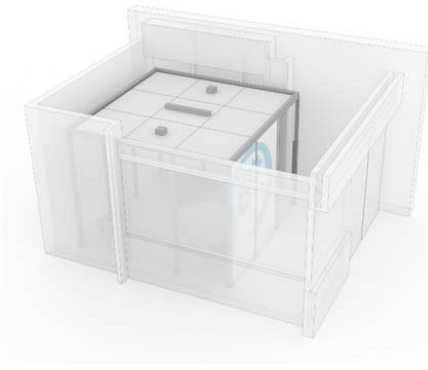


Figure 4 - Concept rendering of SDL installed in Dallas Independent School District high school.

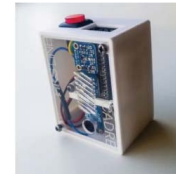
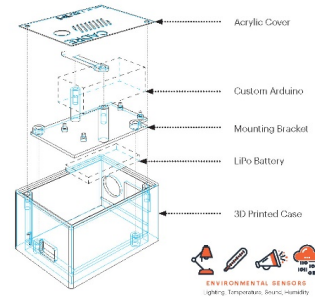


Figure 5 - Custom made sensors by HKS LINE measuring and recording values for light, temperature, sound, and relative humidity, which are used to correlate with survey response of interaction and response to the spatial design.

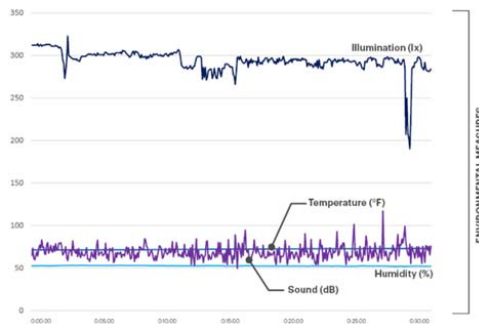


Figure 2 - Graph plotting environmental data for one study session.

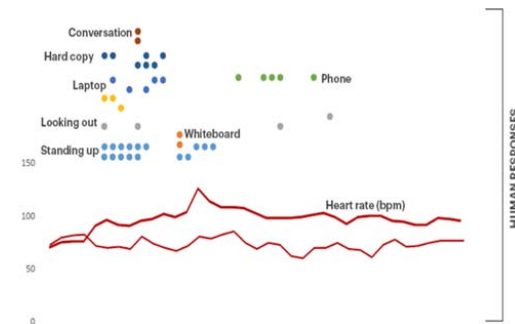


Figure 3 - Graph plotting students' heart rate in comparison to interaction.

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## Correctional Lighting is Bad for Your Health

Jay Farbstein, PhD, FAIA, Richard E. Wener, PhD, Melissa M. Farling, FAIA, LEEDap, Erin Persky, Associate AIA, CCHP, Eve A. Edelstein, PhD, EDAC, Associate AIA, F-AAA

### ABSTRACT:

The AIA Academy of Architecture for Justice has been exploring a variety of conditions in typical correctional facilities that affect lighting. These include generally limited access to adequate natural lighting, the limited spectrum artificial lighting that is provided, and the fact that at least some lighting is kept on at all hours of the night (in cells and dormitories). It is hypothesized, based on research in other settings, that the typical correctional lighting provisions result in negative impacts on both inmates and staff (especially those staff who work night shift or who rotate shifts on a regular basis). The expected impacts include disruption of sleep patterns and circadian rhythms with attendant associated psychological and health outcomes, which can be very powerful especially given the involuntary nature of confinement and its long duration for many individuals.

The potential of improved design layouts together with new kinds of artificial lighting (programmable LEDs) to remedy the situation are worthy of study, given the potential very great beneficial impacts which could include improved physical and mental health and reduced utilization of health care and mental health services, improved attentiveness when attending classes and other programs, reduced stress and related behavioral manifestations including conflict, fights and assaults, and many others.

This session focuses on the issues and theories associated with the physical design of correctional facilities and its psychological and behavioral impacts, strategies in other types of facilities which may be applicable, with the goal of outlining a neurobiological research model for these facilities.

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#### JAY FARBSTEIN, PhD, FAIA

President of Jay Farbstein & Associates, Inc., Mr. Farbstein has more than 30 years of professional experience and is nationally recognized for his contributions in the field of facility planning, programming, and post occupancy evaluation – on which he has spoken and published widely and for which he has received many awards. Mr. Farbstein has led or participated in numerous research projects for clients including the National Institute of Corrections, U.S. Postal Service, the World Bank, the U.S. Department of Labor, and the Bruner Foundation. Recently, he led a study of the application of neuroscience to the evaluation of correctional environments; this project received a Certificate of Research Excellence – along with the only special commendation – from the Environmental Design Research Association. Mr. Farbstein earned a MArch from Harvard University and a PhD from the University of London. He is a Fellow of the American Institute of Architects where he co-chairs the Academy of Architecture for Justice's research program. He served as chair of the Environmental Design Research Association which awarded him its lifetime career achievement award.

#### RICHARD E. WENER, PhD

Richard Wener is Professor of Environmental Psychology and head of the Sustainable Urban Environments program in the Department of Technology, Culture and Society at the Tandon School of Engineering of NYU. He received his Ph.D. in psychology from the University of Illinois-Chicago, and is a fellow and past president of Division 34 of the American Psychological Association. The Environmental Design Research Association gave him its award for distinguished service to the field of environment and behavior in 1995 and its Career Award in 2013. He has published extensively on Post Occupancy Evaluation of the built environment including correctional settings and sustainable design. Professor Wener's research on the behavioral impacts of correctional settings began in 1975 with evaluations of the new federal Metropolitan Correctional Centers. He has since conducted assessments and other studies in dozens of jails and prisons, culminating his 2012 book "The Environmental Psychology of Prisons and Jails: Creating Humane Environments in Secure Settings," from Cambridge University

Press. He presented the Distinguished Scholar lecture at ICAP 15 – the conference of the International Correction and Prisons Association, in Colorado Springs, October, 2013. Prof. Wener is Managing Editor for a forthcoming volume from the International Committee of the Red Cross on the design of humane prisons, and currently serves on the Mayor of New York City's Justice Implementation Task Force Design Working Group which is tasked with closing and replacing the Rikers Island detention facilities.

#### MELISSA M. FARLING, FAIA, LEEDap

Melissa is principal of Gould Evans in Phoenix. Her 25-year architectural career has focused on criminal justice facilities, public projects, behavioral health hospitals, and an active investigation of the effects of architecture on behavior. She is a member of the AIA Academy of Architecture for Justice (AAJ) Leadership Group, AAJ Research Committee, and Academy of Neuroscience for Architecture Advisory Council. Farling has co-facilitated workshops including the "Neuroscience and Correctional Facility Design Workshop" in New Orleans and the "Neuroscience and Courthouse Design Workshop" in Brooklyn. The former workshop led to a National Institute of Corrections funded study to examine impacts of views of nature on stress in a jail intake area. She was one of the principal investigators along with Jay Farbstein and Richard Wener. This study received the inaugural Certificate of Research Excellence from the Environmental Design Research Association – with the only special commendation. Farling gives frequent presentations on evidence-based design applications and is contributing author to several publications including "Mind in Architecture: Neuroscience, Embodiment, and the Future of Design," edited by Sarah Robinson and Juhani Pallasmaa and published by The MIT Press. She holds a BA in Architecture from UNC Charlotte and BArch and MArch degrees from University of Arizona.

#### ERIN PERSKY, Associate AIA, CCHP

Erin Persky is a facility planner and researcher specializing in justice facilities. She applies her interdisciplinary research acumen to the practice of criminal justice planning by providing services integral to the development of architectural programs, needs assessments, feasibility studies, design-build criteria documents, and Post-Occupancy Evaluations (POEs).

Erin has over 10 years of experience conducting civic-related research, with a focus on justice and civic building design. Her current research focuses include therapeutic justice environments and POEs. She has presented her work to the American Institute of Architects (AIA), National Association for Court Management (NACM), and the National Commission on Correctional Healthcare (NCCHC), and has been featured in Architect Magazine for her research. She works closely with the AIA, having served as member and chair of the AAJ Research and Communications committees and was the 2017 AAJ Chair. Erin is also working with the NCCHC to develop and integrate evidence-based design guidelines into Correctional Healthcare Facility standards.

Erin holds a Bachelor's Degree in Psychology and Social Behavior, summa cum laude, and a Master's Degree in Political Science, both from the University of California, Irvine. She also holds a Master's Degree in Architecture, magna cum laude, from the NewSchool of Architecture and Design in San Diego.

#### EVE A. EDELSTEIN, PhD, EDAC, Associate AIA, F-AAA

Dr. Eve Edelstein's expertise as a clinician, researcher, educator and designer, includes degrees in clinical neuroscience (Institute of Neurology, University College London), architecture (NewSchool of Architecture & Design) and anthropology (University of California, Berkeley). Dr. Edelstein's research includes novel systems that simulate multi-spectrum circadian light exposure, and circadian design guidelines for the AIA Latrobe Prize research.

Dr. Edelstein directs the Perkins+Will HxLab that explores the human experience of design across all scales and practice area, and works with clients and design teams to translate rigorous data into design solutions that support the human continuum of clinical, psychological, physiological and behavioral needs. Eve directs the Perkins+Will Gadget Lab, using bio-sensors, research and custom tools in pre and post occupancy studies, to reveal the influence of design on cognition, emotion, intelligibility, and wayfinding among other topics. Co-founder of Clinicians for Design, Dr. Edelstein leads an international group of clinicians to formulate new design solutions. With international top-tier academic centers, innovative virtual reality simulations explored immersive and interactive 4D spatial sound objects that simulate speech intelligibility and noise intrusion, and the impact of interior and exterior architecture on sight lines and functional design.

Dr. Edelstein publishes and presents keynote and educational lectures internationally.



# Does Views To Nature And The Design Of Spaces Matter? A Pain Stress Experiment

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## ABSTRACT:

Previously, we have shown that the design of spaces can influence the physiological stress reaction to psychosocial stress in terms of the stress hormone cortisol [1]. In the current experiment, we examined the physiological reaction to a pain stressor (the Cold Pressor Test). We used three different computer models in a virtual environment (a Cave): a closed room, a room with openings onto an empty landscape potentially allowing for escape, and due to the general consensus that a view to nature is de-stressing [e.g. 2,3,4], a room with a view to nature through the openings. We predicted that we would find the highest cortisol level in the closed room and the lowest one in the room with a view to nature. We measured reactivity of the autonomous nervous system (ANS) with high frequency heart rate variability (parasympathetic activity), and T-wave amplitude (sympathetic activity) recording, and HPA-axis reactivity with saliva cortisol levels. In contrast to the previous experiment with psychosocial stress, there was no significant difference in cortisol levels for any condition. There was no significant difference in ANS activation between the closed and open room, but contrary to consensus, the stress reaction was significantly strongest in the nature condition (fig.1). This might be explained by the fact that our experiment, as far as we know, is the only one in which participants have been exposed to the natural setting during both baseline measurements, stressor and a subsequent de-stressing period, while previous experiments solely have concentrated on the de-stressing effect. We have now tested two different stressors in the same computer model with different outcomes (fig.2), implying that the effect of a space depends on a combination of the design and on the events taking place in the space. This hints at the limitations of architecture as architects can only control the design of the environment and challenges one-to-one designs of studies of reaction to architectural stimuli. As the referred experiments is just two limited studies, this calls for further research and for discussion on the affordances of spaces [5,6].

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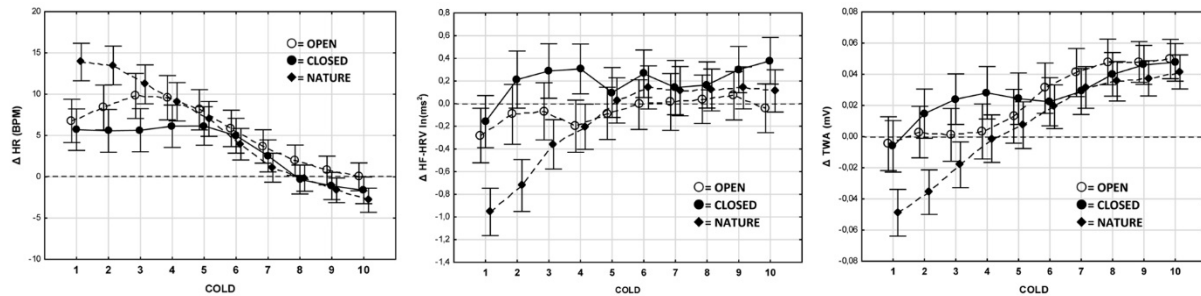
**Figures:**

Fig 1. Heart rate, reactivity of the autonomous nervous system measured with high frequency heart rate variability (parasympathetic activity), and T-wave amplitude (sympathetic activity – low values corresponds to high activity).

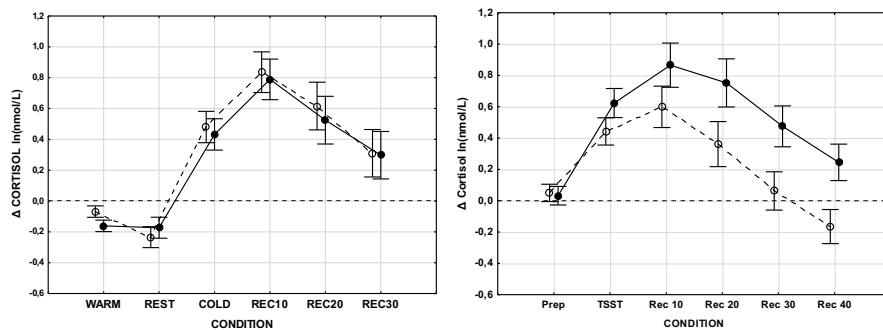


Fig 2. Participants Saliva cortisol levels measured in Virtual Reality (Cave) computer models of a closed space (closed line) and a space with openings (dotted line), when exposed to a pain stressor (left) and a psychosocial stressor (right). As can be seen, the stress reaction depended on the design of the space as well as on the type of stressful event that took place within the space.

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LARS BRORSON FICH (presenter), Architect. m.a.a., Ph.d., associate professor; graduated as an architect in 1984, and has worked as a practicing architect until 2008. He is now leading a four-year research project on the influence of space on stress.

ANTJE GIMMLER, Dr. phil, Ph.D. is professor of applied philosophy and research director at the Center for Applied Philosophy. In her interdisciplinary research and with a framework stemming from classical philosophical pragmatism, neopragmatism and critical theory she is interested in developing a more empirically oriented philosophy.

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PETER JÖNSSON is an associate professor in psychology at Kristiansstad University; Sweden. He has specialized in stress research using virtual models and has led the development of the virtual version of the Trier Social Stress Test.

# Shifting Teacher Practice in an Innovative Learning Environment

Raechel French

## ABSTRACT:

Research shows that many schools continue implementing traditional pedagogy, despite inhabiting spaces intended to support a variety of teaching and learning opportunities (Saltmarsh, Chapman, Campbell & Drew, 2015). This fact is concerning as more schools are trading in their identical classroom models for multi-modal, flexible, technology-infused facilities with hopes of spurring pedagogic shifts. The research presented here is a sub-project of the Innovative Learning Environments and Teacher Change (ILETC) research study conducted through the University of Melbourne and was completed through a Fulbright Postgraduate Scholarship. The research goal was to understand the ongoing transitions (i.e. changes in behavior) made by teachers inhabiting these new spaces to inform future strategies and tools to quicken and ease the transition for future teachers. To this end, four case studies were completed on schools making the shift from traditional to innovative facilities in Australia and New Zealand asking the question, "What characterizes a successful transition of a school from traditional classrooms to an innovative learning environment in the context of the design and construction process?" While findings spanned organizational and cultural factors, what is most relevant to this presentation is evidence of the built environment itself spurring changes in teacher and student behavior. Analysis of this aligns with recent work on the sociomaterial view on the inhabitation of space in which "the building gives (users) 'licence...to ask those bigger questions' and to 'crowbar' the process of curriculum and pedagogic change" (Mulcahy, 60 Cleveland, & Aberton, 2015, p. 10). Basically, it is seen that pedagogic change and spatial change often come to being together in a circulatory fashion. While multiple examples of this were seen in the data, one of the most prevalent findings is encompassed in what this paper calls, "enabling constraints" or, the purposeful removal of common artifacts of schooling, such as desks, singular teaching walls, books, etc., to spur desired shifts in behavior. The perception of these design decisions when paired with organizational routines and structures shifted from constraints to enablers as educators inhabited their new facilities.

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# The Built Environment as Cultural Emotion Generator and External Brain

*The following abstract was written by T.R.A.C.E. member Rainer Gabriel, designer, backed by his fellow research group members Heiner Mühlmann, cultural theorist, Nico Pezer, phonetician & IT-specialist and Thomas Grunwald, neuroscientist.*

## **ABSTRACT:**

Newer evolution-biologicistic models suggest that culture has had an influence on the development of its inhabiting human beings. It seems quite possible that our built environment, architecture, is a product of some kind of co-evolution between man and culture. In the western culture one might assume, that it was the classical decorum, a unit of form and content, and its design rules, that imprinted cultural meanings into the artifacts of a built environment for a couple of 1000 years.

Theories of rhetoric and architecture, like the ones of Leon Battista Alberti, suggest that buildings designed to be high ranking, according to the Western architectural decorum, have more impact on the minds of their beholders than low-ranking buildings. The research group T.R.A.C.E. (Transmission in Rhetorics, Arts and Cultural Evolution) used event-related potentials in a visual object categorization task to probe this assumption and to examine whether the hippocampus contributes to the processing of architectural ranking (Oppenheim et al.(2009) Brain Electrical Responses to High- and Low-Ranking Buildings. Clinical EEG and Neuroscience 40), (Oppenheim et al, (2010) Hippocampal contributions to the processing of architectural ranking. Neuroimage 50). The two groups of stimuli which were needed for the experiments consist of architectural sketches of high- and low-ranking buildings. To avoid recall of existing buildings the stimuli are fast drawn freehand sketches that not try to copy real buildings but show unrecognizable buildings drawn according to the decorum rules.

The neurophysical correlate of architectural stimuli perception gained by the experiments, shows a significant difference between the two classes of stimuli. It was found that early negative potentials between 200 and 400 ms differentiated between high- and low-ranking buildings in healthy subjects and patients with temporal lobe epilepsy with and without hippocampal sclerosis. By contrast, late positive potentials between 400 and 600 ms were higher in amplitude to high-ranking buildings only in healthy subjects and TLE patients without but not in TLE patients with hippocampal sclerosis. These findings suggest that the differentiation between high- and low-ranking buildings entails both early visual object selection and late post-model selection processes and that the hippocampus proper contributes critically to this second stage of visual object categorizations.

Based on this outcome it can be suggested that high-ranking-architecture causes familiarity effects within a viewer – at least when the viewer originates from a western decorum-culture. Following this assumption architectural perception evokes different emotional responses depending on its position inside a cultural/architectural ranking. While the brain electrical responses of western test participants did differentiate between western decorum styled high- and low-ranking buildings both at an earlier and a later stage of visual processing, this difference was not found during the earlier stage when the experiment was repeated in a different cultural surrounding, namely Beijing, with Asian participants (Mecklinger et al, (2014), Cross-cultural differences in processing of architectural ranking. Cognitive Neuroscience Volume 5).

Therefore it seems legitimate to speculate that brain electrical responses to architectural ranking may be influenced by mental modular processes that were influenced by the cultural rule-system which is responsible for the outer appearance (shape and facade-design) of buildings. The connection between form and emotion would function as a transgenerational, artificial emotion memory, that supports the fitness of a population by coordinating cultural tasks and helps to navigate through an artificial landscape.

With significant differences between the outer design of high-ranking buildings from different cultures and being given that all of those buildings represent a highly relevant cultural value for the particular population over

centuries, differences between the brain electrical responses of the cultural populations could be possible. If this would be the case, working with those different responses might help to strengthen the cross-cultural dialogue as well as it might help architects and designers to activate a „forgotten/hidden“ pathway to memory enhancing cultural mental modular processes that are triggered by the shapes and rules of cultural artifacts. But whether you try to avoid a clash of cultures or fight dementia, you should not ignore the traces left by a couple of 1000 years of cultural evolution and the emotions they are able to evoke.

Now it is of significant interest to get to know architectural ranking systems from different cultures to be able to experiment if western/European on the brain electrical responses to architectural ranking of western/european participants distinguish between High- and Low-Ranking buildings from different cultures.

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Oppenheim I, Vannucci M, Mühlmann H, Gabriel R, Jokeit H, Kurthen M, Krämer G, Grunwald Th (2010) Hippocampal contributions to the processing of architectural ranking. Neuroimage 50, page 742-752

The research group T.R.A.C.E. is looking for neuroscientific proof of cultural evolution since 2003. The group mainly consists of the the founding members Prof. Dr. Heiner Mühlmann, a cultural theorist who taught at the University of Paris VIII, the Universities of Münster and Wuppertal, the Collège International de Philosophie, Paris, the Zurich University of the Arts (ZHdK) i.a. and Prof. Dr. Dr. Thomas Grunwald, Medical Director of the Swiss Epilepsy Centre in Zurich, as well as of Dr. Nico Pezer, who doctorated in phonetics and linguistic communication 1982 in Cologne and Dr. Rainer Gabriel, designer.



# Aesthetics of Architecture and Vision – Perception and Processing

Arathy Gopal

## ABSTRACT:

Aesthetics have substantial impact on the experience of built environments, but seldom quantified as we know little about its neural representation in the human brain (Choo, et al., 2016). Novel insights from neuroscience have begun to influence various disciplines, leading to a turn to cognition and emotion in the fields of planning and architectural design (Papale, et al., 2016). Noting the presence of the aesthetic phenomenon in architecture, Biryukova concludes the existence of a range of issues in the consideration of the aesthetic qualities of architectural forms (Litvin, 2007), one issue being the inability to quantify aesthetic appeal from subjective appreciation. Neuroaesthetics, becomes relevant in this context as it is the study of how aesthetic perception, production, judgment, appreciation, and emotional response are produced and experienced from a neurological basis (McClure & Siegel, 2015). In quantifying aesthetics of exterior form of built forms, the visual sensory perception and processing becomes very relevant. From the study of research work already done in understanding neural underpinnings of aesthetic perception and judgments, it was found that though there are studies on inputs from aesthetic perception and many other studies on subjective aesthetic appreciation, an empirical research relating the two is missing. This study addresses this gap in literature, and tests the relation between the subjective aesthetic appreciation and the analysis of parameters of aesthetic perception focusing on vision. Parameters were identified from study of the neural underpinnings of visual perception, processing and aesthetic judgments in typical as well as different brain. The scope of the study was limited to the study of imagery of exteriors in architecture though perception is multisensory. Also all aspects of relevance in visual perception cannot be extracted through imagery analysis. Imagery of selected buildings were then analyzed and rated based on the parameters. People of same socio-cultural background and age group were selected and the subjective appreciation of imagery was studied. Analysis showed that though there are differences based on gender and artistic background, the subjective aesthetic appreciation is significantly related to the parameters derived from study of visual perception, processing and aesthetic judgments.

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### **ARATHY GOPAL**

Arathy Gopal is an Architect-Planner currently pursuing her PhD in Urban Planning in School of Planning and Architecture (SPA) Delhi, India and the Research Director of a charitable trust ASPIRE. She was recipient of National Best Thesis Award for PG thesis (2nd position) in 2014. She was co-investigator for the research that won the Hay grant from Academy of Neuroscience for Architecture, San Diego in 2015 and presented the teamwork at ANFA Conference at San Diego in September 2016. She was offered a travel grant by University of Texas at Austin for their conference on Psychology and Architecture in December 2016, but had to decline. She was certified on 'Neuroscience for Architecture' from Newschool of Architecture and Design, San Diego in August 2017 after attending a four day intensive course in their campus. She earned the certificate on 'Social Norms, Social Change I' by University of Pennsylvania & UNICEF on December 2017 and selected as a Sahapedia – UNESCO Research Fellow 2017, for her work on studying the aesthetics of a historic urban precinct. Her understanding of the neural mechanisms underlying experience of designed spaces and urban areas aided her in the paper, 'Aesthetics of Architecture and Vision – Perception and Processing'.

Research Director, Architectural Solutions Planning Innovations Research Enterprise (ASPIRE)

# Is Ornament Necessary? Answers from Brain Science

Mark Alan Hewitt, FAIA; Ann Sussman, FAIA

## ABSTRACT:

Ernst Gombrich, the Viennese art historian, wrote his final book on the persistence of pattern decoration in architecture and the decorative arts, citing many psychological links to vernacular and high art ornamentation. After more than a century of denigration by architects, ornament is back on the radar screen, as eye tracking experiments note the attraction of texture and pattern in the visual brain. This is especially true around the edges of buildings and openings in walls.

James J. Gibson also noted the necessity for thickening of texture around occluding edges in the environment. Now that we know more about both the visual system and affordances in the environment, we can make more precise observations and hypotheses about architectural ornament as a persistent feature in buildings. This paper will present a literature survey and analysis of these recent discoveries, and offer a summary of why the authors believe that ornament is necessary in all buildings and artifacts.

Ann Sussman's recent book, *Cognitive Architecture*, points to ornament as an aid to legibility when humans look at facades for significant features such as doorways and directional cues. Mark Alan Hewitt's research in the 1980s used Gibsonian principles to study ornament. His new book, *Draw In Order To See*, analyzes key aspects of visual design that architects must understand in terms of neuroscience, including pattern recognition and occluding edges.

Both researchers presented poster sessions at ANFA's last conference in 2016. They are members of the PLACE-SCIENCE research group organized at Englesberg, Sweden in 2017. In 2018 the group will do experiments on the human experience of urban places.

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# Using the Embodied Language Of Space To Develop Stress Assessment Tool For Architectural Experience

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## ABSTRACT:

Despite the growing amount of evidence unequivocally indicating that architecture affects people's psychosomatic health and behavior, it remains unclear how the neurophysiological reaction is linked to the aesthetic (conscious) experience of an architectural space. Following up on previous experimental studies by Fich et al. which showed that features of the spatial setting - presence or absence of openings in the room - influence participants' physiological stress reaction (measured as cortisol levels) [1] and the enactive cognition framework [2–6], we hypothesize that the aesthetic experience of architecture is an anticipatory process of making sense of a situation at hand and hence, at least partially a kind of a risk assessment process which might predict the physiological stress reaction in a given space.

In parallel, a rich body of work within the fields of cognitive linguistics and neuroscience on “embodied language” emphasizes the intrinsic connection between linguistic meaning and range of experiences (sensorimotor, affective, social), in which architecture and more generally, built environment, could act as a scaffolding in language acquisition and understanding of semantic meanings. Therefore, by building upon this well-established link between linguistic meaning and embodied experience [7–10] on the one hand, and the Semantic Environment Description (SED) questionnaire developed by architectural psychologists in 1970s in Sweden [11] on the other, we explore how the space-body-language relationship can be used together with physiological measurements to develop an assessment tool to describe and capture people's aesthetic experiences of spaces and their anticipated stress reaction. Experimental testing of our hypothesis and related questionnaire development is currently underway.

The advantages of the tool are twofold: 1) first, by using the power of language and semantic meanings as being grounded in our bodily and spatial experiences it allows for a well-targeted approximation of people's aesthetic judgements of architectural spaces; and 2) secondly, it addresses the need for developing methodological tools specifically aimed towards scientific exploration of architectural questions, which should facilitate the information exchange and usability of research results in architectural design. Accordingly, this research is inspired by a larger framework for developing neurophenomenological approach for examining architectural experience (following [12]), which unites the strengths of cognitive neuroscience, environmental psychology, philosophy of the mind/phenomenology, and architecture to understand the human being as architectural experiential subject in its phenomenal and biological totality.

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**Dr. Lars Brorson Fich** graduated as an architect in 1984, and has worked as a practicing architect until 2008, from 1998 – 2008 as a partner. During this period, he has designed well over 100 build projects, ranging from a museum to residential and commercial projects and hospital projects. In 2008, he changed carrier and is now teaching and doing research at Aalborg University. He is now leading a four-year research project on how the design of space can influence the effects of stress on e.g., cognition.



# Shaping Space by Experience Data

Johanna Jõekalda

## **ABSTRACT:**

"Shaping Space by Experience Data" is an ongoing research on amplifying spatial experience by interactive media techniques. It focuses on tracking beholder's spatial experience in data format and applying this data in the design process.

The theoretical part of the research examines how the main actors in spatial perception as a cognitive process – space, senses and the brain – have become definable in terms of data, and how to make use of it while shaping spatial experience. The practical part of the research proposes techniques that allow to extract test subjects' experience data from brain-computer interfaces, galvanic skin response sensors, heart rate sensors as they visit real and virtual environments, and apply this data in the design process.

The indicators of the test subject's emotional state are ascertained by valence-arousal method on the scales of activity-passivity and positivity-negativity. The data is analyzed by post-scientific methods that allow to enter the indicators into spatial models and manipulate their formal properties on the basis of these data.

The potential use of these techniques is illustrated by a set of installation projects that demonstrate how spaces can be programmed to adjust according to the visitors' experience data. The principles for the adaptation of the spaces are based on various illusion techniques that allow the ostensible properties of the environment to be distorted in a data-based manner. The boundary situations and adaptation logic are designed by the architect, while the user shapes the situation at a given moment in time. This results in an experience-charged space that recognizes the beholders' spatial experiences and adapts itself accordingly.

While data-based solutions are increasingly improving our everyday lives, in architecture they are related more often to optimized production, environmental sustainability, programmatic functionality, economic applicability and other technical aspects that do not pay any particular attention to user experience. In its most common present forms data-based approaches devalue spatial quality in architecture. Considering the experiential impact the main criterion for spatial quality, "Shaping Space by Experience Data" proposes techniques to manage spatial experience in all its complexity.

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JOHANNA JÕEKALDA MArch

Johanna Jõekalda (1990) is a young Estonian architect. She has studied architecture and urban planning at the Estonian Academy of Arts and Studio Lynn at the University of Applied Arts Vienna. For the last years she has been working on virtual reality and brain tracking experiments that have led her to innovative methods of expressing spatial experience in data format. It was also the research topic of her master thesis ("Shaping Space by Experience Data" 2017) with a specific focus on the interdependence of digital and physical environments. The developed workrow and practical solutions evoked the interest of several designers and developers both in Estonia and abroad, where she has lectured about her approach and organized workshops. Johanna has previously worked in Angewandte Innovation Laboratory, Allianss Architects design office and Skanska construction company, spoken at different architecture symposiums, published writings in various cultural publications, curated several architecture exhibitions and participated in many more – multiple Venice Architecture Biennales among others. For instance in 2014 she co-curated the Estonian national pavilion "Interspace" that speculated on the spatial consequences of a data society. She is currently supervising the architecture and interior design students of the Estonian Academy of Arts.

## Individuals' Visual Attention to Interior Elements in the Audio-visual Context of Lived Experiences

Jain Kwon & Juyeon Kim

### ABSTRACT

Sensory experience in built environments is highly complex, and the multimodality of human perception plays a crucial role in interior occupants' spatial experiences. This study explored how visual attention to the interior elements of commercial settings was affected by auditory stimuli, involving eye-tracking experiments and semi-structured interviews. The participants consisted of 13 females and seven males (ages 19-23). Three photo images of coffee shops were used as visual stimuli (Figure 1). For data collection, a SMI-iViewRed eye tracker (with a sampling rate of 30 Hz) was integrated into a high resolution 27-inch 1920x1080 pixels widescreen monitor. As auditory stimuli, two songs in different genres were used: soft pop (music 1) and dance-pop (music 2). Each experiment was conducted through the following procedures: 1) each photo was displayed on the monitor while the two songs played consecutively, for 60 seconds/music and with a 10-second break in between songs; 2) this procedure was repeated three times, paired with the three images displayed in a random order; 3) a 20-minute, semi-structured interview followed. To determine fixation count and dwell time, each 60-second associated with one music was broken down into six 10-second segments (from T1 to T6); the averages of fixation count and dwell time with music 1 (M1) and with music 2 (M2) were compared. To sufficiently explain the details, this abstract illustrates specifically the findings from data analysis using image 1.



Figure 1. Visual stimuli for eye-tracking experiments (from left, coffee shop images 1, 2, & 3)

The averages of fixation count (FC) and those of dwell time (DT) showed the opposite patterns from each other: e.g., FC-M1 lower than FC-M2 in T1, T3, and T6 while DT-M1 higher than DT-M2 in the same T-segments. The averages of fixation count (FC) per AOI with M2 appeared higher than with M1; FC, DT, FC per AOI, and visual attention count showed little differences between M1 and M2, particularly in T2 (Figure 2 and 3). The fixation frequency averages by T-segment showed little differences, except in T6—significantly higher with M2. Fixation duration with M2 were longer in T5-T6 and shorter in T1-T4 (Figure 4).

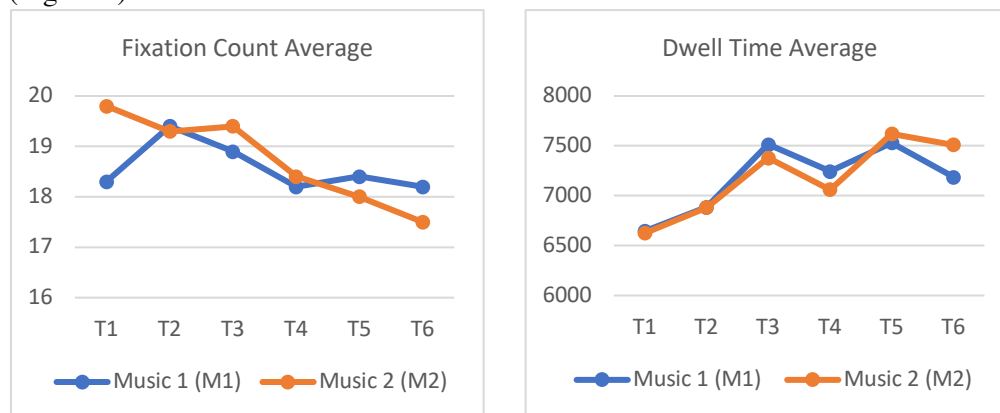


Figure 2. Comparison of the averages of fixation count and dwell time – with M1 versus M2

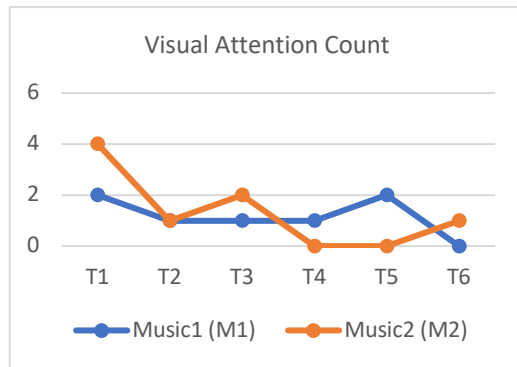


Figure 3. Visual attention count (highest 10% of the data) in category I – with M1 versus M2

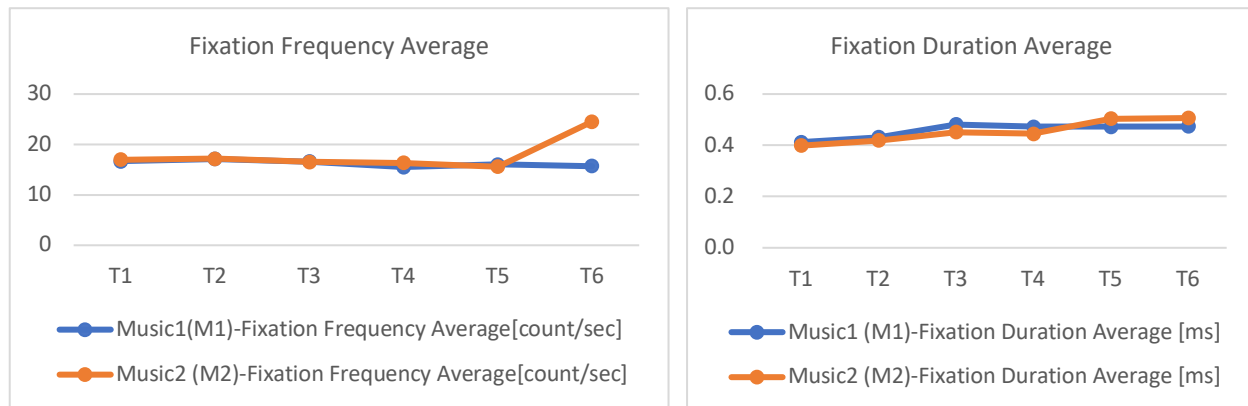






Figure 4. Comparison between M1 and M2: Fixation frequency and fixation duration

Despite the individual differences of scanpaths, general patterns were also found: with M1, sparse distributed fixations; with M2, densely distributed fixations, higher fixation count, and longer dwell time (Table 4). The participants gave their visual attention to the overall interior elements while slow and soft music was playing; their visual attention to signs, objects, and retail elements was noticeable while fast and intense background music was playing. The findings from the semi-structured interviews provide explanations of the various influences on and motives for such patterns and specific attentions.

Table 4. Exemplary comparison of the patterns of two individuals' fixation sequence, with M1 versus with M2 in the first 10-second segment (T1)

	Participant 1 (P1)		Participant 2 (P2)	
	with Music 1 (M1)	with Music 2 (M2)	with Music 1 (M1)	with Music 2 (M2)
T1				

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# Blurring the Self/Space Boundary to Increase Mindfulness: Perspectives from Japanese Architectural Philosophy, Neuroscience and Psychology

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## ABSTRACT:

Mindfulness means paying attention in the present moment, on purpose and non-judgmentally (Kabat Zinn, 2003). Research supports we are happier and potentially healthier when we are mindful (Goleman & Davidson 2017, Killingsworth & Gilbert 2010). This paper explores how space might be designed to increase mindfulness, by integrating Japanese philosophies of architecture and mindfulness with perspectives from neuroscience and social psychology.

Based on a literature review, we focus on an aspect of mindfulness in which the boundary between self and other, i.e., space/surroundings, is blurred. In Japanese philosophy, one's internal is externalized and the external is internalized, leading to subject and object being simultaneously separate and united (Izutsu 1975). The authentic self with active intuition/perception is the self at this stage (Nishida 1926), when the conscious submerges and intuition extends to the external world (Yuasa 1987). In neuroscience, this blurred self/space boundary is evident in the brains of meditators who show increased coordination between brain networks attending to internal/external environments, which are typically anti-correlated (Josipovic et al. 2012).

We've analyzed Japanese spatial concepts to see how they contribute to the blurred self/space boundary. *Yugen*, art of untold, and *Ma*, in-betweenness, are in opposition to discrete spatial components required for clear spatial recognition (Kaplan 1981), and therefore may contribute to blurred self/space boundary. *Ma* and also *Utsuroi*, ephemeral, represent the world as non-static which further blurs/distorts spatial comprehension. Additionally, Japanese spatial concepts are always from a first-person perspective in motion, such as *Hashi*, moving on the boundary between two shores and *Michiyuki*, moving over boundaries slowly or in a meandering way. In all of these Japanese spatial concepts, time and space are undifferentiated and time does not pass at a constant pace (Isozaki 2006, Inoue 1985, Nitscheke 1993, Haga 1995, Hara 1987, Katagiri 2007, Takeuchi 2011).

We've integrated these Japanese spatial concepts with more commonly used space and movement concepts, to develop a vocabulary for architectural design to be used for spatial interventions to increase mindfulness. This novel Space-Traveler's notation system applies DirectorNotation technique used in film (Yannopoulos 2013) and Labanotation used in dance choreography (Guest 2005) to represent space from a first-person perspective and include a representation of time, which is not currently represented in architectural notation.

In conclusion, this new Space-Traveler's notation system, integrating vocabularies from Japanese spatial concepts, can be used to represent, research, and design spaces with the goal of increasing mindfulness. The broader interest is whether a spatial intervention designed using this new notation system to blur the self/space boundary could increase mindfulness, thereby increasing well-being and workplace productivity. From the above findings, we propose a pilot study in the workplace measuring mindfulness by real-time monitoring of an index of neural signals (electroencephalography) in response to spatial intervention, and evaluating change or difference in well-being and productivity.

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Kathleen A. Garrison, PhD, is an Assistant Professor of Psychiatry at the Yale School of Medicine. Her background is in cognitive and clinical neuroscience. Her research interests are to better understand the cognitive processes of addiction and improve treatments. A major focus of her work is the study of mindfulness and the potential for mindfulness training to treat addictions. Her research involves clinical trials of mindfulness-based addiction treatments, and neuroimaging studies of the related neurobiological mechanisms, such as how meditation shapes the brain.



## Neural Mirroring Architecture – Empathy and Atmosphere

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*"...the environment can modulate the function of genes and, ultimately the structure of our brain. Changes in the environment change the brain, therefore they change our behavior. In planning the environments in which we live, architectural design changes our **brain** and our behavior."*<sup>i</sup>

My research is based on **the possibility of and means by which an architect might create atmosphere inside a building**. What are the architect's means for working with atmosphere(s)? Is there a direct link between the quality of the architecture and the atmosphere of the design?

One of the focuses of my work is finding out how emotions and experiences of spatial conditions are born. One word for describing these emotions could be "atmosphere". Something makes us feel—similar to the way that we feel music—the atmosphere of the building as soon as we enter it. As the architect Peter Zumthor says:

*"I enter a building, see a room and—in the fraction of a second—have this feeling about it."*<sup>ii</sup>

Zumthor explains that the theme has interested him already for a long time and another concept that has risen to his mind when thinking of atmosphere is "...the **magic** of the real world."<sup>iii</sup>

Zumthor is one of the few practicing architects describing his impressions and feelings on the concept of the atmosphere in architecture. One of the points of departure for my research is the oft-cited lecture by Zumthor in which he gave nine "answers" to the question of creating atmosphere and the architect's possibilities of creating atmospheric qualities in a given room or building.

Zumthor's answers:

**the body of architecture**

**material compatibility**

**the sound of a space**

**the temperature of a space**

**surrounding objects**

**the emotions between composure and seduction**

**tension between interior and exterior**

**levels of intimacy**

**light on things**

**+ two "appendixes": architecture as environment and coherence**

My intention is to reduce Zumthor's answers to five areas of research:

**Light (natural and artificial):** the architect "sculpting" light volumes in darkness / Sarah Robinson states:

*We fail to appreciate that light actually contains darkness.*<sup>iv</sup> / the concept of time in architecture

**Material compatibility:** material contributions to a sense of intimacy / the influence of materials on the sound and temperature of space / materials as a part of our sensual understanding of age and ageing

**(seductive) Movements:** the influence of materials and light on the intimacy and tensions between interior and exterior

**Architectural metaphors:** The "body of architecture" is already discussed by Alberti, as Harry Francis Malgrave suggests we interpret: *architecture as a metaphor of the human body and the human body as the metaphor for architectural design*<sup>v</sup>

**Empathy:** as a part of understanding the levels of intimacy, meanings of surrounding objects and architecture as a part of its milieu and of the coherence of the built environment

Neuroscience has had a strong influence recently, mostly because of new methods of mapping brain function developed during the past twenty years such as functional magnetic resonance imaging (fMRI), positron-emission tomography (PET), electroencephalography (EEG) and magnetoencephalography (MEG).

Vittorio Gallese, of the University of Parma, is one of the researchers who has been able to locate so called "mirror neurons" in the brain and explain how these neurons may possibly function. According to Gallese's research team, part of our brain **reacts to the environment** by means of an empathetic mechanism:

*"This mechanism maps the sensory representation of the action, emotion or sensation of another onto the perceiver's own motor, visceral-motor or somatosensory bodily formatted representation of that action, emotion or sensation. This mapping enables one to perceive the action, emotion or sensation of another in a certain sense—the distinction here is pretty complex—as if she were performing that action or experiencing that emotion or sensation herself, up to a certain limit of course."*

Gallese continues:

*"Embodied simulation is also triggered during the experience of spatiality around our body and during the contemplation of objects. [...] embodied simulation seems to constitute a basic characteristic of our brain, making possible our rich and diversified experiences of space, objects and other individuals, which is the basis of our capacity to empathize with them. Embodied simulation not only connects us to the others, it connects us to the world—a world inhabited by natural and manmade objects (with or without symbolic nature) as well as other individuals."*<sup>vi</sup>

In short, this means that we react to the environment in the same way that we react to a smiling baby. **We "cry" and "laugh" when we experience our environment. This experience molds our brain and stays part of our memories and consciousness.**

The Finnish architect Alvar Aalto always spoke of the user's needs. In Malmö, Sweden in 1957 he reminded us that:

*(...) Inside of the house you have possibilities of several forms (of life), as well inside the ugliest of the palaces and the cheapest of the huts. Here, we have finally the synthesis of architecture: if we are able to concentrate on the huge possibilities of it, so by playing with all of them (possibilities) we are like the poets of this World and at the same time we create a physical human happiness in all its forms. That is not a bad destination, probably it is the greatest under the stratosphere.*<sup>vii</sup>

I believe that it is exactly this opportunity that Zumthor refers to when he speaks of the imprint that a building can make on our minds.

*"That is the first transcendent level of my work: the attempt to conceive of architecture as human environment. (...)—perhaps it has something to do with love. I love architecture; I love surrounding buildings, and I suppose I love it when other people love them too. I have to admit it: it would make me very happy to have made things which other people love."*<sup>viii</sup>

<sup>i</sup> Gage, Fred. "Neuroscience and Architecture" Theme presentation, Convention Center, San Diego, May 9, 2003 2-3. The quote is from Melissa Farling: "From Intuition to Immersion: Architecture and Neuroscience" in Sarah Robinson and Juhani Pallasmaa (Eds.): *Mind in Architecture; Neuroscience, Embodiment and the Future of Design* (Cambridge, Massachusetts and London, England: The MIT Press 2015).

<sup>ii</sup> Zumthor, Peter. (2006) *Athmospheres -- Architectural Environments -- Surrounding Objects*. Basel Boston Berlin: Birkhäuser. 13.

<sup>iii</sup> *ibid.*

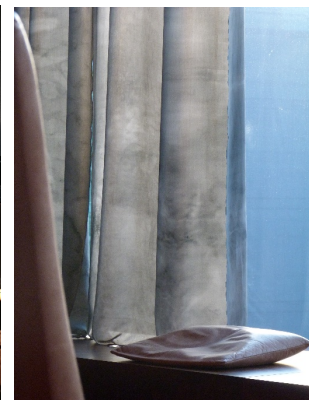
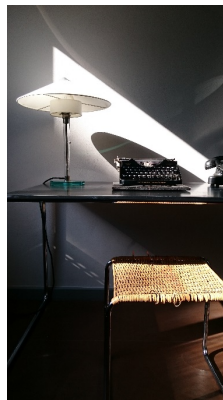
<sup>iv</sup> Robinson, Sarah (2011). *Nesting: body dwelling mind*. William Stout publishers. 84.

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<sup>vi</sup> Gallese, Vittorio. *Architectural Space from Within: The Body, Space and the Brain*. in Philip Tidwell (ed.), *Architecture and Empathy*, A Tapio Wirkkala Rut Bryk Design Reader, Tapio Wirkkala Rut Bryk Foundation, 2015. 64-77.

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<sup>viii</sup> Zumthor 2006. 65-66.



# Design factors related to postpartum environments: Preferences for sense-sensitive spaces

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## 1. Introduction

Despite recent design improvements following person-centred care in hospital settings and birthing environments (Verderber, 2010; Stichler, 2007), the key elements for a restorative hospital postpartum environment are not known.

Building design can affect psychological-emotional and physiological wellbeing of women who have hospital births (Foureur, et al., 2010). In postpartum spaces women are increasingly faced with noise and multiple disruptions from healthcare providers (Boehm, & Morast, 2009), triggering lack of sleep and rest, due to not having a single room (Eberhard et al., 2000). This situation also contributes in shaping midwifery practice by creating cognitive and emotional responses, for midwives who work in such spaces (Hammond, et al., 2014; Hammond, et al., 2013).

In a different context, combinations of architectural considerations and therapeutic outcomes have been used for what are called sense-sensitive designs in healthcare environments (Mazauch, 2014; Mazauch, 2005). Very little is known about how interior postpartum environments affect women's physical restoration and wellbeing. The pertinent question is how to create a therapeutic postpartum environment for healthy women as increasingly more births occur in hospitals.

## 2. Research methodology

An on-line questionnaire surveys using Qualtrics (2017) was started from October to November 2017 to determine the specific physical restorative factors for postpartum spaces in New Zealand hospitals. 229 postpartum women and 58 midwives participated in the surveys.

Survey questions covered interior features and sensory comfort as shown in Tables 1 and 2.

## 3. Results and Discussions

An association of postpartum recovery and wellbeing was found with interior features and sensory comfort for the postpartum space design. Room restfulness, equal variances not assumed  $t(59.905) = 1.43$ ,  $p = 0.158$ ; Natural daylighting,  $t(248) = .259$ ,  $p = .796$ ; Air quality and room freshness,  $t(241) = 0.44$ ,  $p = 0.660$ ; Hygiene/clean environment,  $t(241) = 0.26$ ,  $p = 0.796$

There was a statistically significance difference in the opinion on privacy and noise control between women and midwives; Privacy:  $t(244) = 3.30$ ,  $p < .001$ ; Noise control:  $t(241) = 3.88$ ,  $p < .001$  (see Figures 1 to 6).

Table 1: Means and Standard Deviations of Preference Ratings for Interior Features

	Women		Midwives		
Category	Mean	SD	Mean	SD	<i>P</i>
Interior features					
A restful room is important to my birth recovery	4.88	0.38	4.77	0.52	.158
Appreciate a room daylighting can enter	4.50	0.62	4.52	0.58	.796
Be in a room where the door is closed for privacy	4.46	0.85	4.00	0.97	.001

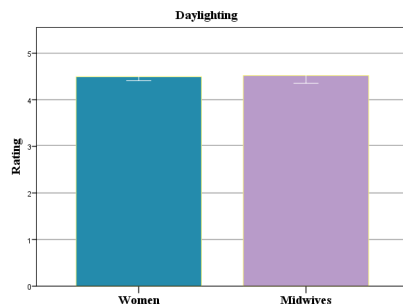


Figure 1 Natural daylight bar graph (with 95% CIs)

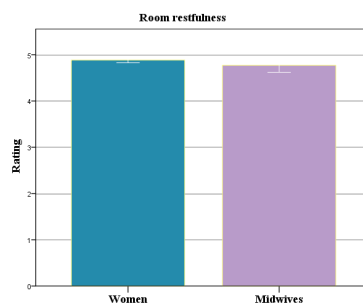


Figure 2 Room restfulness bar graph (with 95% CIs)

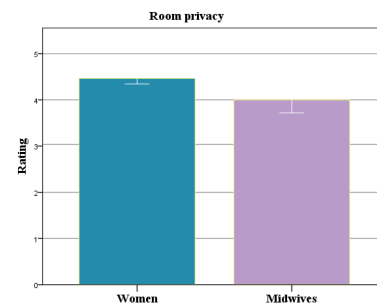


Figure 3 Room privacy bar graph (with 95% CIs)

Table 2: Means and Standard Deviations of Preference Ratings for Sensory Comfort Features

	Women		Midwives		
Category	Mean	SD	Mean	SD	P
Sensory comfort					
Air quality and room freshness	4.72	0.53	4.68	0.59	.660
Hygiene/clean environment	4.91	0.34	4.89	0.38	.796
Noise control from equipment	4.06	1.03	4.66	0.48	.001

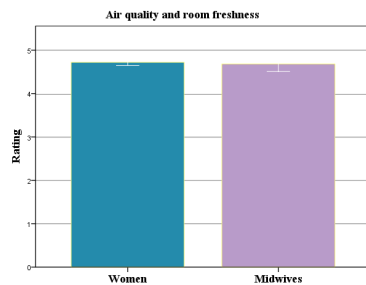


Figure 4 Air quality and room freshness

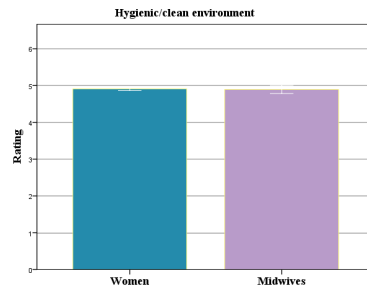


Figure 5 Hygienic/clean environment

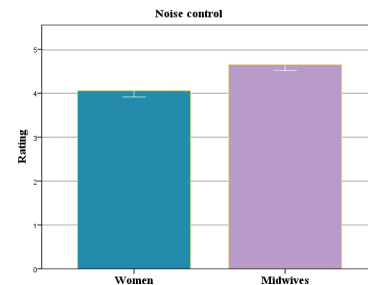


Figure 6 Noise control

#### 4. Implications for Design and Neuroscience

The interior postpartum environment plays a pivotal role for the recovery process. Creating an indoor environment in which women and their caregivers can feel comfortable is vital in the postpartum environment. Daylighting in the interior environment is an important element, while a noise-free environment can foster good recovery. Developing restorative interior environment strategies that will address the noisiness and unconducive postpartum hospital environment will require an evidence-based design solution towards a wholistic improvement for both women and their caregivers.

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# Wellbuilt for Wellbeing: Using sensors and surveys to explore the indoor environment and health

Casey M. Lindberg, Ph.D.<sup>1</sup>

Brian Gilligan, M.S.<sup>2</sup>

For the Wellbuilt for Wellbeing Team

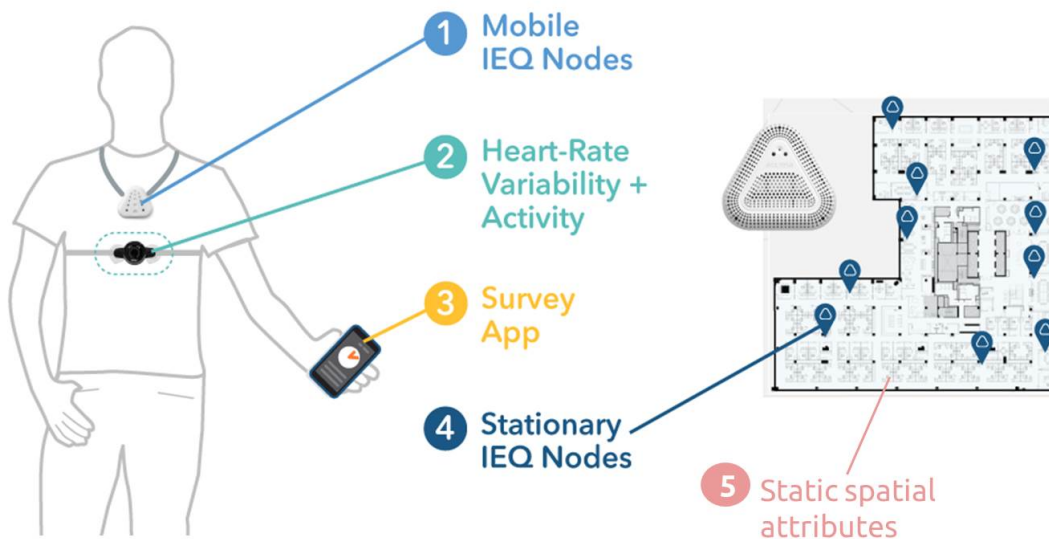
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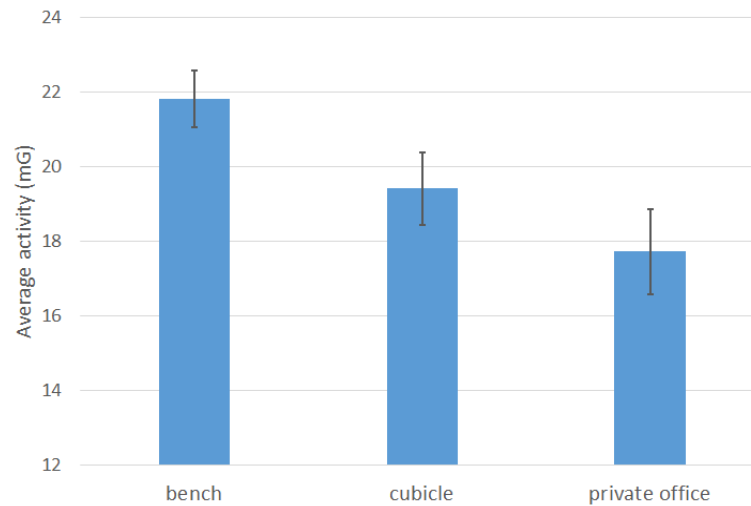
## ABSTRACT:

The U.S. General Services Administration controls indoor environments that influence the health and wellbeing of more than 1 million federal workers. The Wellbuilt for Wellbeing project is the first to explore this influence by directly measuring in real-time the impact that several indoor environmental quality (IEQ) variables had on workers' physiological stress. We found relationships between several IEQ factors and health outcomes, and, are now using machine-learning processes to use that same data to dig deeper into the behavior of building occupants.

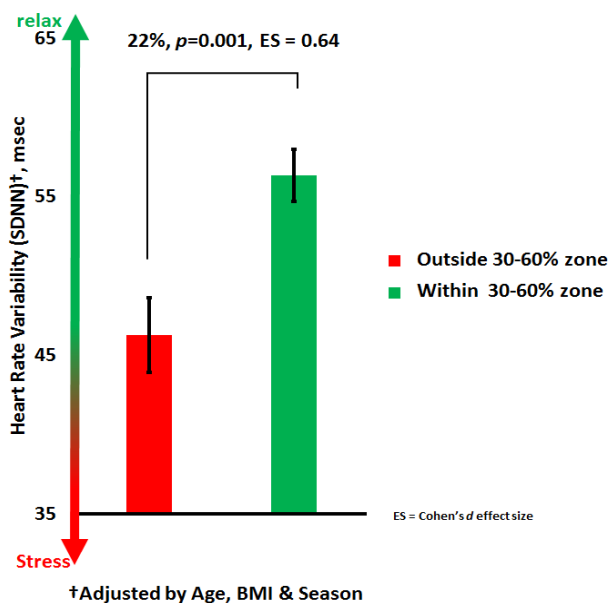
Wellbuilt observed 231 office workers from 4 federal office buildings over three days and two nights. IEQ factors were recorded continuously at work and health outcomes measure stress by heart rate variability, physical activity, and sleep quality. In addition to an intake survey, workers answered hourly survey questions while at work related to mood, comfort, and performance. Workstation design and other recorded spatial characteristics varied across participants.



Individuals in open-office arrangements were 32% more physically active at work than those in private offices, and 20% more than those in traditional cubicles. Moreover, workers with higher physical activity at work had 14% lower physiological stress outside the office compared to those with lower activity



Those spending most of their time in “comfortable” conditions (30-60% RH based on ASHRAE 55-1989) experienced 22% less stress at work and, indirectly, better sleep at night than those in “uncomfortable” conditions.



Further explorations suggest evidence of inflection points for stress response to RH, sound, and CO<sub>2</sub> that may inform discussions on IEQ ranges for optimal health and comfort.

Ongoing analysis centers on the interactions that built characteristics and occupant behaviors (i.e. working alone vs. with others) have on outcomes such as stress, both perceived and physiological, and activity. These results will be presented and can have immediate design implications toward optimizing the workplace as both a dynamic and static environment for wellbeing and performance.



# Aging with Urbanism - Urban Design with Psychoanalytic Approach

Haonan Lu

## **ABSTRACT:**

This urban design proposal integrates clinical techniques with the design process. It tries to repair the urban environment to support the residency and activity among the elderly. It is presumed that by making urban place easier for this vulnerable group to use, it can provide better accessibility and higher safety standard for all citizens.

Starting from cognitive mapping, interpersonal techniques, psychoanalysis, and surveys, the design process firstly utilizes clinical techniques to better understand senior group's perception towards space. Several behavioral patterns and psychological conflicts are identified and analyzed. Some extreme clinical conditions help to provide critical standards for the design of spatial features, for example, the prioritized perception of spatial clues in way-finding during a heart attack.

Accordingly, new design guidelines are results of the analytical process. For some internal psychological conflicts, which can be alleviated through psychotherapy (especially CBT), the spatial design provides environmental settings for corresponding clinical solutions. In this proposal, the guidelines respond to how to build a "holding environment" to promote the sense of self-efficacy (Bandura, 1977); as well as how to design a place to help "work through" one's fear towards previous life-threatening experience (Freud, 1914). Therefore, certain urban space can be reconfigured to allow for activities with therapeutic effects.

To give a physical manifestation to these design disciplines, a site is chosen in North Berkeley, California. The spatial design shows in detail regarding the modification of sidewalks, facades, traffic lanes, street median, storefronts, parks, etc. Meanwhile, as an urban design project, the proposal is integrated into urban infill development in a larger city area. New housing projects as well as college facilities are proposed with care service and deliverable assistance, providing higher quality urban features to the community, and sharing facilities with the adjacent neighborhoods.

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# PERCEIVED AND YET NOT SEEN: NON-VISUAL EFFECTS IN DAYLIT SPACES

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## ABSTRACT:

Findings from neuroscience are increasingly interwoven with architectural research (1,2). Understanding physiological responses to environmental stimuli in the built environment is critical when evaluating occupant health and wellbeing. Research in the field of photobiology has shown that lighting conditions can significantly alter our circadian rhythms through the non-visual system (3,4). This might result in acute changes regarding fatigue, vigilance or cognitive performance during our daily routines (6). Among the variety of architectural parameters of relevance to lighting design (e.g. orientation, material choice, environmental conditions...), the challenge is to determine which specific features, if any, have a significant influence on the physical properties of light initiating a neurobehavioral process.

Until recently, most of the studies on the non-visual system were done at night with controlled light exposure. In order to test if realistic daylight exposure during working hours triggers physiological and behavioural responses, we designed a field experiment at the EPFL (Switzerland) to monitor different lighting conditions. The experimental conditions were created using an adaptive façade glazing technology called electrochromic. Participants were recruited and asked to work for 6 hours per day in either a classroom with the glazing turned on (which makes the light bluer), or turned off (neutral lighting condition) (fig.1). We know from photobiology that the intrinsically photosensitive retinal ganglion cells (ipRGCs) responsible for converting light into a neurological signal, are most sensitive to wavelengths around 480nm (blue light). By exposing participants to blue and neutral light we can test if the spectral sensitivity of the non-visual system produces noticeable changes on alertness, fatigue or cognitive functioning, but also, on heart rate variability or skin temperature. Each of these markers was assessed qualitatively and quantitatively with hourly app-based self-rated questionnaires and performance tests, and with continuous physiological measurements. Circadian rhythmicity was also monitored outside the experimental setup using skin temperature sensors and app-based sleep-activity diaries. Vertical illuminance and irradiance was continuously recorded at the eye level with a customized wearable device (fig. 2), and used as an input for a predictive computational model (7) to assess the potential of lighting for non-visual responses.

Tracking light exposure over time under “real life” conditions is essential to evaluate the role of adaptive architectural strategies, such as glazing, on improving behaviour and mitigating negative effects on wellbeing in classrooms. The protocol developed for this study allows us to monitor, for the first time and with limited intrusion, effects of different daylighting conditions on circadian rhythmicity, physiology and subjective behaviour.



Figure 1. (a) Experimental design. Control group experienced daylight neutral conditions (left) and intervention group experienced red-impooverished daylight (right). (b) SMEAS, customized wearable device to measure vertical illuminance and irradiance.

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is a PhD Candidate at the LIPID laboratory at EPFL and holds a diploma in architecture from ETSA Sevilla (Spain). Before joining EPFL, she was Research and Honorary Assistant at the University of Sevilla, from 2011 until 2015. She completed an MA in Technology and Design, and an MSc in Sustainable Environmental Design (Architectural Association School of Architecture, London UK). Her doctoral research focuses on the interaction between architectural design, daylight and acute non-visual effects in occupants, for working environments.

**FORREST WEBLER**

is a PhD Candidate at the LIPID laboratory at EPFL. He completed a master of science in biomedical engineering from Brown University, and holds a bachelor of science in physics and mathematics. Forrest's research interest lie at the intersection of engineering, health, and design and is currently investigating the circadian non-visual effects of light on occupants in the built environment.

**MARILYNE ANDERSEN**

heads the Laboratory of Integrated Performance in Design (LIPID) at EPFL, whose research activities focus on building performance and decision support in the architectural context, especially as it pertains to human comfort, perception and health and on the use and optimization of daylight in buildings. She is Full Professor of Sustainable Construction Technologies and Dean of EPFL's School of Architecture, Civil and Environmental Engineering (ENAC). Before joining EPFL as a faculty member in 2010, she was Assistant then Associate Professor tenure-track at MIT, where she founded the MIT Daylighting Lab in 2004. She holds an MSc in Physics and a PhD in Building Physics from EPFL, and has been a Visiting Scholar at the Lawrence Berkeley National Laboratory in California, USA, in 2001-02 and 2009. She is the author of over 100 refereed scientific papers, recipient of several awards including the Daylight Research Award 2016. She was the leader and faculty advisor of the Swiss Team, who won the U.S. Solar Decathlon 2017 competition. She is a member of the Board of the LafargeHolcim Foundation for Sustainable Construction and co-founder of the Sàrl OCULIGHT dynamics. She is also a member of the Editorial Board of the Elsevier Journal Building and Environment and of the Taylor and Francis Journal of the Illuminating Engineering Society (IES) LEUKOS.

# Agents' Cognition in the Smart City: Agent Architecture Assessment Framework

Joe Manganello

Architect, Human Factors Consultant

## ABSTRACT:

### OVERVIEW

This paper presents an agent architecture interaction assessment framework developed using constructs and measures from architecture, agent-based modeling, human factors, systems science & engineering, cognitive science, neuroscience and evolutionary biology. This work elaborates the ANFA Conference Mission, "...the range of human experiences that occur in context with elements of architecture, both exterior and interior..." by expanding the constructs of 'human' to 'agent' and 'elements of architecture' to include all physical and non-physical architectures that function as part of an agent's ecological niche. This reframing of the constructs of and relationships between humans and architecture is useful for modeling and analyzing interactions between humans, other intelligent agents, and their environments, because it puts all agents and environmental elements into one unified representational framework, defining them through a single, consistent, comprehensive schema with shared constructs and measures. This agent-based information processing systems assessment framework is especially useful now, as designers and researchers develop new constructs, methods, and tools for modeling, analyzing, simulating, and designing smart environments (e.g., smart cities, intelligent buildings, interactive environments, augmented cognition, etc.). As part of expanding the sense of what constitutes a 'cognizing agent' and an 'architecture', readers/attendees are introduced to emerging system types, including: complex, interactive architectural systems (CIAS), cyber-physical systems (CPS), socio-technical systems (STS), cyber-social systems (CSS), ultra-large-scale systems (ULS), complex, large, integrated, open systems (CLIOS), multi-scale systems (MSS), and the Internet-of-Things-Enabled Smart City Framework. These emerging systems entail increased complexity, a high degree of real-time interactivity between agents (people, buildings, other organisms, hardware, software), and an accelerated rate of adaptation/evolution.

### NEED

Environmental design is an ethical act because the environments we create challenge and/or affirm people's beliefs and enhance or degrade their sensory perception, cognition, task performance, and well-being. As Winston Churchill noted, "We shape our buildings and afterwards our buildings shape us." (Churchill, 1941) This same sentiment, expressed from an extended mind perspective as stated by philosopher Andy Clark, is,

"In all this we discern two distinct, but deeply interanimated, ways in which biological cognition leans on cultural and environmental structures. One way involves a developmental loop, in which exposure to external symbols adds something to the brain's own inner toolkit. The other involves a persisting loop, in which ongoing neural activity becomes geared to the presence of specific external tools and media.....the true power and beauty of the brain's role was that it acted as a mediating factor in a wide variety of complex and iterated processes, which continually looped between brain, body and technological environment, and it is this larger system that solved the problem." (Clark, 2003)

In summary, Clark states, by the environments we make, we, "...make better worlds to think in." (Clark, 2003) Our environments and tools are extensions of our minds. Architects and environmental researchers and designers should develop design and analysis tools to model and assess the likely beneficial or detrimental impacts of design decisions on human sensory perception, cognition, task performance, and well-being during the design process. We should simulate the likely impact of design decisions on said performance and well-being during design, construction, and on an ongoing basis during organizational use. As a first step toward achieving these goals, people and their environments and other tools must be placed in a shared representational framework. If people's sensory perception, cognition, task performance, and well-being cannot be modeled directly in relationships with environmental structures and behaviors, then it is not possible to simulate and analyze how those environmental and tool affordances likely impact sensory perception, cognition, task performance, and well-being.

The challenge of developing such a shared representational framework is made more arduous by the current proliferation of complex and interactive systems and software, in our environments and as parts of our daily routines, as well as their rapid paces of evolution. This complexity, interactivity, and the rapid rates of change of these technologies increases the challenge of creating such a shared representational framework while also increasing the need for such a framework. Humans currently innovate and evolve their environments and behavioral routines faster than the concomitant changes to sensory perception, cognition, task performance, and well-being can be integrated into our work processes and cultures. How can we design systems of cognizing and socializing systems so complex that none of the designers has a complete understanding of exactly what is being designed, what its boundaries are, how best to design it, how best to simulate/test/validate its performance, or how it will impact the sensory perception, cognition, task performance, and well-being of individuals and groups?

## PROPOSED SOLUTION IN DEVELOPMENT

This paper uses agent-based modeling constructs and methods to frame the relationships between human, non-human, and physical agents. It presents an agent architecture interaction assessment framework --- a shared representational framework for humans and their environments and tools --- designed to be useful for creating and analyzing models of how environmental design decisions likely impact human sensory perception, cognition, task performance, and well-being. The agent architecture interaction assessment framework also uses constructs and measures from architecture, agent-based modeling, human factors, systems science & engineering, cognitive science, neuroscience and evolutionary biology.

This agent-based information processing systems assessment framework is especially useful now, as designers and researchers develop new constructs, methods, and tools for modeling, analyzing, simulating, and designing smart environments (e.g., smart cities, intelligent buildings, interactive environments, augmented cognition, etc.). Emerging system types, including: complex, interactive architectural systems (CIAS), cyber-physical systems (CPS), socio-technical systems (STS), cyber-social systems (CSS), ultra-large-scale systems (ULS), complex, large, integrated, open systems (CLIOS), multi-scale systems (MSS), and the Internet-of-Things-Enabled Smart City Framework expand the sense of what constitutes a 'cognizing agent' and an 'architecture'. These emerging systems entail increased complexity, a high degree of real-time interactivity between agents (people, buildings, other organisms, hardware, software), and an accelerated rate of adaptation/evolution.

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Manganelli's goal is improving the capacity of the built environment to enhance human health, well-being and cognition. He is an architect and human factors consultant. His research engages architecture, cognitive science, human factors, systems science, and evolutionary biology. He develops constructs, methods, measures, and tools for placing and analyzing the performance of agents (people, buildings, other organisms, hardware, software) within a shared representational framework.



## Nature is Restorative:

A model for a therapeutic, collaborative learning environment for teenagers that incorporates biophilia and neuroscience research to encourage learning and well-being.

J. Susan Campbell Marano, M.A.I.D., Washington State University, Interior Designer

Judy Theodorson, M. Arch., Associate Professor, Washington State University

### ABSTRACT:

This project explores linkages between biophilia, neuroscience, and the built environment to develop evidence-based design considerations that support troubled teens within a live-learn rehabilitation facility. This population is characterized as having numerous psychological, emotional and learning challenges and thus, would benefit from a built environment that is specifically designed to reduce stress, promote restoration, and facilitate learning. The method of investigation is a design-research project. First, a literature review was conducted to identify theoretical themes and empirical studies that look at how the natural and built environment promote learning and restoration for the target population. Three key themes were identified: the restorative value of nature, daylighting for neurofunction, and physical movement for executive function. These themes are further explored below. Next, these findings are considered within the context of a live-learn facility for marginalized teen-aged girls, resulting in the formation of an interior design interventions framework that identifies spatial, sensory and visual patterns (Figure 1). Finally, this framework is used as a basis for a conceptual design proposal for a therapeutic living and learning environment for teen-aged girls. The design concept integrates nature, light, views, and opportunities for movement (Figure 2). Ultimately, this design-research project offers an evidence-based and theoretical foundation that can be adapted for a variety of special populations and, for school design in general. Additionally, the work is being used by a community organization for capital fund raising to build such a facility for teen girls.

### KEY LITERATURE THEMES AND DESIGN INTERVENTIONS

1. Nature is a restorative element in our built environments. Kaplan (1995) argues that

increasing pressures of the modern world lead to mental fatigue and that natural environments are thought to be rich in characteristics that reduce mental fatigue and provide restoration. E. O. Wilson, a biologist, developed a school of thought that focuses on the need to bring humans in contact with nature. He uses the term "biophilia", which he describes as the innately emotional affinity of human beings to other living organisms (1984). The concept of biophilia has since been developed into 14 design principles by Terrapin Bright Green, a group that conducts in-depth research in design (2012). Design Proposal: The building is set in a natural, rural environment with five secured interior courtyards. Every space has physical access to, or views of, nature. (Figure 2).

2. Daylight is important to neuro-function. The teen circadian cycle is commonly disrupted by hormonal fluctuations and excessive blue light exposure through digital devices. Emergent research indicates that exposure to daylight helps regulate the circadian system, which in turn impacts sleep/wake cycles, hormone regulation, and mental alertness (Figueiro, 2013). Many research studies suggest that daylighting positively impacts performance and mood (Edwards, et al, 2002). Design Proposal: Every space, including offices, is day lit. Spatial programming exposes students to bright light early in the daytime schedule.

3. Physical movement improves executive function. Teens that have experienced adverse environments and relationships may have impaired executive function, which is described as a set of cognitive skills that facilitate learning and behavior control. It is known that exercise is linked to improved executive function, putting the body and brain into balance (Ratey, et al, 2008; Willingham, 2013). Design Proposal: The building is designed with looped circulation paths that facilitate walking within a secure facility. For sustained exercise, there are several options including a basketball half-court, yoga and workout space.

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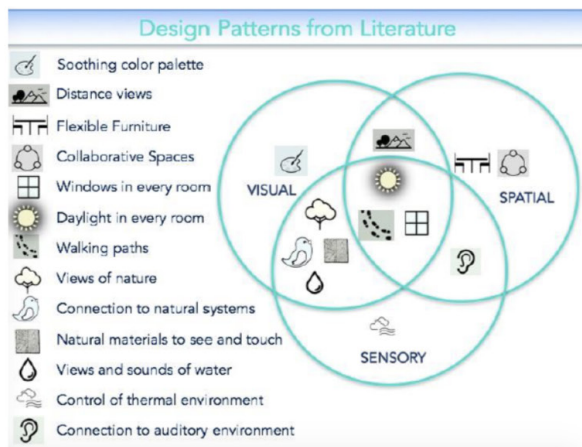
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**FLOOR PLAN HIGHLIGHTING THE DAYLIGHT EXPOSURE AREAS OF THE TEENAGE REHABILITATION FACILITY**



Figure 1: Framework for Design: Design Patterns from Literature - Visual, Sensory and Spatial

Figure 2: Floor Plan: Detail of Courtyards and Daylight Exposure Areas

*Selected references to both neuroscience and architecture design literature will be detailed with visuals on the poster and accompanying paper.*

# Mind and Matter: Office Amenities and Design in the Wellness Era

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## **ABSTRACT:**

As technology has blurred the lines of work and life, and as real estate models have evolved, the phenomenon of “workplace as a service” has emerged. Occupants may now expect their physical workplaces to be more than just a collection of desks, offices, and equipment - in addition, they seek out employers and spaces that offer amenities and thoughtful design that make for a great place to work. This shift is apparent in coworking or shared spaces, as well as in more traditional office arrangements. As the service model becomes more common, designers should look to cognitive and behavioral sciences to inform the next generation of workplace amenities. How do these environments need to be designed and operated in order to optimize both for human and corporate benefit? How can environmental design use cognitive research - restrooms provided to the value of ritual in various cultures to circadian rhythms - into designing the optimal work/life environment?

We have long known there to be a link between humans' behavior and the physical environments they inhabit, including the workplace. For example, studies have shown that architectural projects that prejudice aesthetic over meaning can engender feelings of loneliness (Roessler, 2012). Access to natural lighting at work keeps our circadian rhythm in its correct balance (Barinaga, M. 2002), which has direct impacts on levels of fatigue, mood, alertness and hunger. The audibility of background speech adversely impacts human ability to perform demanding cognitive tasks (Haka, 2009). Even smells play a large role in where and how people elect to work in the office. Corporeal porosity (Warren, S., and Riach, K., 2014), induced by odors in the office, have a direct impact on collaboration and propinquity.

Our research explores how these types of findings have informed or should inform the amenities provided in top workplaces, such as comfortable dining or lounge areas; exercise facilities or classes; and nap rooms or lighting that is conducive to the body's natural daily rhythms to help with sleep and increase energy. As a leading provider of shared workspace and amenities, WeWork conducts extensive research on trends and occupant preferences around the world. For example, an in-depth study of regional dining habits informed specific considerations for eating spaces at WeWork, such as more likelihood for overcrowding in Mexico and Brazil “due to the tendency of members to eat a long lunch (1-2 hours) in large groups” and a need for other accommodations for practices like a post-lunch nap in Chinese workplaces (Lau, G., and Montana, R., 2018). Another study on the use of mother's rooms yielded recommendations for bright, warm lighting and cushioned seating to avoid a cold, uncomfortable experience (Cosgrove, A., and Montana, R., 2017).

Additional primary research on dining habits at several U.S. WeWork locations included on-site observations in common areas to discern utilization patterns during breakfast and lunch hours. We tracked occupancy, eating group size, use of space and furniture options, and use of kitchen equipment to understand how members made choices about when, where, and how to eat at WeWork. We also conducted interviews with WeWork design and community management staff to learn about how they incorporate research and user input when planning and designing amenities such as childcare and restrooms, as well as how they make a business case for including and updating offerings. When referenced with neuroscience and environmental psychology literature, we were able to infer how these design and programming decisions promote the intersection of neuroscience and architecture, as well as options for improving design and amenities offered to support neuroscientific findings.

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# Experimental Design for Evaluating the Effect of Lighting Interventions on patients with Alzheimer's: A Review

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## ABSTRACT:

Alzheimer's disease is expected to become a major public health problem in the U.S. for the aging population. It is projected that in 2050, 65% of the aging population will die of Alzheimer's. This raises the questions of whether and how we are prepared to provide care for this growing population. In this regard, the built environment can have a crucial role in supporting care and cure processes for the disease. Among the environmental variables that impact the provision of care for Alzheimer patients, lighting is especially consequential as it is known as a non-invasive cure method that can stimulate the circadian rhythm and mitigate the issues of sleeping disturbance and agitation. Nevertheless, previous experimental research on this topic is inconclusive since many studies failed to present important variables and strategies used in their experimental designs (e.g. characteristics of the lighting device, time-series design and frequency of the interventions, the amount of light entered into the subject's eyes). This paper reviews the existing research on lighting and Alzheimer's to develop a framework that gives structure to the design of experimental research on the effect of lighting interventions on Alzheimer's patients (e.g. variables, contextual factors, control strategies). This framework can facilitate future research on this topic as it enables the researchers to improve the internal validity of their results by improving their research design. Furthermore, this proposed framework can lead to a consistency in defining and using variables, control factors, and applicable findings across different studies to facilitate replication of experimental studies and inform the researcher on the generalizability of the findings.

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Pegah's area of interest in research is the influence of Built Environment factors, such as lighting on human's health, specially the cure process of Alzheimer's and aging memory disorders. She is focusing on Daylighting and Lighting as a cure stimulus factor for alleviating the Alzheimer's patients' symptoms in the cure process.

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# The Space Between: An Exploration Into How Urban Environments Influence Affect and Distance Perception

Robin Mazumder, B.Sc, MSc. OT, and Colin Ellard

## ABSTRACT:

A study by Azgarzadeh et al (2012) suggested that viewing skyscrapers caused feelings of oppressiveness, which they defined as the sensation of crowdedness. In their study, participants rated pictures of urban settings using an oppressiveness scale. They found a correlation between building height and oppressiveness. Although Azgarzadeh et al suggested that oppressiveness influenced feelings of stress, they did not measure this directly. Building on Azgarzadeh's work, we used psychological methods to examine the experience of participants in oppressive urban environments. Using immersive virtual reality, participants were placed in low and high building environments, with or without landscape architecture. They were monitored for physiological arousal using skin conductance and asked to complete an oppressiveness questionnaire. High building environments were rated as more oppressive and were associated with higher arousal levels as compared to low building environments. In a follow up study, we are exploring how high oppressive (Mgure 1.a) and low oppressive (Mgure 1.b) environments influence affect as measured by the Positive And Negative Affect Schedule (PANAS) and the Affective Slider Scale. As in the first experiment, participants are monitored for skin conductance. In addition to the affect variables, we are examining egocentric distance estimation of objects and avatars within the environment. Lappin et al (2006) suggest the context in which objects are perceived can influence accuracy of distance estimation. Given this, we predict that environmental oppressiveness will influence estimates of distance. Furthermore, little research has been done on whether distance estimation is influenced by the nature of the target, specifically whether the target is an object or a person. We will explore this by asking participants to estimate their own distance from a telephone booth and an avatar. We hypothesize (1) participants in oppressive environments will have higher negative affect, (2) that the feeling of oppressiveness will influence spatial perception as measured with the distance estimation task and (3) that the influence of oppressiveness on perception will be stronger for avatars than for inanimate environmental objects. This work sets the foundation for future research on how the urban built environment impacts the distance people keep between themselves and others.

(google doc with Mgure available here: [https://docs.google.com/document/d/1JZglnw9viEKMSJ14UT8ueeBA08t5E\\_nOKIGlcVO2Xk/edit?usp=sharing](https://docs.google.com/document/d/1JZglnw9viEKMSJ14UT8ueeBA08t5E_nOKIGlcVO2Xk/edit?usp=sharing))

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COLIN ELLARD is a cognitive neuroscientist in the Department of Psychology at the University of Waterloo, and the director of its Urban Realities Laboratory, which focuses on research at the intersection of experimental psychology and architectural and urban design. Ellard conducts research on the human response to built spaces both using simulations in immersive virtual reality and in real settings using Meld methods. In both streams of his research, Ellard combines traditional psychological methods with data from psychophysiological sensors to develop rich characterizations of the interplay between an individual and their surroundings. In addition to his basic research, which he has published in peer-reviewed journals for 30 years, Ellard contributes to the public discussion of urban and architectural design through his work with museums and the media. Most recently, Ellard's Psychology on the Street installation ([psychologyonthestreet.com](http://psychologyonthestreet.com)), based in Toronto, consisted of a series of experiments designed to gather Meld data on the psychology of urban design, and an opportunity to engage the general public in a dialogue about the work of the Urban Realities Lab. Ellard's most recent book is *Places of the Heart*, Bellevue Literary Press, 2015.

ROBIN MAZUMDER B.Sc, MSc. OT, is a doctoral candidate in cognitive neuroscience in the Department of Psychology at the University of Waterloo, where he is studying the psychological impacts of urban design. He is particularly interested in how the built environment of the city influences emotion and proxemics. Prior to beginning his doctorate, Robin worked in clinical mental health as an occupational therapist. This front-line work in urban areas greatly inspires his current research interests. In addition to research, Robin advocates for better urban design through blogging and speaking at conferences around the world. His blogs can be viewed at his website [www.robinmazumder.com](http://www.robinmazumder.com). Robin's research is funded by the Vanier Canada Graduate Scholarship, Canada's most prestigious doctoral award.

# Legibility, Orientation and the Mantle of the 'Other'

Elizabeth McNicholas, AIA, Matthew McNicholas, AIA

## ABSTRACT:

Hippocrates' directive "first, do no harm" has application beyond the field of medicine. Neuroscience provides new and novel ways to monitor stress, and architects who aim to serve as good stewards of the built environment ought to seek to minimize the causation of chronic stress upon its inhabitants and end-users.

In this session, we present the most practical architectural design considerations relevant to the useful inquiry and input of Neuroscience.

The multitude of aspects that must be considered for individual projects and building types present a distinct challenge to an architect when undertaking the planning of buildings and places. The consummate designer mindfully inhabits each space during the design process, prior to any construction. Users of buildings also intuitively, if not explicitly, understand the designer's intentions via a Theory of Mind.

Through this phenomenon, this exchange of mind, the designer and user have an interaction on an intangible (but not immeasurable) level. As such, there is an ethereal, but nonetheless actual, exchange of cognition between the user and the designer, inside and out of every created space. This exchange is not limited by time or astral plane but embodied in place and in space.

The idioms of architecture that have the most significant positive neurological impact on the human condition are by and large excluded from neuroscientific research. The characteristics that define "humane" architecture are numerous and varied, and all have lasting beneficial effects on the mind, and accordingly on the body. We focus on two specific elements largely ignored or used without sophistication in contemporary architecture: Orientation and Legibility. In order to have a complete conversation about the impact of neuroscience on architecture these characteristics must be studied further.

"Orientation" impacts use, exploration, Theory of Mind, and wayfinding; "Legibility" impacts function, organization, memory, and hierarchy. The detrimental repercussions and chronic stress caused by the lack of these attributes are cumulative – increasing with time and with their systematic elimination from the architectural environment. We show that employing these specific elements in architecture has neurological and physiological benefit, specifically in the typologies of health care, institutional, academic, and office settings.

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# Assessing Architecture Students' In The Moment Creativity

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## ABSTRACT:

We report a new study of biological correlates of creativity in architectural design, which tests the effect of experience in reaching a creative state. Our study to build on an experiment conducted on 40 top architects (1958-9) by Berkeley's Institute of Personality Assessment and Research.<sup>2</sup> Allied is the work of E. A. Carroll's "In the Moment Creativity" (ITMC), which proposes creative evaluation as a measurable biological response, in turn eliciting decreased arousal level during ITMC."<sup>3</sup> Our experiment tests for differences in arousal levels of graduate students (in their last semester of education) versus sophomores (at the end of their first year of architectural education). Our hypothesis is that older students will more quickly enter ITMC, the designer's frame of mind, because of experience in a design curriculum.

In April 2017, we tested eighteen second-year and twenty fifth-year architecture students. Participants first completed a Keirsey Bates Temperament Sorter which provides an alphabetical notation in sequence of Extrovert versus Introvert (E or I), Sensing versus Intuitive (S or N), Thinking versus Feeling (T or F), and Judging versus Perceiving (J or P), from which we noted correlations between personality types and the statistical results for thinking like an architect. We also asked them about their confidence levels in sketching with a pencil. We question their confidence in their abilities to create throughout the experiment to suggest the direct relationship between confidence and "thinking like an architect."<sup>2</sup> The arousal stimulants were six design tasks in two forms: 1) the creativity test used in the Serraino's The Creative Architect, regarding itself as a warm up and cool down in relationship to 2) the iterative test utilizing a repetitive system that requires varied solutions to the same formal inquiry (figures 1a and 1b). The iterative tests were (by necessity) of our own invention, as current science sees iteration as a problem to be solved rather than a fundamental method or craft. Architects use iteration to discover a problem. The four repetitions of the single task allow the subject to enhance their design skills upon each task until a desired result is achieved. We believe by the fourth iteration they will have felt at the height of their creative capabilities. Biological correlates were measured using a BioGraph Infiniti System's finger temperature-measuring sensor, Galvanic Skin Response (GSR), and Electromyography (EMG). During testing, at the end of each task, we asked the subjects for a self-assessment to gauge how creative they felt during that task. Based on these self-reports and the sensory recordings, we were able to compare when and at which task, the participant demonstrated "in the moment creativity."

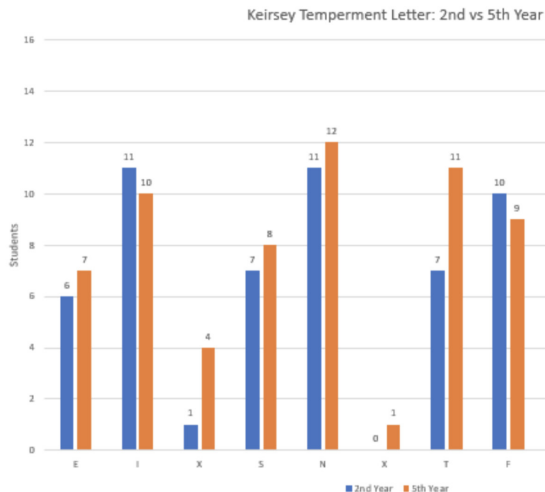
Observations during experimentation bear out that arousal significantly reduces when subjects enter the focused frame of mind we associate with designing, especially evident in the INTP personality type (one who is an introvert, intuitive, a thinker, while also being perceptive suggesting a curious and ambitious attitude) from the temperaments. Preliminary inspection of the data shows qualitative differences between second and fifth year students, and between temperaments, which we think a generalized additive model and statistical analysis will display a signature or line of best fit for ITMC (figure 2). We are currently testing self-proclaimed 'non-creative persons' as a control group. We think we can suggest from our data that tutorial experience in design studios can produce quicker access into the creative frame of mind, although personality or temperament might be more important.

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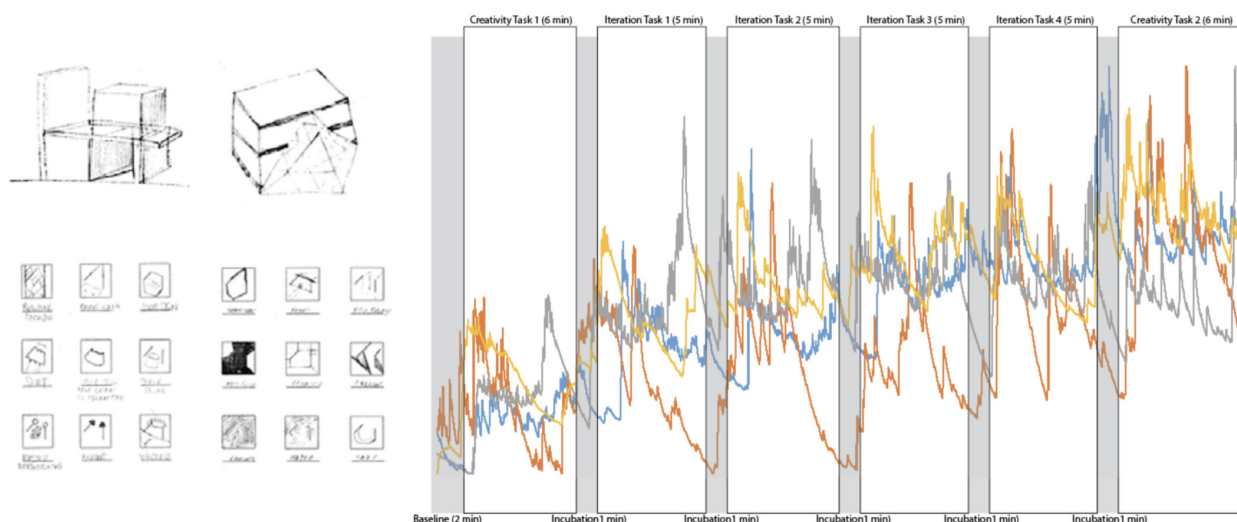
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FIGURES 1A AND 1B: Figure 1a (the bar graph) represents the number of fifth-year students (orange bar) versus second-year students (blue bar) who possess the specific letters found in the Kiersey Bates Temperament Sorter. We are most interested in the S versus N (Sensing or Intuitive) because it exhibits the preference to the think based on concrete facts and details (sensing) or to pursue an idea based on one's "gut" inquiry and thinking in a bigger picture context (intuitive). This innate ability to use one's intuition is unique and most associated with the "architect" personality type. Between the eighteen second and twenty, fifth year temperament results, there is no significant difference, but among the opposite types (for example S and N) the difference is rather distinct. To further demonstrate, the analogue

data of the drawings the participants selected as the time they felt the most creative amongst the four iteration tasks as well as their final creativity task of the experiment (the nine boxes). The drawing tasks elicited a creative mentality. These are the physical results. When presented with the iteration task and the creativity task, second and fifth year students approached the tasks differently, but upon further analysis, the differences appear in their creations. These four subjects were selected as the second and fifth-year students who fit the "architect" personality type (the two sets to the left of the dividing line) and the second and fifth-year who closely resembled the opposite of the "architect" personality type (ESFJ) found to the right of the dividing line. Though only four subjects represent the broader pool of subjects, this trend appears amongst the other twenty-four participants. From left to right, the images depict the design tasks of a second-year architecture with the personality type of the INFJ; a fifth-year architecture student with the INTP personality type; a second-year architecture student with the personality type of ISFJ; a fifth-year architecture student with the personality type of the ESTJ.

FIGURE 2: We concerned ourselves with the biological reactions recorded from the biofeedback machine. These readings align themselves with the same subjects from figures 1a and 1b. The orange line aligns with the second-year students who exhibits a creative personality; blue is a fifth-year student with the architect personality type. On the other spectrum, the yellow path represents a second year who is the opposite of the architect type; likewise, the grey line is a fifth-year with the same personality type. Among the same years, the second-year who demonstrates creative tendencies enter a creative frame of mind more quickly than the second year without that inherent trait. When basing the data on our initial hypothesis, fifth-year enter a creative frame of mind slightly quicker than the participants with less experience. Although this is what we hoped to discover, we were surprised to find the dramatic differences are apparent in the personality realm.





# Color Contribution to Environmental Legibility, Relations of Objective Performance and Subjective Perception in Wayfinding

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## ABSTRACT:

A large-scale indoor environment cannot be recognized at a single vista, and navigation requires more abstract understanding of spatial interrelationship (Peponis, Zimring, & Choi, 1990). Spatial knowledge is hierarchically acquired with the information of landmark, route, and topological layout (Siegel & White, 1975; Tversky, 2000). Recent neuropsychological evidences show that spatial cells in hippocampus react to the specific location in place cell, orientation in head direction cell, at regular distance in grid cell, and spatial edges in boundary vector cell (Hartley et al., 2014). To understand complex built environment, we conceptualize and categorize spaces according to the equivalence and distinctiveness of environmental attributes, however cognitive effects of environmental colors are largely unknown (Arthur & Passini, 1992).

Using the contrast of environmental colors, this research aims to investigate the correlations of objective and subjective color contribution to wayfinding and environmental legibility. Through wayfinding experiments in the virtual environment with twelve different scenarios (three plan configurations \* four color schemes), sketching errors and navigation errors were measured as objective performances. After the experiment, subjects fulfilled self-report about the virtual environment they experienced. These subjective measures included the perceived environmental legibility and color contribution to wayfinding. By examining the correlations of objective performance and subjective assessment, how the level of color contribution was engaged the unconscious and conscious level in subjects' minds is investigated.

In results, there were significant, yet very weak correlations between spatial knowledge acquisition and environmental legibility perception. The correlation between the spatial knowledge acquisition and perceived color contribution to wayfinding was not significant. However, wayfinding performance had significant correlations with two subjective measures.

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# “I spy with my little eye”

## A child-led Assessment of the School Built Environment

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### EXTENDED ABSTRACT:

It has been 40 years since Kevin Lynch and colleagues presented their studies on children's perception of cities. Still, the question of how the built environment influences child development remains both for architects and urban designers as well as for the young users very relevant. Such is the case for schools, important “settings” (fields of action) able to foster physical activity and healthy behaviors, including active transport such as walking or cycling to and from the school facilities (Audrey et al., 2015).

A growing body of international studies underlines the importance of designed spaces on the learning progress, social interaction, and physical and cognitive development of young pupils. In pedagogy, the physical environment is already understood as a “third teacher”: a spatial framework for learning processes that can independently facilitate the development of children (Mau et al., 2010). Recent studies show that high quality designed classrooms can explain up to 16% of learning improvements over a year (Barret et al., 2015). However, empirical research on the specific role of design concerning children's learning achievements, health, and health-related behavior remains very fragmented and unexplored (Saarloos et al., 2009; Nigaglioni, 2016).

The presented investigation is lead by the questions of how can we design more livability, physical activity, and mental well-being into school environments, and how can children play a more vital role in the process. We argue that enabling pupils to participate in research and design processes is key to developing more active and health-promoting learning environments<sup>1</sup>.

For young people and children, participating in projects in which they can design spaces has several positive effects on learning, identification, better catering and acceptance of their needs, and better well-being. At the same time, it is widely accepted that the projects benefit from young peoples' expertise in local knowledge and their age-specific needs (Driskell, 2002).

This presentation discusses the results of a pilot study in an elementary school in the city of Darmstadt (Germany), where pupils from the 1st to 4th grade (aged 6-10 years, n=74) assessed their school's indoor and outdoor environment using a smartphone game prototype based on the principle of the game “I spy with my little eye” (Halblaub Miranda et al., 2017). The data collection included several interactive workshops, in which the children documented their favorite spots – e.g., to become active, to read or to chat with a friend – and places they disliked, producing maps, photos, and drawings to discuss the existing spatial environment and illustrate visions of possible future spaces. The collected data helped to identify a set of active areas in the school, the need for restorative niches, communal spaces of different sizes, and the importance for the participants to be part of the process of improving their environment. Other results outline pupils' use and understanding of the urban context in which their school is embedded. The method is inspired by Lynch's work and reflects on how a new generation of (digitally supported) surveys, mapping, and co-design tools can encourage pupils to participate in improving their learning spaces and bring forward their expectations and needs. The game app and co-design toolbox presented will be of interest to planners and architects of learning environments seeking to engage children in the process.

The overall aim of the research project is to better understand the influence of the built environment on pupils' learning, physical activity, and well-being. This entails identifying discrete architectural elements and configurations, which encourage specific behaviors. In a further step, architecture students of the Technical University of Darmstadt will redesign the evaluated elementary school taking into account the results of the pilot study, and including a new group of pupils into the design process.

<sup>1</sup> The World Health Organization (WHO, 1995) defines a health-promoting school as an institution that creates a healthy environment by providing programs and services that support physical and mental health for the staff, the children, their families, and community members.

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Maria Ustinova is an Education Consultant at the World Bank's office in Russia. Her areas of professional and research expertise include early childhood development, education facilities design (kindergartens and schools) and education quality assurance. In 2015 she received a German Chancellor Fellowship from Alexander von Humboldt Foundation and completed a research on education facilities design in Germany at the Technische Universität Darmstadt.

Thomas Tregel studied computer science at the Technische Universität Darmstadt and is a research associate at the Multimedia Communications Lab at Technische Universität Darmstadt. His main research focus lies in the fields of automated personalization of multiplayer serious games and procedural content generation for context-based games.

Martin Knöll is professor and head of the Urban Health Games research group, Department of Architecture at Technische Universität Darmstadt. He leads new transdisciplinary collaborations between urban designers and health experts to address global health challenges such as more sustainable mobility systems, inclusion, physically inactive lifestyles, diabetes and urban stress.

## LEARNING OBJECTIVES:

- To understand the influence of built environment on children's learning, physical activity and well-being in schools, based on pupils'.
- To include children in the school design and evaluation process through participatory approaches.
- To promote architectural knowledge and understanding amongst school-aged children.

# Childhood Memories and Their Influences for the Architect's Cognition

Ana Mirea

## ABSTRACT:

Research studies in psychology explain that we are influenced by our social environment from childhood, especially by our parents or by the persons we grew up with. Unless we try to change ourselves in a conscious way, the influence will follow us the entire life. But does this also apply to the built environment? How does the brain of the architect function? Are his childhood memories and the environment he grew up in linked with his way of approaching architecture?

In our study, we are trying to answer to the questions above by using two methods: interviewing architects (Juhani Pallasmaa, and Dorin Stefan) and by filling questionnaires about the childhood memories of the architects. Neuroscience teaches us that our cognition is enriched when inhabiting a complex environment. Either perceived consciously or not, with all our senses, these surroundings affect us on a mental and emotional level. Perceptions are translated later into memories and consequently a question is raised: in which way do they affect the architect's brain? Later on, can we trace any patterns and correlations between the environment they lived in and their cognition? Juhani Pallasmaa, and Dorin Stefan, are going to answer to these questions in the interview, and their responses will be compared with the survey's results. For the moment, at the survey will take part only Romanian architects, but in the future, the target is to compare the responses of the Romanian architects with the ones in foreign countries, and also with people who have no tangencies with the field.

The final aim of this study is not only to discover if the architect's brain is influenced by the built environment from his early life, but also to identify in which manner does these connections influence his future designs. Moreover, by understanding the experiences embodied in one's childhood, we as architects could approach differently the designs we propose. Design implications? The ultimate goal of architecture should be a transcendental one, to make us better human beings, so if we improve our buildings, they will eventually complement our lives.

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I graduated from the University of Architecture and Urbanism "Ion Mincu", Faculty of Architecture, in Bucharest, in 2016. Now I am continuing my Phd. Studies at the same university, with a thesis which is trying to connect architecture and neuroscience: "The Significance of the Built Environment for the Brain", coordinated by two professors, Professor Architect Dorin Stefan and Associate Professor Andrei Miu, with a Ph.D in Psychology. My thesis will be a continuation of my dissertation thesis, where I studied the notion of place, from a phenomenological point of view, and I used as a case study, my hometown, Constanta. Apart from my academical studies, from March 2017 I am working in Iasi, as an architect, at multinational company based in Netherlands. We are delivering concept design solutions for the automotive industry, and we pay special attention to the customer's journey, which is of great help for my Ph.D. research, as it increases my beliefs in architecture as a sensorial experience.



# "Here and beyond": Synergies between Gordon Cullen's townscape qualities and Environment / Behavior / Neuroscience Paradigm

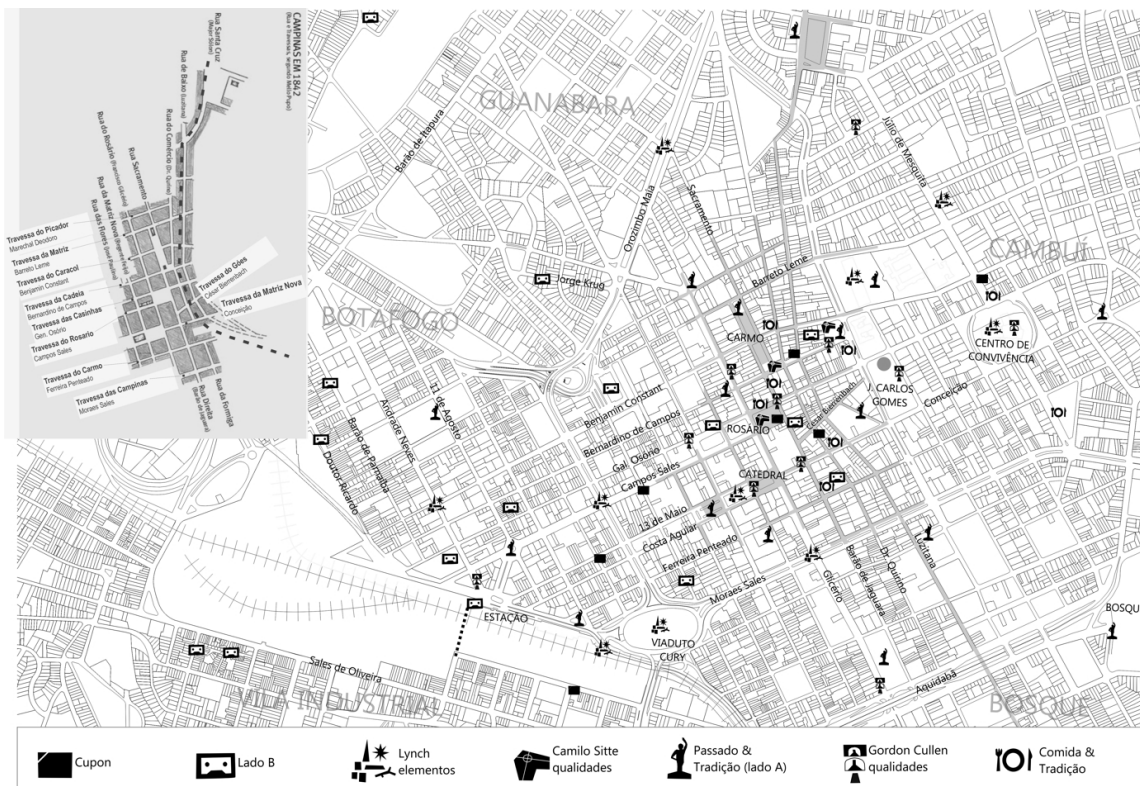
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## ABSTRACT:

For architecture and urban studies learning processes, it is important that students acquire a diverse repertoire of knowledge and experience in the most diverse spaces of the city. Such diversity may be well covered once a complete range of old and new regions of a city is considered. In this context, Cullen's book "Townscape" is considered an architecture and city planning classic in its approach and seek of qualities and beauty of the urban fabric at pedestrian level. On the other hand, critics often argue that its approach is limited to very specific areas of a city or unsuitable to a contemporary urban context. This research aims to enlarge the perspectives of the concepts and "standards" proposed by Gordon Cullen by associating them with the concepts of the Environment / Behaviour / Neuroscience Paradigm (E/B/N), described by Zeisel [10]. Thus, the methodology here proposed articulates the 46 "place" qualities and the 32 "content" qualities as categorized by Cullen [3] with the E/B/N concepts, such as: Place [5-7;10]; Personalization [9;10]; Territory [10]; and Wayfinding [5; 10]. This articulation is structured as a perceptive game (gymkhana) [2] focused on introducing the students into activities addressed to analysis of spaces, environments and places in the historical center of the city of Campinas, Sao Paulo, Brazil. As results we highlight: a) an expressive contribution to reinforce the importance of the field activities (T5 and T6 spectrums/urban center and urban core [4] respectively) as a way to compensate for the new generations of students' lack of repertoire [8], often restricted to the landscape of non-central areas (T3 spectrum/sub-urban) in their daily lives [1;4]; b) a strong engagement of the students to experience the city's space reached from E/B/N paradigm contributions [10] to Cullen approaches [3], which provide them with a rich diversity of spatial, interpersonal and perceptual experiences of the contemporary urban landscape; and c) a new model of understanding for architecture and urban studies learning processes based on neuroscience knowledge and focused on renew standardised methods in this field.



**Figure 1.** Map of the 'gymkhana' performed at the city of Campinas, Sao Paulo, Brazil, and executed to the "Fundamentals of Urbanism" course, in the Bachelor's degree programme in Architecture and Urbanism, Unicamp University, in 2016. The icons indicate points where possible synergies between the E/B/N concepts and Cullen standards can occur.



**Figure 2.** Students of the Fundamentals of Urbanism" course is receiving the maps and directions of the gymkhana. The "start" was in the Carlos Gomes Square, in the city of Campinas, Sao Paulo, Brazil, 2017.

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# A New Shelter Typology Fostering Mutual Child/Animal Rehabilitation: The Neuroscientific Connection

Sabrina Nagel & Madlen Simon AIA

## ABSTRACT:

This research explores how design settings can foster rehabilitation in children and companion animals through mutual interaction. Human-animal interaction has been researched since the 1970's, offering insights into powerful effects of one on the other (Morrison 2007, Barker and Wolen, McCardle et al 2011). Research in environmental and behavioral psychology underscores beneficial healing qualities of this interaction, highlighting the potential for healing environments to improve overall well-being by accommodating humans and companion animals on a neurobiological scale. This project draws upon recent work on the use of animal assisted therapies in counseling (Chandler 2017) to propose a new setting for this type of therapeutic interaction in a youth population. This paper examines physical design implications embedded in research on animal assisted therapy and the use of space by animals and humans (Esser 1971) to examine how architecture can improve overall well-being of both children and companion animals, fostering mutual rehabilitation through the human-animal bond in accommodating environments.

Through an understanding of the neuroscientific linkage between child and animal and surrounding environment, we formulate design principles for spaces that promote mental and physical healing. These include providing opportunities for both exploration and interaction, balance of interior and exterior spaces, choices between interaction and solitude, connection to nature, and exposure to natural light. Architectural precedent studies of both animal shelters and healing spaces expands upon these various principles and either showcases their translation into architectural expression or highlights their exclusion from facilities whose inhabitants would have otherwise benefitted.

Based on this research, we find that architecture has the potential to facilitate rehabilitation, and in conjunction with the bond formed between human and animal can expedite the healing process in an abandoned animal or troubled child. The purpose of this paper is to provide a set of guidelines that can inform architects designing facilities to further the mental and physical well-being of humans and animals. This study is a component of a Master of Architecture thesis that will expand upon these healing principles and apply them to a design for child/animal therapy, which will act as a precedent for future rehabilitative and facilities.

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Sabrina Nagel is an architecture student from Long Island, New York in the graduate program at the University of Maryland, College Park. She completed her undergraduate degree in May of 2016 at the University of Maryland with a Bachelor of Science in Architecture and a minor in Sustainability, and will complete her graduate degree in May of 2018 with a Master of Architecture degree. In her Master's thesis, Nagel is conducting design research that underscores the role of architecture in fostering human/animal relationships and mutual healing. Based upon a literature review of human/animal interaction and environmental behavior, healing theories, and precedent studies, Nagel is identifying relationships between environmental features and human/animal responses, deriving relevant design principles and applying them to the design of a facility for mutually beneficial interaction of abandoned animals and troubled children.

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# Is there anybody out there?

## Anonymity and Aesthetic Emotions in Music and Architecture

Aishwarya Narayana, IGNCA Bangalore  
Anirudh Gurumoorthy, GSD Harvard University

Johann Wolfgang von Goethe said, 'Music is liquid architecture and architecture, frozen music'. Architecture has been exploring musical influences through projects like Coca-Cola's Beatbox Pavilion<sup>1</sup>, Dithyrambalina's Music Box<sup>2</sup>, Star Wars Barrel Organ<sup>3</sup>, Court of Water Wall<sup>4</sup>, Frank Gehry's Walt Disney Concert Hall<sup>5</sup> etc. Whereas theatres, auditoriums, and concert halls have been musicians' second home and architecture has always aided the evolution of music<sup>6</sup>. Both music and architecture thrive in the glory of mathematics<sup>7, 8</sup> – Geometry and material as well pitch and rhythm are objective elements in space-time that elicit a subjective phenomenal experience in the inhabitant/user and audience/listener. We have found that this relationship between the music and architecture (that are also a product of technological, cultural and psychological factors) has a lot to offer to our understanding of how the artist, art, and the observer work together.

Further on, we critically analyzed music and architecture as art forms that on three fronts – Firstly, the 'Artistic Creation' that involves a cognitive abilities like intelligence, creativity, memory, attention etc. Followed by the 'Artistic Expression' -the interpersonal phase engages the creation with the medium and collaborators. Finally, the 'Aesthetic Experience' in which the observer/user/audience/listener becomes a part of a reciprocal dynamic, mediated through with cognitive and affective empathy<sup>9, 10</sup>.

*This paper has been motivated by the question - Is it the art or the artist that an observer 'empathizes with' in an aesthetic experience?*

This grounded research project addressed the conundrum of 'anonymity and signature' and 'intersubjectivity'<sup>11</sup> and individualistic experience' with regard to the aesthetic emotions elicited by musical<sup>12</sup> and architectural experiences<sup>13</sup>. We conducted a pilot survey (across 49 respondents) to study the variations in the emotions 'felt' when exposed to architecture (photographs of spaces) and music 'intended to induce similar aesthetic emotions'. Six such pairs of 'Intended Aesthetic Emotions' were selected; two for Happiness (Relaxation vs Joy), two for Sadness (Melancholy vs Boredom) and two for Awe (Fascination vs Vitality). Key observations upon comparing the intensities of felt emotions were that 'joy' in Symphony 2 and 'melancholy' in Symphony 3 and 4 were consistently recognized in music whereas 'Awe' was aptly recognized in spaces 5 and 6. The pilot has made us wonder - How does one's mood, personality and memories make a difference? What kind of emotions do architectural spaces explicitly express and how is their perception affect by the cultural symbolism, function and activity associated with the spaces? And are there behavioral, cognitive, neural or cultural patterns in these responses that we can systematically study to apply in architectural design and pedagogy?

In the poster, these space-music pairs have been further juxtaposed with thematically coherent examples of films (space, characters and instrumental background scores) to further examine the differences in the emotional experience in the aftermath of aesthetic works, speculating whether we readily respond to intellectual content and emotions or just empathize with the people/characters in such scenes. The scope of this study extends beyond Neuroaesthetics, emotion and empathy research; it has direct applications in Neuromorphic architecture<sup>14</sup>, affective computing<sup>15</sup>, emotion/mood related parameters in Building Information Modeling, human-centric analysis of Design Performance, 'Affective' design pedagogy, and practice. As aspiring academicians we are enthusiastic about exploring this interdisciplinary channel for engaging Theory of Architecture and Phenomenology with a holistic body of knowledge curated through experimental psychology and neuroscience.

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### Aishwarya Narayana

As an architect and a student of psychology, I am driven by an elvish curiosity to explore how emotions, empathy and consciousness relate to architecture. My current work with Dr. Deepti Navaratna at the 'Music, Culture and Cognition Lab' at IGNCA, Bangalore deals with the perception of emotions and complexity in the multi sensory experience of temple architecture.



### Anirudh Gurumoorthy

All of my thoughts originate from and land on Architecture. But I often take a few interdisciplinary diversions, where I delve into History, philosophy, theory, and psychology of art and architecture. Currently, I'm looking forward to being a part of the M.Des. program at Harvard Graduate School of Design where I intend to explore the idea of "Utopia" in Architecture.

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# Applied Cognitive Architecture: The Restorative Impact of Perceived Open Space

Bill Witherspoon | Debajyoti Pati, PhD | David A. Navarrete

## **ABSTRACT:**

A growing understanding of the neurobiology of spatial cognition will enable architects to superimpose a cognitive architecture over its conventional counterpart, effectively altering the psycho-physiological experience of the observer in the built environment. Collaborating with an architect, a neuroscientist, and an environmental psychologist, this study identifies the neural correlates of multisensory imagery, revealing how illusions of nature modify perception of place to generate a restorative, biophilic experience of vastness that yields therapeutic benefits.

By understanding the malleable nature of the body schema—the integrated neural representation of the body—neurobiology has established that the separation between the observer and the environment is arbitrary (Robinson, 2015). That is, the separation between our cognitive experience of body, peripersonal space, and extrapersonal space is subject to constant revision depending on the attributes or atmosphere of place.

The Biophilia Hypothesis proposes a kinship with living systems that presupposed an elemental separation between the observer and nature. However, the notion of embodied perception and the discovery of MN (mirror neurons) reveal that our perception is action-oriented perception (Arbib, 2015). That is, our neural simulation of action and movement in others also extends into a dynamic interaction with our environment.

Our emotional assessment of place leads us to extend our sense of self into our environment, or retract from it, into our body proper. This newfound neurobiology of human perception unveils a remarkable opportunity to use cognitive architecture—re-wiring our experience of real space in thought—by tapping our memory's spatial maps.

Given that the sensorimotor systems we use to navigate space share the same neural infrastructure we employ for higher cognitive functions, including memory, can architects and neuroscientists tap this two-way ('wetware') street to evoke embedded (biophilic) spatial reference frames and thereby alter the occupant's experience of enclosed interiors?

We used 3.T fMRI technology to address this hypothesis. Ten participants belonging to five age groups were subjected to short (25 seconds) exposures of 32 images while their brain activation was monitored via the BOLD response. In a separate run, participants were subjected to extended exposures (12 minutes) of photographic Open Sky Compositions (multisensory illusions), and an image of a traditional ceiling, in an effort to demonstrate that sky imagery can be: 1) composed to engage our memory's spatial maps, and 2) evoke an experience of vastness.

The study found activity patterns in the brain consistent with our theorizing that multisensory Open Sky Compositions not only share the same patterns produced by positive images, but also produced unique areas of activation, including those associated with spatial cognition and the expansion of space.

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**DEBAJYOTI PATI**, PhD. Dr. Pati chairs the Rockwell Professorship in the Department of Design, Texas Tech University. He has written and published extensively on healthcare design research, serving as VP and director of research at HKS Architects before moving to Texas Tech in 2011.

**DAVID A. NAVARRETE**, Director of Research Initiatives, Sky Factory. David is a writer and researcher in Cognitive Biophilia. He has written for *Human Spaces* and *Conscious Cities Journal*. He's the co-author of the AIA/RIBA/USGBC course, *The Restorative Impact of Perceived Open Space*.

# Topological Anticipation of Modern Patterns and Visions in Baroque

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## ABSTRACT:

**These:** In the history of creativity and thinking, the roots of paradigm shifts are deeper than expected. Traditional ways of interpretation of the history of art are focused on formal appearance of works of art and architecture, or their symbolic meaning. Such approaches are however inadequate to the task of understanding of art as a creative process of interaction of senses with the intellect. Inspired by a rather provocative hypothesis by Gilles Deleuze identifying a fold as a key shape of birth of Modernity in the Baroque Leibniz mathematics we are studying some other stimuli of changes in cultural history of Baroque. We believe that this these can be interpreted in the context of neurosciences, mathematics, architecture and biology.

**Theme:** In the centre of our attention is a network of attempts of the intellectuals of Baroque time to understand science and art as something much more complex than are only isolated disciplines of creativity and knowledge. There were much more significant motives of Baroque to develop a manifolded cultural discourse consisting of interactions and penetrations of artistic and scientific disciplines than use to be taken in account in the majority of approaches to Baroque art in the history of art since 19th century up today. Athanasius Kircher's concepts of Museum Kircherianum, Giambattista Vico's role of poetic wisdom in Scienza Nuova, Blaise Pascal meditation on two meaning of geometry, Cesare Ripa's emblemata together with Amos Comenius Orbis pictus are some of the cases of interacting disciplines and areas of Baroque discourse.

**Case study:** the Santini-Aichel's works of architecture as a subject of an interplay of divers knowledges and skills, as well as in architectural and mental construction of shapes in mind and space, in the combination of cabala-mathematics and linguistics, in the combination of the new, or personal architectural elements together with vocabulary of the historical manifestation of architectural language and visions, particularly with Gothic art. This analysis does not just involves genius loci and history account but the whole mind set and socio-economical setting of middle Europe in transition from distant past towards future. The subject of Santini Aichel architecture calls for an innovative topological approach thus revealing the latent, processing structure. This kind of research may be as well interesting from contemporary scientific point of view and undertaken deconstruction of the whole cultural context.

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## Beyond Survival Through Design: Lessons from Evidence Based Medicine

Raymond Richard Neutra MD Dr.PH

### **ABSTRACT:**

By choosing the word "Survival" to be in the title of his 1954 book "Survival Through Design," <sup>(1)</sup> Richard Neutra was signaling the potentially dire consequences of moving ahead without design, or with designs that didn't consider consequences and were not evidence based. He really meant "flourishing" through design, and although he was focusing on the survival and flourishing of humans, his same principles would apply to the flourishing of humans and their surrounding ecological system. He envisioned a profession of architecture that would come closer to the practice of medicine. The word "design" was meant to apply equally to an unchanging structure like the Taj Mahal or Neutra's Boomerang Chair as well as to a structure or a designed process that anticipated the possibility of change to accommodate biological individuality <sup>(2)</sup> or changing functional demands as would be the case in convention centers, schools and dwellings<sup>(3)</sup>.

In environmental medicine as with environmental design, evidence may be gathered about end-points that: the patient/client is aware of (satisfaction surveys, Yelp comments or anthropological interviews), that require professional categorization (epidemiological case definitions, behavioral observations) or that are important even when not evident ( blood lead or blood pressure levels.) Some of the evidence may be about "upstream" events, thought to be relevant to "downstream" consequences of value to flourishing. While laboratory and statistical evidence has prestige value, some of the most important impacts of design decisions may best be captured in simpler and less expensive ways, with a potential for a much wider application. <sup>(4)</sup>

In large community-based health care systems that target a defined population, there is a budget and an organization with a variety of professionals to provide the feedback to practitioners to guide prevention, cure and care <sup>(5)(6)</sup>. What are the institutional and organizational challenges to evidence-based practice in industrial and software design, city and landscape planning and architecture?

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RAYMOND NEUTRA, MD DrPH

Raymond Richard Neutra MD DrPH taught Epidemiology at Harvard and UCLA before heading an environmental and occupational research unit at the California Department of Public health for nearly 30 years. He has been interested in the application of scientific evidence to environmental policy. He will present case studies of program and architectural evaluation. He is the youngest son of architect Richard Neutra



## Home as Health Intervention

Winifred E. Newman, Ph.D., Kinsuk Maitra, Ph.D., OTR/L, FAOTA, and Sonit Bafna, Ph.D.

### ABSTRACT:

What kind of knowledge is needed to inform building design in an effort to address the issues related to cognitive disability? According to the International Classification of Functioning, Health, and Disability Framework (ICF), the functioning of an individual—which can be described in terms of bodily functions, individual activities, and social participation—is related to personal and environmental factors (WHO 2001). Much of the current intervention relies on personal factors (See Levasseur et al 2015a for a review); our research program, in contrast, is an attempt to explain how home environmental factors can influence an individual's functional ability [Foley et al, 2014, Levasseur et al 2015b]. The central premise behind our approach is people function in their environment not just by negotiating directly with the physical constraints and affordances of the environment, but also indirectly by working with mental or cognitive models extracted from the physical environment. From an empirical research perspective this means rather than seek direct associations between aspects of the physical environment and human behavior and perception, the better approach is to seek associations of behavior, perception, and even psychosocial health attributes with mental constructs that capture distinctive aspects of the built environment. The intellectual case for this premise comes from recent work in architectural morphology or the evolution of form in the built environment, some of it conducted by us (Bafna 2003, Peponis 2012, Peponis and Wineman 2002). In a recent study we found classifying the arrangement or room layout in apartments of a low-income Latino community into two kinds using models of spatial and social arrangement—circulation-centered and living-centered—could account for almost 40% difference in the risk of depression of women in these households (Chambers, Bafna, et al. 2017). In this paper, we outline a program of research in a NORC community in Atlanta where physical models of inhabitants' homes and the mental constructs derived from them will be used to explain the degree to which the home environments support or augment mobility and health. We end by discussing how studying perceptual -cognitive constructs of space can help us acquire better understanding of the mental models people create of their domestic environments.

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# Shaping the Human Biosphere: A Systematic Review of Research on Visual Attributes of the Built Environment and Their Applicability in Architectural Practice

Dr. M Dana Oprisan, Interior Architect, Assoc. AIA  
Biophilic DC Practice Group

## **EXTENDED ABSTRACT:**

### **SUMMARY:**

Any space we create is an interface between the outside world and our inside nature. The key to a health-promoting built environment is achieving harmony between those two. Research in environmental psychology, neuroscience, biology, and medicine reveals that the physical environment appears to be a significant determinant in how people feel and act.

Neuroscience research is expanding our understanding of human brain response to the built environment. It has the potential to inform architectural practice in the creation of environments for promoting health, wellbeing, stress relieve, increased performance and productivity. There has been considerable progress in this direction, and a growing number of studies address the connection between architecture and neuroscience. The current body of research already is very informative.

People communicate with the external world through the senses: sight, smell, taste, hearing, and touch. The signals perceived from the environment follow a complex path in the brain and generate intricate responses to the environmental attributes.

Out of the five senses, the visual perception has the strongest and most complex impact. More than half of the brain is devoted to processing visual information. Brain activity in response to visual stimuli is comparable to that of an orchestra, whose clusters of cells in different parts of the brain cooperate to process various components of visual information (Katz and Shatz 1996). Understanding from a psychological and neurophysiological perspective how visual attributes impact humans may be a valuable "tool" for designing in a conscious and intentional way to meet people's needs in specific instances. For this reason, it was considered useful to investigate the body of knowledge regarding the visual attributes of the environment and their role in spatial perception as primary designing tools of architectural practice.

### **METHODOLOGY AND RESULTS:**

This work is a quantitative literature review of the correlations between Artificial and Day Light, Color and Indoor Nature Exposure as visual attributes of the environment and their impact on how humans feel, act and perform. (Oprisan 2017)

The literature search identified 325 articles in peer-reviewed medical, psychology, neuroscience, architectural research, and human ecology journals and selected 88 relevant articles addressing daylight, artificial light, color, views, and indoor nature exposure covering 11,052 participants.

Despite the lack of standardization of tests or of systematic methodology and differences in how terminology is used it was possible to categorize and sum up the relevant evidence currently available. Almost fifty percent of the selected studies addressed the impacts of artificial light while the impacts of color, daylight and indoor nature exposure covered the other half of the studies. The impacts of the visual attributes were grouped in psychological impacts, environmental psychological impacts, and physiological impacts.

The leading theories of environmental psychology were considered: The Kaplan's Mystery/Complexity/Legibility/Coherence (Informational Variables) Model (Kaplan, Kaplan et al. 1989, Stamps Iii 2004), Attention Restoration Theory (Kaplan 1995, Kaplan and Berman 2010) and The Prospect-Refuge Theory (Dosen and Ostwald 2013,

Dosen and Ostwald 2016)

The analysis of the results explores how the visual attributes, regarded as architects' tools, may best be handled in the design process to create spaces that meet specific humans psychological needs, promote wellbeing, health, performance, and create salutogenic environments (Golembiewski 2012).

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DR. DANA OPRISAN, EDAC, LEED AP BD+C, Assoc. AIA is an interior architect and researcher. She holds an M.D. Degree, a B. Arch and an MS in Sustainable Design. Her work is focused on innovative, creative design and communications across disciplines for improving healthy building practices, and human-centered and salutogenic design. She is a member of the Biophilic Practice Group in Washington, DC. Currently, her work explores the biological mechanisms of biophilia and how this body of knowledge can be applied to architectural practice.

# Emotions and Senses: The Relation between Architecture, Emotion and Perception

Andrea de Paiva

## **ABSTRACT:**

The built environment impacts behavior. Neuroscience applied to architecture has proved that different environments can evoke emotions and influence brain processes. Can a building arouse negative or positive emotions? If individuals feel different, will that change their behavior? As a sequence of the poster presented at 2016 ANFA Conference (neuro architecture & workplace design: how space can affect performance and well-being), this paper intends to discuss the built environment impacts on emotions and, consequently, behavior.

The brain is hardwired to provoke emotions in response to stimuli from outside and inside the human body. According to Damasio [1], emotions are generated in the brain and experienced by the whole body. These are innate reactions of the brain that are expressed on facial expressions, body language and attitudes [3]. They affect the way people feel (consciously or unconsciously) since feelings are mental experiences of body states, which arise as the brain interprets emotions [1]. That, in turn, triggers changes in behavior and wellbeing.

But what environmental features will change emotional states? And how does it happen? The brain uses the information brought by all senses to create its own perception of reality And it is hard-wired to respond to some stimuli with emotions to help survival. Sizes, shapes, colors, proportions, temperatures, smells, movements, sounds, body states, those are some of the features that alone or combined can induce the brain to react generating a specific emotional state.

How can architects use such knowledge on the buildings they design? Which emotions should be evoked or avoided? If architecture is evoking an emotion, will it impact on wellbeing, socialization and the use of space? This paper intends to discuss some of the findings that show how architecture can impact emotions and to inspire architects and neuroscientists about future researches.

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Lecturer and professor of neuroarchitecture, with publications about neuroarchitecture, smart cities and construction industry. Working as a consultant in the biggest think tank in South America – Fundação Getulio Vargas. Main areas of research are neuroscience applied to architecture; neuroplasticity; the brain on communication and emotions.

Poster presenter at the ANFA Conference in 2016 - neuro-architecture & workplace design: how space can affect performance and well-being.



# Impact of Face-to-Face Social Interaction on Performance in the Workplace

Stephanie Park

## ABSTRACT:

The workplace across industries has drastically changed over the last few decades due to rapid changes in the technology development, communication tools, and general work culture. In order to support such transformation with structural organization changes, cross-displace collaboration and dynamic work processes, the physical environment of the workplace has been positioned as a vital part of the company's success. Social interactions in the workplace can help build social cohesion and sense of belonging to the organization, which can impact employees' work productivity. Therefore, the design of the physical settings in the workplace that fosters social interactions can have a crucial impact on the employees' performance. This study seeks to examine the behavioral and physical impact of face-to-face interactions on employees' productivity by using wearable electronic badges (sociometric badge) that are capable of measuring the amount of face-to-face interaction. Prior studies using this data found positive correlation between amount of face-to-face interaction in general, both work related and non-work related, and task performance (Wu 2008). The goal is to build on the existing studies using the sociometric badge data and examine the implication of casual and social interaction that happen in different physical settings in the workplace. This study seeks to find if the amount of social face-to-face interaction is positively correlated with higher worker productivity, and more specifically, amount of social interactions is compared with tasks that have higher complexity.

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### STEPHANIE PARK

Stephanie Park is a senior lead workplace strategist at WeWork, where she develops strategies to enhance the user experience, using her multidisciplinary background and expertise in design, psychology, and data science.

Stephanie earned her dual-degree in Architecture and Psychology from Carnegie Mellon, where she worked with both architecture and cognitive neuroscience faculty to explore ways that design decisions can be informed by neurological and physiological data. After few years of applying the research strategies as a design strategist at Gensler, she earned her Master's degree in Data Science at Columbia University to further pursue her passion in using data and research to understand users and design an ideal experience.



# Strengthening the Physical and Mental Health of Children Means of Environmental Design: The Method Of Forming A Therapeutic Landscape

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## Abstract:

Lack of physical activity and contacts with nature negatively affect the health of the younger generation. This raises serious concerns among pediatricians and sharpens the issue of creating conditions for strengthening and preserving the health of the child population.

Since the soviet period in Russia and Armenia the network of institutions of restorative and preventive medicine, such as sanatoriums and dispensaries, struggles with this problem. Recently there appeared a tendency for redevelopment of such facilities. The factors affecting children's health, in particular, the role of architecture and design of the environment [6, 7] especially landscaping [1, 4], in strengthening the health of children are considered.

Our research is based on the analysis of examples of international experience in development of therapeutic gardens in children's hospitals, using various types of play-ground equipment, their impact on children health as well as the impact of contact to nature [13, 14, 16, 17].

The hypothesis of the study is the assumption of the importance of educating the child for the desire to interact with nature at an early age, because "the ecological education in childhood creates the basis for treatment with landscape therapy in sickness and in older age <...> This hypothesis requires significant studies in different regions to identify the nature of this dependence" [22].

Based on the research, a method for developing therapeutic landscape projects for children from 2 to 7 years is proposed, taking into account the potential of play-ground equipment, planting and hard-scape design to stimulate the perception of the environment and the activity of children, which can be applied both in healthcare institutions, residential areas and kindergartens, as well as children's hospitals, if adopted to their profile.

Approbation of the methodology is carried out on model projects which are planned to increase the therapeutic potential of landscapes in children's health centers in St. Petersburg and Yerevan.

In St. Petersburg, the work is based in the DESIS laboratory of St. Petersburg University, in Yerevan – in the Department of Hygiene and Ecology of Yerevan State Medical University.

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# Cognitive Architecture: A Model for Professional Practice

Sarah Petrocelli, RA, LEED AP and Luke Petrocelli, RA

## ABSTRACT:

The question regarding architectural experience has long been addressed by architects and theorists. Central to the debate is an attempt to identify a universal order found within architectural form. At one end of the extreme is a philosophical discussion about the phenomenology of architectural expression, described by Christopher Alexander as being "inextricably connected to the innermost nature of human feeling."<sup>(2)</sup> At the other end, is a highly categorical approach tightly ordered by guiding principles, as evident in Alberti's "concinntitas".<sup>(1)</sup> Both views arguably lack a contemporary scientific understanding of human experience. Recent developments in the cognitive sciences have made significant advances in this regard. However, the question remains: how can architecture fulfill its role in accommodating human need and enhancing the human experience through practical application?

This question defines the two-phase analytical process of Prospect Cognitive Architecture & Design, an architecture and research group in Brooklyn, NY. Central to Prospect's research is a desire to align abstract architectural principles with findings in cognitive science. The first phase of research classifies the built environment into spatial categories. These formal groupings are derived from a range of contributions to architectural theory, and are aimed at deciphering intuitive aesthetic preferences regarding the built environment. Sources include Humanist views on geometry and proportion; Embodiment theory, including work by Thiis-Evensen, Moore, and Bacon; Neutra's views on biorealism; and Alexander's "Pattern Language".

The second phase of research evaluates each of these findings through three main branches of the cognitive sciences: Anthropology, including evolution, social behavior, and linguistics; Biology, incorporating neuroscience and biochemistry; and Psychology, exploring perception and emotion. Research draws from Edelman's theory of Neural Darwinism, Zeki and Ramachandran's work in Neuroaesthetics, and Proshansky's contributions to environmental psychology.

Outcomes of this research seek to generate a scientific basis for architectural intention and provide the infrastructure for design decisions in Prospect's professional work. The goal is not to impose a set of formal rules upon the design process, but to provide a framework for understanding and to radically inform the discourse between architects and their clients.

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LUKE PETROCELLI is an architect and researcher based out of Brooklyn, NY. He completed his Master of Architecture at the University of Maryland in 2015. His thesis dissertation, titled "A Neuroethical Architecture: ANFA NYC", explored the challenges facing neuroarchitecture and proposed an intervention on Roosevelt Island in New York City. This work received the Architectural Research Centers Consortium King Student Medal. It was presented as a poster presentation during the ANFA 2016 BridgeSynapses conference. It will also be presented during the IAPS 2018 conference in Rome as an oral presentation. He holds a position as adjunct faculty for the University of Maryland's study abroad programs in Southern Italy and Turkey. His research includes archaeological excavations in both regions, with preference to the psychological implications of experiencing ruins. His research interests have broadened to include cognitive science as a basis for decision making in design. He has over eight years of professional experience and holds an architecture license in New York State. He is one of two founding principles for the design and research firm Prospect.

SARAH PETROCELLI is an architect and researcher based out of Brooklyn, NY. She completed her Master of Architecture at the University of Maryland in 2013. Her thesis dissertation, titled "Architecture & the Senses: A Sensory Musing Park", studied architectural experience through sense-stimuli relationships within the built environment. Her proposed intervention explored user interaction through a series of hypothetical installations in Parco della Rimembranza, Rome. This work received the Architecture Thesis Award. It was presented as a poster presentation during the ANFA 2016 BridgeSynapses conference. It will also be presented during the IAPS 2018 conference in Rome as an oral presentation. Her research interests have broadened to include cognitive science as a basis for decision making in design. She has held an adjunct faculty position at New York City College of Technology as well as mentorship positions with Architecture in the Schools, a program of the AIA DC. She has over ten years of professional experience, including several years of experience in the affordable housing industry. She holds architecture licenses in the state of New York and New Jersey and is one of two founding principles for the design and research firm Prospect.



## A Neuroaesthetics of Ionian Capital

Bianca Predoi, PhD, architect, enterprise BPArchitecture, 1050 Brussels, Belgium

### ABSTRACT:

Key: spatial cognition, visual imagery, reward, memory / patrimoine, Ionian capital

Specific to the architectural representations across time, the image of the 'Ionian capital' marched alongside all expressions of humanity related to the universally acknowledged values of built space. The aim of this presentation is to outline the current meaning of the patrimonial architecture in humankind's imagery through a new lens of cognitive development applied in thinking the architecture today. Be it neoclassical references or fictitious anticipations in cinematography, the classical elements of Greek antiquity still constitute a model base for archetypal memory with a widespread global significance in expressing immutable human values. These values are used, as well as manipulated in visual imagery, in order to recall perennial values, security and trust. We are inquiring here through a comparative method of research whether the visual fulfillment that a historical architectural reference generates on a wide social scale is due to the activation of the neural centre of reward<sup>1</sup> in individual cases of visual perception of the same element.

We seek to determine whether the Western visual culture, due to two thousand years of experience, has established itself as a learning and cultural cognitive model relevant for advancing references and defining tools for communicating power, stability, or wealth; we propose as example the Ionic order around the world – temple of Priene, 340 BC (ca) – 140 BC, 'White House' eclectic architectural neoclassicism 1792 – 1800, gypsy villas in Eastern Europe etc.

Here we open a discussion on the basic reward model already developed in the neuroesthetic literature and other experiments capable of synthesizing memory studies, identity studies and egocentric representations of sensory states and actions. The relationship between the existing formal models / visual elements in terms of imagery, planning, memory (the "Ionian Capital" iconic model) and the recurrent revival elements of refurbishment renewing 'classical' architecture always enriches the development of spatial cognition despite it often constrains the relationship itself from a critical thinking perspective.

Although often decontextualized and rarely linked to its original emergence, our cultural experience still allows us to understand the iconic "Ionian capital" as a perennial element of architecture (in terms of intangible heritage). It radiates significance in all domains influenced by architecture, from artistic, to sociological and cognitive sciences. But for how much longer?

It is still present in contemporary architecture within the new aesthetics of transparency, used as a decorative element beyond a sheet of photovoltaic glass, revealing both the beauty of a technological structure, as well as recalling the contradictory rearrangements of the deconstructivists years<sup>2</sup>.

However, beyond the stylistic statement that surrounds it, beyond its grace and elegance, the "Ionic Capital" has a deeper meaning from a paradoxical perspective, as the icon of a humanistic approach to the built realm in a posthuman<sup>3</sup> era. To be more explicit, the implication for our socio-affective development is related to education. Thus, inherited neurobiological abilities of the human brain (as part of all species) are correlated with the complex cultural variability of acquired traits leading to specific neuronal responses as a function of cultural nurture. In our case, visual activation of the brain, as well as emotional feeling while contemplating an iconic element of classical architecture, vary according to cultural learning, sociality, and identity.

So, should we consider its perpetuity as the expression of a more complex phenomenon occurring above its ornamental appearance whose beauty is able to tickle, or not, the reward centre of our brains? On one hand, it looks like an object in a museum, the incarnation of the highest aesthetic achievements of humanity, capable of accommodating the ultimate meaning of the architectural understanding as public art; on the other

hand, from a sustainable discursive point of view, in the urgent conditions of human precariousness, a critical perspective associates its still vibrant relevance with a specific oriented language capable of transforming it into a communication vehicle of power<sup>4</sup> or steadiness, yet not related to its original significance, but with its role in the machinery of manipulation.

But we do not intend to refer to global areas of emerging economies of the world where, for example, the clash of cultures destroys local heritage in favor of kitsch pastiche made on a "dollar bill"; or the poor appropriation of the cultural heritage in cases of accidental proximity to immense patrimonial values, ending to be forgotten in ruins just because the absence of their "commercial relevance". The study is meant to pursuing the research of neural processes and analysis of the visual cortex within social contexts which implies such conducts.

We examine the way of thinking about architectural heritage in megalopolises such as Rome or Athens where, in addition to the scholars' discourse, different meanings, depending on the perception and emotions of the individual status/person<sup>5</sup> coexist.

Overcoming disputes over taste<sup>6</sup>, this proposal brings into discussion the idea of a new legitimacy of the architectural practice from a perspective offered by its interaction with the human brain<sup>7</sup> which sees the perennial built environment.

By articulating this proposal on the semiotics of architecture in a neuroscientific setting, its relevance would be to explain why and how developments in neuroscience could be applied to advance affective, social, cultural, political ('belonging to the polis') and, above all, architectural consideration for the material and the intangible cultural heritage.

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# Applying Neuroscience Research to Boost Creativity

Bianca Predoi, Ph.D

## **ABSTRACT:**

NTA Neuro-Test for architecture is a multidisciplinary tool thought to provide quantitative and qualitative research support in order to anticipate how the architectural project design impacts people on a variety of levels; Engaging the role of the aesthetics, planning and engineering of the project is inevitable related to the neuronal vs. psychological factors that influence humans and their well-being. The aim of NTA is to advance and disseminate in the process of the architectural design the importance of the brain response interacting with a 3D architectural synthesis image. NTA is meant to provide an efficient complementary tool consisting in a computational cognitive/neural model related to spatial memory in order to improve the design of the built environmental context.

In few words NTA addresses the purpose of architecture as it relates with our brain.

The human reaction to the architectural design is not a matter of disinterested aesthetics, but a result of mutual exchange of information. In the past it has been researched through multidisciplinary methods, social and psychological survey research, field observation, interviews or data sources and measurements etc.

The architects could be often absorbed by an overwhelming project process and management related to technical, environmental, legal, and contractual demands; once a building is ended it serves functionally as well as physically; despite that, people don't respond all the time as planned expectancy/supposition levels. Sometimes these suppositions could be deceiving, even related to proper analysis methods of reading the architecture; in years living, having the spatial experience during a long amount of time within an inappropriate built environment could become a nightmare. Nevertheless, like in a polygraph test, the brain gives an immediate response in contact with such spaces, un-mediatly involved in the spatial perception. The question if certain architectural or urban configurations correspond to our real needs becomes legitimated.

NTA is meant to answer to this question.

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# Effects and Influence of Entrance and Lobby Design on the Care of Mental Health Clients

Nadia Rachel

## **ABSTRACT:**

This study explored the shared behavioral outcomes, the phenomenon of feeling serviced and returning, of mental health clients within the context of community mental health centers. Today, a community-based approach has become the standard model of care where clients receive services at their local community mental health center or CMHC. The goal of this study was to investigate the influence of exterior entrance and interior lobbies' physical design features on the process of initially perceiving mental healthcare services. An ethnographic study, entering and waiting within CMHCs in Washington, USA was observed on two separate days during the month of September in 2016. Data was collected through the direct observation of both the researcher and the clients' use of space and movement behaviors prior to, during, and after entering the following existing CMHCs: (1) Site A in Everett, WA; (2) Site B in Seattle, WA; (3) Site C in Everett, WA. The results demonstrated one optimal CMHC environment and two that failed to meet the expectations of a supportive environment thus contradicting the community-based care model in which the facilities were programmed. Finally, the results, assessed via a Salutogenic approach, informed the psychosocially supportive design proposal of a CMHC entrance and lobby.

## **AUTHOR BIO:**

NADIA RACHEL: Psychologist, Psychotherapist, and Environment Health Designer

Nadia Rachel is an early career Psychologist, Psychotherapist, and Environment Health Designer, currently living and working in Dublin, Ireland. She provides trauma-focused psychotherapy and trauma-informed design consultation for clients across the lifespan. Nadia specializes in utilizing a combination of clinical verbal and nonverbal communication techniques to optimize long-term healing. In 2015, she was project lead for the redesign of a residence for Bay Cove Human Services clients living with neurodevelopmental delays and early-onset Alzheimer's, in Boston, Massachusetts. In 2016, she was a special presenter at the Design and Emotion Conference for "Laban Movement Analysis in Design Research: An Embodied Experience" in Amsterdam, Netherlands. In 2017, she consulted in the redesign of Stanford University's Office of Sexual Assault and Relationship Abuse Education and Response. This year's ANFA conference seeks to provide examples of behavioral outcomes in various building types, thus serving as a platform to share her thesis from the Boston Architectural College, "The Effects and Influence of Entrance and Lobby Design on the Care of Mental Health Clients." The study uses Salutogenic principles to outline the successes and pitfalls of three separate community mental health centers located in Washington, followed by the design proposal for a psychosocially supportive center.





## A School designed to improve student's brain activity using integrated Neuro-architectural design aspects (QEEG-VR)

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Ahmad Amr, Virtual Reality Designer in A.C.H , Grad student, Department of Architectural Engineering In Future University In Egypt.

Osama Al Rawi, Professor of Architecture, Department of Architectural Engineering In Future University In Egypt

### 1. Abstract:

#### 1.1.Purpose:

Here we demonstrate a recorded (EEG-VR) method to improve middle school student's brain activity (11-14 years) through designing the learning environment by integration of different Neuro-aspects by practical application. So that A middle school was designed as an application of the following design methods.

#### 1.2.Methodology / Procedure Purpose :

**1.2.1.The Research Aim:** Improving student's brain activity by urban spaces are designed by different design aspects :

1-Physiological Environmental Green Aspects:

Environmental interaction & Control (Exposure to enriched environments increases the birth of new neurons (Neurogenesis)+Air quality & distribution+Sun+Acoustics+Day lighting+Temp+River+ Natural materials+Sensory rich-environment+Shade & Shadow+courtyards

2-Aesthetics and golden ratio Aspects:

Void Boxes+Ratios+Angles+ Bio geometry Principles

3-Emotional Design Aspects:

Directionality+Places for group learning—alcoves+Different Levels,Shapes,Sizes and Views+Void boxes+Diversity+Landmark+Symbolism+Out & Indoor interaction between spaces+Contrast between solid & void+Harmony with nature+Movement & experience Individualization: Low Space Density, Inappropriate Scale, Personalization, Flexibility)

4-Archeoastronomy Aspects:

Linking the buildings to Orion Nabula by shafts directed to it (Multidimensional power spots—————)

5-Biogeometry Aspects Ratios, rotation, interfacing, shifting and transparency.



#### 1.2.2. The Design Process:

This project aims to make an interaction between students and the environment and to make the urban and architectural spaces an effective element in the process of emotional rehabilitation of these children so that the psychological state is changed to become their scientific a spontaneous step after the process of psychological & mental rehabilitation. The school designed to give the sense of a free space in addition to a group that gives a sense of containment and cosmic continuity with the artificial river that has been added to the mountain site of the project for making the required contrast between the hard dry stones & The element of flowing water represented in the river water. Through following and integration between the previous literary theories and by a practical EEG recording during a real time virtual reality simulation, an elementary school was designed to accomplish and evaluate this process.

**1.2.3. The Evaluation Process:**

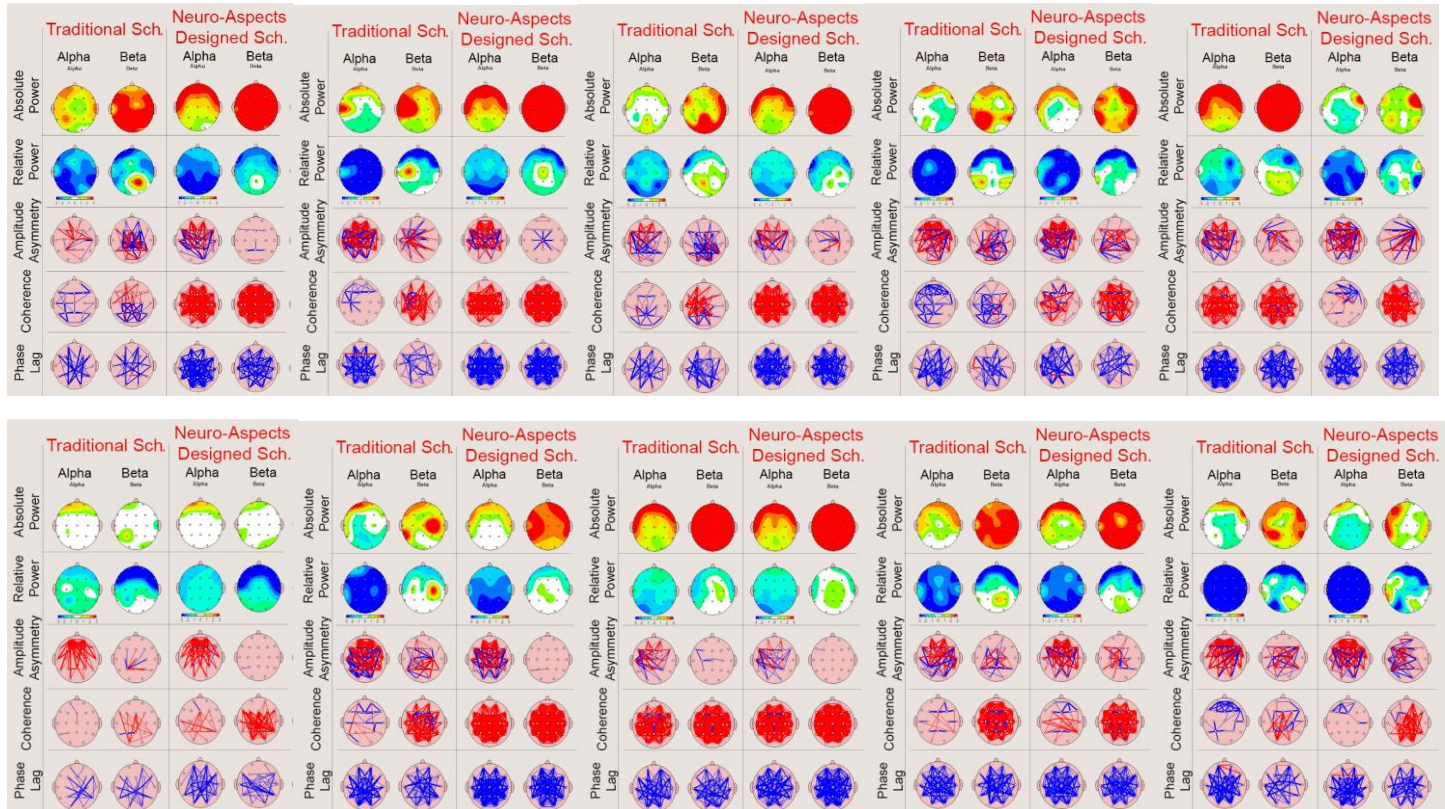
QEEG recording during virtual reality simulation was tested on 10 middle school students'

**1.2.4. Inclusion criteria:**

· Age 11:14 years-Normal IQ-No medical comorbidities-Acceptance of enrollment

**1.2.5. Outcome / Discussion:**

The measurements of QEEG recording during Virtual reality simulations for 2 models (Traditional school Vs Neuro-Aspects designed school) showed that 80% of the cases had the frontal lobe activation Which has been reflected by the increase of alpha and beta waves in the frontal areas in their brain, And It has been scientifically proven that the frontal lobe is responsible for concentration, attention, problem solving and judgment of things, The measurements also showed that the brain produced alpha waves and produced less beta waves, It has been scientifically proven that beta waves express the concentration, focus, cognition and the five physical senses Therefore the alpha and beta waves indicates the person's willingness to receive information.

**1.3. Future Steps:**

Applying the school design in a virtual reality environment used by students in schools to make a positive impact on the brain to help them receive study information

**1.4. References:**

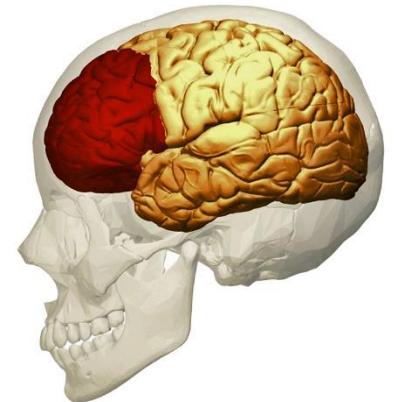
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# How Buildings Teach Kindness: social emotional learning across generations in neuroscience and architecture

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Loren D. Johnson, Associate AIA, LEED BD+C, Pamela Harwood, AIA, Dr. Marcel André Robischon

Neuroscience data shows that social emotional learning and relationship building is the core to healthy and happy learning for all generations. Research from the neurosciences has greatly improved our understanding of how architecture shapes behavior, how multisensory experiences create meaning essential for learning, and how architectural space and form express emotions that can enhance or impede social interaction. Educator and author Patricia Wolfe discusses how the brain encodes and stores information and why meaning is essential for social emotional learning. Because a building is multi-sensory in its perception, involving all of our senses over a temporal span through our movements within and around three-dimensional space, scholar and architect Harry Mallgrave describes architecture as an embodied experience in which we perceive, feel and sense. This experience engages neural mechanisms creating the embodied simulation of materials, forms, spatial relationships, sounds, smells, tactile qualities, scales, textures, patterns, and atmosphere that impact social emotional learning.

Linking neuroscience and architecture, we will identify the precepts of social emotional learning in and explore how early learners and elderly interactions benefit both age groups promoting brain growth. Experiential learning and environmental education examples that have the potential to engage neural mechanisms to create architectural embodiment will be considered in ways to demonstrate how buildings can teach kindness. Essential to this social emotional learning is that we “feel” or project ourselves emotionally into the actions of other people and empathize with the forms of our built environment.

As architects, we observe that buildings can teach and be part of the curriculum inspiring learning across generations, that the environment can influence the way we feel, think, and learn. **So how do buildings teach kindness? What does kindness look like in architectural space?**

**The built environment embodies the connection between space, time, and pedagogy. We will present a consideration of five attributes of an architecture that teaches:**

1. **Exposure**, relating to the visibility of architectural elements within a building and in nature, the corporeality of the body's time and space is engaged when in the midst of learning
2. **Diversity**, across different learning styles and learning space typologies, architecture is an assemblage of mind, brain, and body
3. **Adaptability**, design must allow for flexibility, re-imaging of space, a flow of ideas, technologies, and ever-changing needs
4. **Interactive** design relates to how we alter our environments to create the mysterious and curious, to extend the boundaries of space into the interior and exterior, the public and private, the active and focused worlds of learning
5. **Immersion** in space is intentional through the qualities and sequence at which spaces are revealed; immersion allows the inhabitant to fully engage and embody social emotional learning

**Implications of architecture and neuroscience for design include opportunities to create and evoke the following five topics:**

1. **Embodied Simulation** Embodiment has far-reaching consequences in architecture for it not only defines “our identification with and connectedness to others, but also forms the basic ground of our development and being, how we grow and construct our social relations with others and ourselves.” Theorist and architect Harry

Mallgrave discusses an essential nature in this embodied simulation is that every “reading” of one's intentions (in design) at the same time provides space for one's self-exploration. Neuroscientific evidence supports the relationship between the motor system, the body, and the perception of space, objects, and the actions of others. Architecture of embodied simulation constitutes a basic characteristic of our brain and makes possible our rich and diversified experiences of space, objects, other individuals, and our capacity to empathize with them.

**2. Multisensory Experiences** Hapticity in architecture allows us to read something of our humanity into the materials with which we build. Sensory appeal should have a human fingerprint, as it were, etched into its surfaces. Memory is what enables us to learn by experience and our starting point in understanding learning and memory is sensory perception. Everything in our memory begins as a sensory input from the environment. The role of sensory memory is to take the information coming into the brain through sensory receptors and hold it for a fraction of a second until a decision is made about what to do with it. All sensory input arrives simultaneously! Perception is the meaning we attach to information as it is received through the senses. Architecture that engages multi-sensory experiences will be most embedded and therefore most remembered.

**3. Spatial Ambiguity** Perceptual richness can be produced by a continually changing sensory experience found in architecture. Spatial conditions in design with varying levels of ambiguity and tension create a neurological event open to multiple interpretations. Referred to in Semir Zeki's neuroaesthetics, this “neurological play” engages and challenges the brain to allow multiple meanings to be decoded. It evokes something that forces the brain to pause, engage multiple areas, and reflects upon the unfamiliar phenomenon it encounters. This ability to represent simultaneously on the same canvas, not one, but several multiple interpretations of space and form is an important way to enrich and enhance the brain's neural efficiency. We can explore this theme of ambiguity, in Zeki's specific sense of a neurological event open to multiple interpretations, as an integral part of architectural spatial design. Spaces that bleed into one another, forming a public and private overlap, or half-inside, half-outside interstitial space, are examples of spatial conditions that invite an ambiguity of relationships.

**4. Movement and Form** The fact that architecture requires movement around and through combinations of form presents a very different experience of form than other arts as we do not perceive a building in static manner. Through eye-tracking devices, we learn that most people look at the same formal features of a building or street scene, often in the same sequence. In a remarkable verification of formal insights, we apparently gaze at regions with contrast, curves, detail and ornament. Additionally, neuronal architecture discussed by Thomas Albright suggests that the existence of the cortical system for organizing visual information facilitates the processing of commonly occurring relationships between visual features. Implications of this for architecture are that when people view random patterns of line segments, any collinear, or nearly collinear relationships within those patterns tend to stand out perceptually from a background of noise. Repeating lines in collinear, curvilinear, parallel and radial patterns in human-made designs benefit detection facilitated by tapping into the highly organized neuronal system. This formal sense of order and pattern is exemplified in Fay Jones's Thorncrowne Chapel as well as the Rue de Rivoli arcade in Paris. Both architectural examples support the ways that humans walk and encourages movement forward through the space. The part of the brain that is important to architects, the hippocampus, is one of the principal sites of our spatial navigation and imagination.

**5. Biophilia and Atmosphere** The qualities that are embedded within a space and the sensorial qualities that a space emits are referred to as “atmosphere.” Theorist Juhani Pallasmaa and architect Peter Zumthor discuss “building atmospheres” as the craft of creating, capturing and understanding sensorial qualities of space in physical construction. Atmospheric attributes in architectural design, such as light, sound, color, wind, water, matter, vegetation, and landscapes constitute ways we can better create the human-nature connection. There have been measured physiological and neurological effects of nature and “atmosphere” on the human body and the brain. Biophilia is a term used to explain how humans are innately drawn and biologically encoded to be attracted to natural settings and elements (be it direct, indirect, or symbolic). This has proven instrumental in enhancing human physical, emotional, and intellectual well-being. Architectural theorist Juhani Pallasmaa argues that the experience of atmosphere is related to the concept of space. “The quality of a space or place is not merely a visual perceptual quality. The judgment of environmental character is a complete multi-sensory fusion of countless factors, which are immediately and synthetically grasped as an overall atmosphere, feeling, mood or ambiance.”

# The Criminalization of the Mentally Ill within the US Prison System

David Redemske

## **ABSTRACT:**

**BACKGROUND:** "Mass incarceration" has been the description of the recent dramatic expansion of the criminal justice system in the U.S. Research has shown that most of the increase in the prisoner populations is due to the "war on drugs" and mandatory minimum sentencing laws. Underserved communities disproportionately have borne the burden of mass incarceration. Among incarcerated adults, rates of mental illness and suicide are at least double compared to the general population (Cropsey et al., 2012). Over 50 % of the incarcerated population suffers from psychiatric symptoms and up to 25% suffer from a serious mental health problem such as schizophrenia, as compared to an estimated 10 % and 5 % of the general population, respectively (Macmadu 2015). Many inmates also suffer from substance abuse disorders, with prevalence rates four times as high as that of the general population (Cropsey et al., 2012). Even though half of U.S. inmates have a psychiatric disorder, and they have prevalence rates of major depression and psychotic disorders four to eight times as high as the general population, only 22% of state prisoners receive treatment while incarcerated (Rich et al., 2011). The cost of incarcerating inmates with severe mental health disorders is estimated at \$1.5 billion annually (Kinsella, 2004). As a comparison, it costs approximately \$60 per patient per day for community mental health programs, versus \$137 per inmate per day to house a mentally ill inmate in prison (Kinsella, 2004). The purpose of this literature review was to shed light on the healthcare process and settings for prison inmates with mental illness, and to generate recommendations for the future.

**METHODS:** A systematic review of the literature was conducted, including key word searches of several relevant databases, title and abstract reviews, and full text review of 169 pertinent sources.

**RESULTS:** The radical reduction in the number of long-term, intermediate, and short-term inpatient mental health beds under the jurisdiction of mental health providers dramatically affected the corrections system (Lamb & Weinberger, 2005). There are three times more mentally ill people in prisons in the U.S. than there are in mental health facilities (Abramsky, 2003; Reingle Gonzalez & Connell, 2014). Because of this paradigm shift in the U.S., many people now get their inpatient mental health treatment in prisons (Lamb & Weinberger, 2005; Reingle Gonzalez & Connell, 2014). In fact, Los Angeles County Jail, Chicago's Cook County Jail and New York's Riker's Island now house more people with serious mental illness than in any of the nation's psychiatric hospitals (Macmadu & Rich, 2015). The lack of adequate community mental health resources shows a direct link to the number of incarcerated individuals with a mental illness (Abramsky, 2003). Thousands have been prosecuted for crimes they would have never committed if they had access to adequate mental healthcare in their communities (Abramsky, 2003). Prisons were never intended to be care centers for the mentally ill; however, that is one of their primary functions today (Abramsky, 2003). Prisons have been described as "toxic" environments for the seriously mentally ill by many mental health providers (Abramsky, 2003). They are overcrowded and tense places where all prisoners struggle to maintain stability, despite the presence of violence, the lack of privacy, limited family contact, and few, if any, educational and work opportunities (Abramsky, 2003). In addition, mentally ill prisoners are typically housed in segregated units, even though the isolated confinement can cause psychiatric breakdown (Abramsky, 2003).

**CONCLUSIONS:** The U.S. prison system is at a crossroads. Funding was never provided for community-based mental health services after the deinstitutionalization of the 1960s. Because of this, there has been a criminalization of mental health disorders. In order to provide adequate, compassionate, and ethical care for mentally ill inmates, funding must be provided to construct appropriate housing; develop programs, treatments, and therapies; train correctional officers on the signs and symptoms of mental health disorders; and to increase staffing for mental health professionals. In addition, there are alternatives to the incarceration for the mentally ill. Policies such as diversion programs that redirect patients to treatment centers, and increasing funding for community care programs either through new funds, or redirecting some of the money from corrections to mental health treatment, can all be used to decriminalize and destigmatize mental illness, as well as reduce the burden on the corrections system.

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## AUTHOR BIO:

DAVID REDEMSKE is an Architect and Health Planning Principal at HDR, with over 27 years of industry experience. He has designed facilities throughout the U.S., Canada and Middle East. An expert in the design and planning of correctional health facilities, Mr. Redemske has designed health facilities for many State Departments of Corrections, including Illinois, California, and Texas, as well as for the country of Kuwait. He is also a Certified Correctional Health Professional (CCHP) from the National Commission on Correctional Health Care (NCCHC). Mr. Redemske was the recipient of HDR's first Research Fellowship, and spent a year examining health care in the U.S. prison system. His research focused on the complexity of the environments in which health care is delivered to U.S. prison inmates, including the prison clinic or infirmary, regional correctional medical facilities, and community hospitals.



# The Student Experience: The Future of the Academic Library

Mark Thaler, Maddy Burke-Vigeland, Kimberly Hickson, Ben Regnier  
Gensler

## **ABSTRACT:**

How are academic libraries currently being used? What spaces are popular? What kind of activity is taking place? How much has technology penetrated this ancient space? What inferences can we draw from these observations that can help drive the design of future libraries? While there is a wealth of intuitive knowledge about use patterns in academic libraries, there is very little observational study of how these critical spaces are actually used.

Using digital observational tools that allow for direct recording of use space-by-space over time, Gensler has conducted a "time lapse" site surveys of a wide variety of college and university academic libraries, observing focused and collaborative activity, space qualities, and tools used. Direct observational data collected hourly over several weeks at each site provides data on occupancy, activity, and context. Combined with student and faculty surveys, and librarian round tables, this has provided insight into not only use patterns and occupancy rates, but how students and librarians differ in how they perceive the value of the academic library.

The collection of academic institutions was broad, ranging from community colleges to 4-year research universities, and the results were likewise diverse. Each library demonstrated a different rhythm of use pattern that remained consistent over time, as it was tied to the other scheduled activity and nature of the student body (resident or non-resident). At each library there was an observed "social period" where group interaction spiked, normally near meal times or later in the evening.

The dominant finding was a confirmation, supported by surveys and interviews, that individual focus work is still the dominant use of libraries, with 73% of students and faculty performing this activity. Despite this finding, the most common seating type observed at these libraries was aggregate seating at large tables. Visitors to the library performing focus work were unlikely to sit at a 4 or 6 seat table if another student had occupied the table, even when the library was acting "at capacity." When study carrels or divided tables were provided these were far more popular as they are designed to support focused activity.

Group work was also common, with 10% of observed users working in groups of 2 and another 15% in groups of 3 or more. The most popular locations for group work were in dedicated conference rooms or in informal lounge areas outside the main stacks, not the large tables mentioned above.

Tool use confirmed the librarian "common sense" answer provided in round tables that, while computers and digital devices are very common, many students still use physical books and pen and paper in library activities. Physical note taking with digital reading was the most common combination observed. This accommodation of both digital and physical tools is a key aspect library use that should be highlighted.

The study also tracked access to amenities (food, power, daylight) to attempt to see if any of these factored into seat choice. No observable connection was found, instead the seat type and privacy or suitability to activity as mentioned above was the primary driving factor. This suggests that providing furniture more closely matched to user needs could help drive occupancy for the academic library.

Student and librarian interviews and surveys provided some additional qualitative information to the quantitative data from the observation reports, particularly in a discrepancy between the two groups on the future of library use. While librarians see a future "learning commons" with a broad and vibrant array of engagement methods and a focus on navigating new digital resources, students see continued value in libraries as a bastion of quiet, and a prime place to complete individual work. Negotiating this base difference is crucial to the future of these core academic spaces, and as the research suggests successful design plays a large part in determining occupancy and use rate. Providing spaces tailored to focused work, collaborative activity, and social gathering,

that support both physical and digital tools, in proportions that match the expectations of the use base, are a key starting point to reevaluating library design.

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# Cognitive Differentiation and Design Thinking – Louis Kahn as an Early Pioneer – Next Directions

John Roth

## **ABSTRACT:**

The achievements of the architect, Louis Kahn, continue to receive acclaim and admiration. Yet the prevailing tendency has been to focus recognition more on physical artifacts and less on conceptual means and methods. Louis Kahn approached his work like a scientist. He would consistently declare assumptions and intentions as he began a project. He would enforce that hypothesis with rigorous detachment. Afterward he would recognize what actually went well and not so well. Then he would revise his assumptions and intentions for the next endeavor.

Clearly, Louis Kahn and Jonas Salk shared a strong rapport with the construction of the Salk Institute for Biological Sciences, in La Jolla, California.

Considering several decades of his working career, Louis Kahn's primary motivations changed perceptively and dramatically over time. The particular response to each successive challenge would concentrate on an immediate motivating theme, later becoming continually modified and adjusted, effort after effort. And, those prevailing motivations can be seen to be related to basic human cognitive capabilities in general. While externalizing emphatic architectural possibilities, Kahn was also continually examining the internal experience of his own mind. The results can be seen as manifestations of distinctive patterns of perception and realization. Progressing forward, it may now be possible to discern and to measure emergent cognitive patterning through the means and methods of neuroscience – (Dario Nardi, Ph.D., UCLA.)

The practice of thoughtful design can be characterized as an awareness of idealized cognitive stances – that will systematically vary throughout the course of a complete cycle of activity. Today, this approach is often described as Design Thinking and usually explained in the context of collaborative teamwork. But it may also be recognized that truly accomplished architects or designers will be capable of shifting personal awareness through an extended spectrum of cognitive stances, apart from any influence or pressure of interactive group dynamics. The benefits of thoughtful design can be balanced against the insights of the thoughtful designer. Through the deliberate pursuit to be more and more thoughtfully inclusive, Louis Kahn may be regarded as an important early pioneer of Design Thinking.

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**AUTHOR BIO:****JOHN ROTH**

John Roth has earned a B. A. degree with a major in architecture, a M. Arch. degree, and also an M.B.A. degree (M.M.) A formal thesis paper was entitled, "Works of the Architect, Louis Kahn, in Relation to Psychological Principles of Integration." Associate Member, AIA.

ANFA Conferences 2014, 2016  
NewSchool Summer Intersession 2017

There has been a long-standing interest in objective decision management, especially concerning insights based in psychology. There has also been a long-standing involvement with the Salk Institute for Biological Sciences, especially since 1990, including direct conversations with Dr. Jonas Salk during a period of controversy over the expansion of the building complex.

## Contemplating Temporal Architecture: Toward better buildings and deeper neuroscientific study of architectural experience and perception.

Alissa Rupp, FAIA, LEED BD+C  
Principal, MIG | Portico  
Seattle, WA

### **ABSTRACT:**

The premise for this poster presentation is that the perception of architecture is not possible without the perception of time. The relationship between architecture and cognition or perception may be studied through the lens of our experience of space over time.

Architecture (that works well for humans) is sensitive to, and reflective of, its place; the site, climate, patterns of habitation, cultural context and built context contribute to good design. The design of a built space must emerge from the context in which the building will live its life.

Tied to the idea of place is the question of whether a building is suitably designed to be understood over time. Such an evaluation considers how the built space accounts for our experience of the day, the season, the year, the era in which we encounter it, as well as the path of travel and duration of the individual experience. This presentation will suggest that human understanding of architectural space considers both place and time, and that we can improve design outcomes by accounting for how humans perceive and report on the passage of time.

When we think of what makes a good building, particularly in the modern era of sustainability, and design for human health, we think of factors that are primarily spatial. If we consider factors that are temporal as well as spatial, we may then expand the list of qualitative assessments of the space. We may find new ways to evaluate occupants' experience of the space. We will then need to consider the ability of the built environment to absorb and reflect change. Time and change are inextricable from each other, so architecture that accounts for both place and time (change) will take us toward a temporal architecture.

Users of our built environments change over time. They grow, gain experiences, and have different needs depending on age, activity, ability and mood. If our buildings are to reflect time, or afford change, then the materiality matters, and the organization of the space matters. Materials and program facilitate change (or changing perceptions); just as they allow us to be grounded to place, they allow us to be aware of, and responsive to, time - both in the design of buildings and in the design of scientific studies around architecture and neuroscience.

## REFERENCES:

Referenced studies/papers will include the following:

- Studies of how acoustics and soundscapes affect people's perception of space (sighted and low vision subjects);
- Subjects' estimates of how much time has passed in a real or virtual environment; studies of people who report being "in the zone" during a task;
- Studies of individuals working night shifts or in underground/non-daylit environments;
- Quality of task performance or learning outcomes in spaces with access to daylight;
- Use of "landmarks" in mapping spaces;
- Discussions of learning, to reflect the process of apprehension, organization, use, recall and retention over time, and how our brains are changed by learning (Albright);
- Work by Thomas Albright: our brains are already set up to find order, to appreciate pattern, to notice change and variance in specific ways relevant to our survival;
- Lecture and writings by Pallasma: Architecture requires the Body, Memory, Imagination, not the instantaneous gratification of the captured photograph;
- Lecture and writings by Holl: The whole of the building vs. the lived experience: this may be the central question of how architecture should work;
- Lecture and writings by Gage: our buildings are changing people, and this may be where the capacity of architecture to generate meaning or emotion comes from.

## AUTHOR BIO:

ALISSA RUPP, FAIA, LEED is a registered architect with more than 20 years of professional experience. Bringing a range of skills to the practice, Alissa focuses on places for informal education and public learning. Her work on visitor centers, children's museums, and zoological facilities includes both architecture and exhibit design, with strong roots in sustainable building practices and interpretation. To achieve this mix, she draws from her unique background in music, museum education, and developmental psychology. Alissa holds a BA in Cognitive Science from Vassar College (1989) and a Master of Architecture from University of Washington (1996), as well as executive certificates in Design Firm Leadership and Management (UW, 2006) and Architecture and Neuroscience (New School of Architecture and Design, 2017). Significant design credits include: Pearl Harbor Visitor Center in Honolulu, Hawaii and KidsQuest Children's Museum in Bellevue, Washington. Alissa has presented at numerous regional and national conferences, including AIA Northwest Region, Association of Children's Museums, Greenbuild, National Children's and Youth Gardens Symposium, Western Museum Association, and the Symposium on Systems Research in the Arts in Baden Baden, Germany.



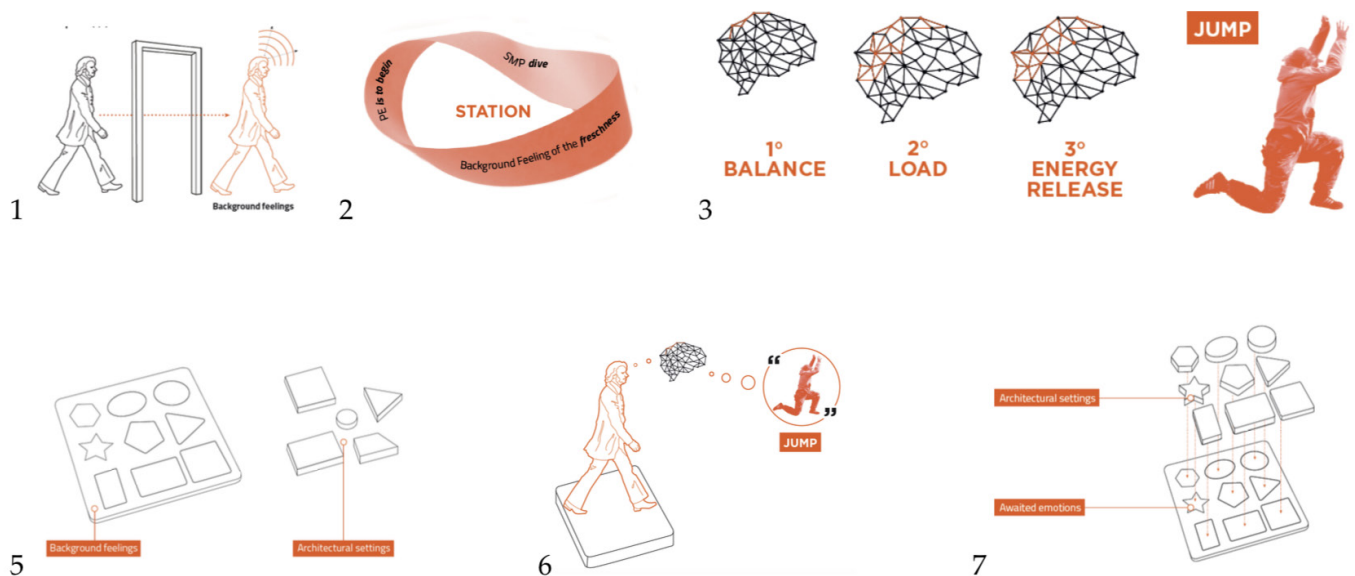
# Tuning Design

Davide Ruzzon TUNED Lombardini22 Milan

How Architectural Settings of Interior Spaces Can Enhance Users' Experiences

## ABSTRACT:

1. Inside the different places in the city, every human experience involves the “**system of seeking**”, from which spring several **background feelings of anticipation**. (1,2)
2. There is an **intertwining** among the Phenomenological Essence of the human experiences **PE** in interior spaces, the Sensori-Motor Programs **SMP** and the Background Feelings **BF** (9,10,13)
3. Along the evolution, each body **gesture** created **cortical maps** featured by their particular relationships with space, by their development phases in the time, and by the flow and direction of the light perceived. (3,4,5,6,7,11)
4. An architectural **setting** (of a particular topology, geometry, proxemics, lighting, or rhythm) can **activate** analogous signals belonging to a specific **sensorimotor program**, involving proprioceptive, vestibular, and visual dimensions. (12,15)
5. Organisms are driven by evolution to seek quicker and more efficient ways to attain homeostasis. The awaited emotion or **background** feeling acts as a **filter** and **catalyst**. It encourages the recognition and selection of architectural environments able to embed emotional, sensorimotor, and visual components proper to the bodily gestures related to the awaited emotion. (12,14,15)
6. Within the experience of a particular place, this **bodily perception** enacts (through the process of **embodied simulation**) the **gesture** associated with the **anticipated feeling**. This coupling—the “nesting mechanisms” regulated by more ancient parts of the brain— focusing the **attention** enhances **cognitive processes**, and produces **wellbeing**. (10,12,14,15)
7. This recognition of bodily gestures is transformed into an **attunement** of input signals from the environment with output elements of memories related to the anticipated feeling. (12,15)



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13. Sarah Robinson 'Nesting' 2011;
14. Antonio Damasio 'Self comes to mind' 2010;
15. Davide Ruzzon 'Tuning Design' 2017;

## AUTHOR BIO:

DAVIDE RUZZON, TUNED Scientific Responsible, Architect, graduated from Luav in Venice. Scientific Responsible of the NAAD Master 'Neuroscience Applied to Architectural Design' at the Luav University of Venice. Director with Sarah Robinson and Alessandro Gattara of the new architecture magazine 'Intertwining' for Mimesis International. Author with Vittorio Gallese of 'Tuned Architecture' for 2016 Overview Publisher Padova and of 'The architecture of the differences' for TArch Edizioni 2013 Padua. He has written and edited collections of essays, coordinated the editorial board of Anfone and Zeto and organized seminars and conferences. He has carried out public and private construction projects and participated in International Competitions.

LOMBARDINI22, a leading group on the Italian architecture and engineering scene, operate internationally through three brands: L22, specialising in architectural design and engineering for the Retail, Office, Hospitality and Data Center markets; DEGW, a leading company in strategic consultancy about work methods and interaction between physical space and corporate performance; FUD Brand Making Factory, focusing on Physical Branding and Communication Design. Lombardini22 is now a workshop employing over 160 people, a dynamic and creative workplace, which is the fourth-ranked architecture firm in Italy in terms of turnover.

# The Biological Effects of Materials: Visual and Tactile Perception of Environment

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## ABSTRACT:

*"It is in the very nature of science that it succeeds by focusing on parts of the whole. The challenge is to determine which the 'right' parts are, and how lessons gained from the study of separated parts may provide a firm basis for study of the larger system formed when the parts are combined."* M.A. Arbib (2013)

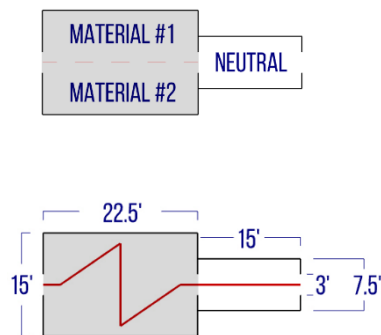
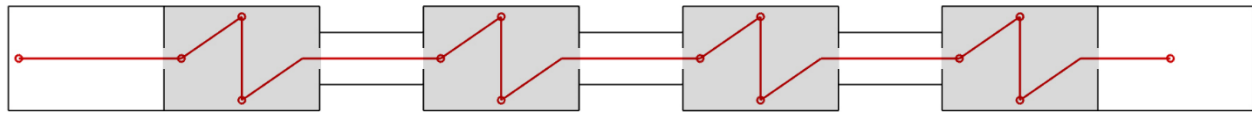
Responding to Dr. Arbib's challenge, which is the ANFA's desire for the vital exchange between architects and neuroscientists, we will sketch a protocol to investigate how MATERIALS biologically affect the individual (i.e. heart rate, galvanic skin response, etc.). We propose that just as various environments have distinct impacts on man, so do various materials leave a measurable imprint as they are experienced through vision and touch. To understand this would be to better understand how we experience architecture—for, to paraphrase Harry Mallgrave, architecture is nothing if not materials touching.

Since many variables can influence our spatial experiences<sup>i</sup> we must examine material because it is the most common variable. Indeed, it takes more than "thingness" to define environment because the power of suggestion can play a larger role; a Berkley study<sup>ii</sup> explored the effects of workspace dividers and discovered that office employees found the symbology of their environment to be more important than physical considerations. Material can be bold or subtle in its physical and suggestive abilities as it precipitates form, interacts with light, and creates color. Therefore, it is reasonable to surmise that material perception (that is, our understanding of the origin or composition of materials<sup>iii</sup>) can influence our bodily experience and perception of environment.

Various studies have explored some aspects of materiality. "The Physiological effects of Shinrin-yoku"<sup>iv</sup> entailed biofeedback experiments demonstrating that a natural environment (a forest) was more physiologically relaxing than an urban cityscape. Students at the Tokyo Institute of Technology<sup>v</sup> created a virtual walk-through among high-rise buildings to understand how different architectural treatments could help reduce feelings of oppression. "Touching Materials Visually"<sup>vi</sup> revealed that tactile assessments of material samples could significantly alter perceptions gathered from visual assessments. Each study suggests a different potential of material's influence, but we are proposing a new, all-encompassing procedure. We propose an experiment that would include various categories of materials, each category within its own virtual environment which the seated participant would evaluate through verbal description, vision, and touch. In the latter case he would be asked to reach out and "touch" a virtual wall while a research assistant held up a correlating physical material sample, providing the participant with the illusion of touching a "real" surface within the virtual simulation. Biofeedback monitoring could be used in combination with functional Magnetic Resonance Imaging (fMRI) to evaluate the potential for embodied simulation in visuotactile mirroring mechanisms<sup>vii</sup>. Our expectation is that an experiment of this caliber could reveal the biological impact of material on Man and his spatial experience in a way which has not been previously done, and therefore could have powerful ramifications on how we approach architectural design in the future.

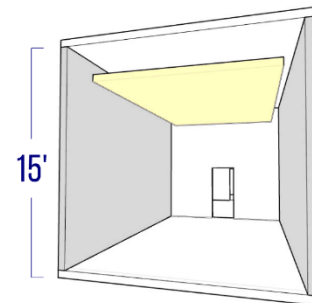


**Figure 1:** There could be four categories of materials: **NATURAL** (wood, brick—suggesting a raw, “earthy” origin), **MIXED** (plaster, concrete—suggesting the human gestures of a craftsman), **MANUFACTURED** (steel, glass—suggesting an artificial origin), and **GARISH** (shag carpet and short carpet with intentionally “ugly” choices of color and pattern, chosen with the intention to provoke a negative response for means of data comparison).



**Figures 2a-2c:** Begin and end the sequence with a “neutral” space, and have each tested room alternated by a “neutral” hallway. The actual “movement” through the sequence would be a predetermined path of travel created within the simulation, activated by a researcher with the click of a button. There would be three “Stopping Points” in each room: **VISUAL Assessment** (near the entry point; a comprehensive “first impression” of the overall space), **TACTILE Assessment One** (touching the first wall + material) and **TACTILE Assessment Two** (touching the second wall + material). At each stopping point, the participant will answer a scripted list of questions which will ask him to describe the environment by choosing between offered adjectives (e.g. Warm or Cold? Friendly or Aggressive?)

**Figure 3:** The proper use of lighting would be important in the setup. An unobtrusive light source within each virtual testing room would have to be determined—imagined here as a neutral panel suspended from the ceiling. Lighting should also be carefully paired with each material category; for example: **NATURAL** with daylight temperature (5000K-6500K), **MIXED** with a soft fluorescent tone (2700K-3000K), **MANUFACTURED** and **GARISH** with a cool incandescent light (3500K-4100K). We imagine a setup in which the brightness would vary with the movement through the sequence: each room would be darkened until the participant “approaches”, and as he enters the space the light would slowly rise (and then dim when he exits).



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# Intentional Designs of Classrooms Support Student Behavioral Changes in Academic Engagement Experiences |

## Significant Findings

Lennie Scott-Webber, PhD

### ABSTRACT:

Evidence suggests the design of active learning educational spaces make a difference in student learning outcomes. Yet this evidence has been primarily garnered in higher educational settings, and no one survey instrument has been developed to measure perceived changes in student academic engagement behaviors by both the students themselves and the educators teaching in them. Thus, our multi-disciplinary research team is working to establish a statistically reliable and valid survey instrument for use in post building occupancy for schools housing students and educators in grades nine to twelve. A Student Engagement Index® (SEI) is being developed. Our research question is, "Can we demonstrate that the design of the built environment for grades 9-12 impacts student academic engagement levels?" This research is the second trial of the instrument, and the convenience sample was four high schools in the USA. Both students and educators self reported on a variety of questions gauging the impact of behavioral changes in students' academic engagement levels. Findings had strong indicators showing the buildings' design makes a statistically significant difference in these levels. Results were excellent on reliability and have convergent validity, with the exception of the last two questions – to be reworked in the final iteration. Statistical evidence from students and educators across all schools, grades, and genders showed that in fact the buildings' designs impact their academic engagement levels ( $p < .0001$ ). When active learning is used as a strategy, in a setting that is designed to support this strategy, students recognize the impact as a positive. Seen as a real effect, all respondents acknowledged that the physical environment impacted engagement in their teaching and learning practices ( $p < .0001$ ). This SEI tool upon completion may be used consistently post-occupancy to measure this type of student success.

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# Comparing Physiological Responses to Modes of Spatial Representation

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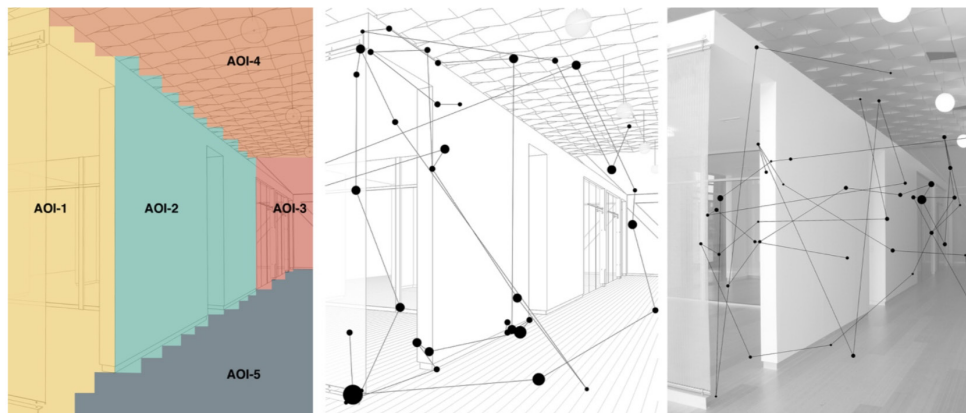
## ABSTRACT:

**BACKGROUND.** Architects design with a range of 2D modalities including rough sketches, precise line drawings, and renderings from digital models. The resulting built works are new configurations of spaces and forms, which humans respond to physiologically. But how does the built work compare with its earlier representations? This project aims to relate physiological responses in the embodied experience of the built space with the responses evoked when looking at architectural representations. Our research questions include: Do viewers consistently respond, physiologically, to the same modalities? Can physiological response to a drawing predict response to the built space?

**METHODOLOGY.** This project has produced two pilot studies investigating the relationship between 2D representations of 3D space and physiological response. Building on the research paradigm of Scene Perception (Rensink, 2000), researchers have been interested in how designers look at scenes. Experiments typically present the scene on a computer screen, allowing for a high level of control over variables of the scene (Holmqvist, 2011). Our initial pilot studies follow this methodology. Our first pilot study was a comparative study, in which architecture students at UNC- Charlotte and Harbin University in China were asked to look at two modalities of representation: a perspectival line drawing and a photograph of the built space. Optical tracking recorded eye movement. A second pilot study attempted to replicate this with architecture students at Cal Poly, and collected EEG data in addition to eye tracking data.

**OUTCOME.** Results suggest that there are statistically significant differences in how the spaces are looked at in a drawing as compared with a photograph. Results from both pilot studies show that participants spent more time looking at the area of the drawing with the greatest graphical complexity (density of linework), while they spent more time looking at the area of the photograph with the greatest spatial complexity. This study helped us to determine the equipment appropriate for data collection, and to develop a protocol for both the study and the data analysis, utilizing a MANOVA method.

**FURTHER RESEARCH.** We will be conducting an expanded study in which we ask: Do emotional response differences parallel these visual behavior differences? This will be measured with EEG, Skin Conductance Response, and Heart Rate Variability, in addition to eye tracking. This study will be constrained to 2D representations of space. We intend to then expand the study to include the embodied experience of space. An anticipated outcome of a future large-scale study would be the identification of representation modalities that correlate with the embodied architectural experience.



Areas of Interest in images / Scan paths and fixations for line drawing and photograph

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TIFF THOMPSON, PhD, is a Marriage and Family Therapist, a board certified Neurotherapist, a Registered EEG Technician license (a medical credential bestowed by the American Society of Electrodiagnostic Technicians), and a Quantitative EEG Diplomate from the Quantitative EEG Certification Board. She owns and runs Neurofield Neurotherapy with her husband and business partner, Dr. Nicholas Dogris. She has composed research on the intersection of EEG and psychodynamic theories of consciousness and is currently researching the profile of Grief in EEG, as well as the application of neurostimulation on various pathological states.

# Implementation of Neurofeedback Paradigms to the Generation of Design & Architectural Features

Nastaran Shishegar, Ph.D. Student

## ABSTRACT:

Sleep disorders and poor sleep quality are extremely common among older adults and influences up to 50 percent of individuals over the age of 65. Poor sleep quality among older adults is associated with higher risk of heart disease, memory and cognitive impairment, depression, anxiety, falls, and accident (Al-Jawad et al., 2007). These will result to poor quality of life. Therefore, sleep quality has been demonstrated as one of the main factors in affecting quality of life among older population (Dam et al., 2008). With life expectancy rising, the number of individuals suffer from poor sleep quality will increase in future years; yet no effective and applicable solution have been found. Proper lighting condition is one of the non-pharmacological solutions that can improve sleep quality of individuals including older adults (Friedman et, 2009; Sloane et al., 2014). In fact, light is the main stimulus for synchronizing the circadian rhythms (biological clock) and hence it impacts sleep quality. The best lighting source to improve circadian rhythms is the one that provides individuals with exposure to light with the right spectra and intensity at the right time (Figueiro et al., 2015). Timing and duration of exposure are two light characteristics that are usually not taken into account in the process of lighting design. The main purpose of this concept paper is to describe an ongoing research project on the impacts of a 24-hour lighting schedule with varying illumination and Correlated Color Temperature (CCT) on older adults' sleep quality, mood, cognitive performance, and quality of life. This will be an A-B-A study with quasi-experimental design that employs wrist actigraphy and standard questionnaires to measure objective and subjective sleep quality as well as subjective mood, cognitive performance, and quality of life of older adults before, during, and after a 2-week lighting intervention. We hypothesize that daily exposure to an ambient lighting with varying illumination and CCT will improve sleep quality, mood, and cognitive performance of older adults which results in better outcomes for quality of life.

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# HOW FRANK LLOYD WRIGHT USED FUNDAMENTAL MECHANISMS OF PERCEPTION TO GENERATE HIS UNIQUELY POWERFUL AESTHETICS

John H. Shoaff, June 28, 2018

## ABSTRACT:

Frank Lloyd Wright insisted that a most "severe" discipline, by which his designs emerged from "The differentiation of a single, certain, simple form", was responsible for "such vitality, integrity, and magic as [his buildings] have" (FLIW, *An American Architecture*, 17-52). He urged followers to find its "basic principles" in his buildings—but never explained them with more than a few cryptic aphorisms.

This presentation reveals by case studies the differentiation process in action; suggests an explanation for its powerful aesthetic consequences that is based on recent theories in the visual sciences; and, finally, argues that the discipline and its aesthetic consequences provide tangible evidence for a theory of aesthetics, one based on the principle of maximum aesthetic impact derived from least effort.

For the first time in print (to my knowledge), this presentation graphically demonstrates, by analyses of his plans, how "the differentiation" unfolds by the multiplication and rescaling of a simple, symmetrical form to generate other forms that overlap and interweave, in accordance with their shared axes of symmetry. These forms retain their integrity, remaining pleasingly simple and aesthetically rewarding even when woven into the fabric of an elaborate design in which they are "nested." The forms can retain their integrity because they overlap in time; the process is dynamic; the forms the percept exists in a duration of time as well as in space.

I then show how Wright's forms, in their development about axes of symmetry and in their modular organization, share essential characteristics of the object-centered coordinate primitives with which, the late MIT scientist David Marr theorized (DM, *Vision*, 295-328), the eye and brain begin the process of recognizing forms. In Marr's formulation, large primitives encompassing the spatial distribution of a whole form combine with small primitives that begin to articulate its components; both are retained in the final percept, the combination, as it does in Wright's works, allowing apprehension of the details while maintaining stability for the whole.

Marr's primitives begin what will be an elaborate process if there is to be full delineation of their object; but freed of this requirement, Wright's primitives remain limited to their simple formal beginnings and their development dominated by manipulations about their axial symmetries. With these limited means, but with great sensitivity, inventiveness, and discipline, he generates a virtually limitless variety of rich, complex, but harmonious forms.

His method and its success, I argue, supports a time-honored, if often casually articulated Theory of Aesthetics that connects visual science and art. In a determined search for simplicity, Wright intuitively went to the heart of the perceptual process itself, and thereby he reaped the reward of great riches from the simplest means—achieving maximum effect from least effort: here in a nutshell is restated a well known theory of aesthetics variously stated as 'unity in variety', or of the greatest multiplicity of effect from the simplest of means. (Wright himself expressed it metaphorically when he wrote of Beethoven's 5th Symphony: "Supreme imagination reared...four repeated tones, simple rhythms, into a great symphonic poem that is probably the noblest thought built edifice in our world.") The formulation was given a rigorous treatment in the 1920s by the important mathematician George Birkhoff. After taking care to differentiate between aesthetic feeling due to the direct sensory experience of an object, to which his theory applies, and aesthetic feeling engendered by associations that attach to the object, to which it does not, Birkhoff argued that Aesthetic measure  $M$  equals the art object's "harmony, symmetry, or order  $O$ ", divided by complexity

$$C:M = O/C.$$

(Because "Order", which he referred to as "the density of order relations in the aesthetic object" is the numerator, and "complexity" the denominator, the less the complexity and the greater the density of order, the greater the aesthetic satisfaction.) Birkhoff assumed the level of complexity would correlate in some manner with the level of physiological effort required to process the perceived forms; but for a fuller explanation he lacked the knowledge we now have about the neuronal means and psychological devices by which the eye and brain generate perception. Now perhaps we can pursue his formula with hope of giving it a secure foundation.

For the architect, this connection of perception theory to Frank Lloyd Wright's method offers a discipline by which the architect can improve his skills. For the scientist, it offers aesthetic experience as a new source of insights for his exploration of the visual process. Aesthetic experience of course is inherently individual and not susceptible to the kind of verification needed for scientific proof; but it can reinforce discoveries already made, and should be able to lead the scientist along pathways that will lead to insights provable by other means.

Fuller exploration of Wright's works reveal how he achieves economies of expression by employing other well-known visual mechanisms: for example, the completion of implied forms, a la the Kanizsa triangle, and the phenomenon of grouping. The clever ways in which he interweaves asymmetry and symmetry teaches lessons that may suggest a powerful role for symmetry in the the perceptual process; and the expressive power in his uses of repetition may suggest a powerful role for top down processing. What I have presented here I hope is the beginning—at least for me—of further explorations that will build a bridge between neuroscience and the arts that can be crossed in both directions, to the further understanding and enrichment of both sides.

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# EEG Monitoring of User Experience in Controlled Virtual Environments: Emerging Methodology to Inform Design Decision-Making

Madlen Simon AIA and Ming Hu AIA

## ABSTRACT:

When we experience the built environment, we often do this in rich settings where we can use many cues to understand what we are experiencing. However, it has traditionally been difficult to figure out which design features or design strategies are most effective and which are less so, due to the complexity and multiple distractions in the real world. The predominant tools for evaluation of built environment features have been user response surveys and expert panel scoring, applied to actual environments or to visual representations of urban environments in drawing or model form (Nasar 1994, Ewing and Handy 2009, Adkins et al 2012). Here we propose to test the validity of combining electroencephalography (EEG) and virtual reality (VR) to overcome the problem of confounding variables in real environments or their representations and to elicit actual user responses in real time. This research combines a neuroscientific technology with an emerging design technology to record electrophysiological brain activity of participants in a well-controlled three-dimensional virtual audiovisual environment. Experimental subjects will be immersed in three different virtual urban settings while wearing EEG equipment. A device called Emotive EPOC Insight, a low-cost mobile EEG recorder, will be employed to monitor the brain activities. This device measures six dimensions of user experience - Excitement (Arousal), Interest (Valence), Stress (Frustration), Engagement/Boredom, Attention (Focus) and Meditation (Relaxation) (Emotiv website). Outfitted with this recording device, experiment subjects will encounter a set of virtual design features, such as sidewalks, storefront, urban landscape. Brain activities will be recorded and analyzed to identify the reaction pattern toward certain design elements and sequences. The aim of this research project is to develop a methodology using physiological, rather than user-reported, responses for evaluation of built environment design features. This research builds upon emerging studies using EEG in the study of human behavior in outdoor environments (Mavros et al 2016), and extends the research by studying the potential for application to design decision-making.

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# Architecture, Psychology and Cognitive Functions in Confined Spaces: Comfort, Appropriation and Habitability

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## **ABSTRACT:**

The presented research was done in the context of a diploma research project by Theodora-Rengina Skantzi, at the Architectural Engineering Department of the Technical University of Crete.

The scope was to pursue greater insight on the psychological implications occurred when living in confined spaces and address these issues through the specific spatial interventions that can mitigate the negative symptoms, through an interdisciplinary framework, based on Psychology and Architecture.

What does comfort and appropriation mean in a confined living space? Living at a time when the available urban living space continuously decreases and people are called to live in increasingly smaller homes, it is essential to research and develop strategies and intervention methodologies that can increase qualitative factors, which enhance the sense of comfort and appropriation.

This specific research is the first step of a longitudinal study to achieve the aforementioned goals, conducted through literature review combined with a field research on the crew of a submarine crew. The presentation includes the data found through the quantitative survey on the reports of the submarine crew, and is examined in conjunction with the visual analysis of the spatial characteristics identified from the on-site research in the submarine of the Greek Navy. The information was gathered through a questionnaire distributed to participating crew and the observation protocols set up for this research. The results of this pilot case study helped significantly to clarify the issues that must be addressed, as well as identify potential counter- measures.

From the initial conclusions of the field research, the project moved towards a proposal that gave emphasis on spatial qualities such as visual "temperature", intensity and color of light, audio landscape, tactile textures and generally spatial features/characteristics that contribute to the sensation of the habitation archetype. A rough retrofitting framework was produced that led to a proposal of a different type of utilization of submarine chassis. The proposal presents an alternative use of a submarine, as a novel habitation "nest" , focusing in the design of spaces that exhibit the qualitative elements of "place", using narrow spaces as an advantage.

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# A Culture of Experimentation: From the Torrey Pines Living Lab to Emerging Neuro-Architecture Lab

Matt Smith, Upali Nanda, Eduardo Macagno, Thom Greving

## ABSTRACT:

An owner, a professor of neuroscience, an architect and a researcher in practice will come together to discuss how a real-life project situated in a university setting, can become a testing ground for neuro-architecture hypothesis.

North Torrey Pines Living and Learning Neighborhood is a 1.6 million GSF project currently in design at UC San Diego. It will be the new home for Sixth College, including housing, academic buildings, retail, dining, administration, a craft center, parking, residential life and public realm improvements. The project enhancements included research in the scope of work, in addition to the Detailed Project Program and design competition. Construction begins June 2018. Once completed in 2020, students will move from the old buildings to these new buildings, which provide the rare opportunity for a longitudinal study in real-life settings. This live-learn community will seek to constantly learn and evolve, serving as a living lab—that is “a user-centered, open-innovation ecosystem ... integrating concurrent research and innovation processes...”[1].

Some high-level conclusions on changes from current to future state may be possible; however, many environmental variables change between an old and new building, making causation (a direct cause-effect relationship between architectural features and human brain/behavior) difficult to establish.

In this study, there exists an opportunity to narrow down some key hypothesis from the “living lab” and test them in a new neuro-architecture test lab. By measuring participants’ physiological and neurological responses to the new built environment, data can be obtained to support (or not) some design concepts. For example, gaze monitoring can reveal dwell time and therefore feature interest and physiological/neurological activity can reveal effects on stress and attention. Data can be gathered through wearable instruments in the real environment or in VR, which allows more experimentation.

This project is a prototype project- that is just in its beginning stages – which will explore how the practice of architecture can intersect with the structure of academia in innovative ways, ranging from real-life to lab-based experiments, so that we can make meaningful (and actionable) contributions to the field of neuroarchitecture in service of creating better environments for human beings.

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Dr. Upali Nanda is Director of Research for HKS, a global architectural firm. She is responsible for spearheading and implementing research projects globally. She also serves as the Executive Director for the non-profit Center for Advanced Design Research and Education. Her doctoral work on "Senshetics" has been published as a book available on Amazon.com, and she has published extensively in peer-reviewed journals and main stream media. Widely published and quoted, her research has been awarded the European Healthcare Design Research Award and two Environmental Design Research Association (EDRA) CORE awards. In 2015, Dr. Nanda was recognized as one of the top 10 most influential people in Healthcare Design by the Healthcare Design Magazine. Most recently, she was honored by Architectural Record with the 2018 Women in Architecture Innovator Award.

EDUARDO MACAGNO, Ph.D.

Dr. Macagno is Distinguished Professor in the Division of Biological Sciences at UC San Diego. After receiving his Ph.D. in Physics at Columbia University in 1968, he shifted to research in Neuroscience during postdoctoral training.

He joined the Biological Sciences faculty at Columbia in 1973 and became full professor in 1985, chair of the Department of Biological Sciences in 1990, and Dean of the Graduate School of Arts and Sciences in 1993. In 2001, Macagno moved to UC San Diego as Founding Dean of Biology, a position he held until 2006, when he returned to the faculty full time. His current research interests include neural development and regeneration, particularly the formation of synaptic circuits. Since arriving at UCSD, he has also initiated novel studies at the interface between architecture and neuroscience using immersive 3D virtual reality approaches to study how older and cognitively impaired humans interact with and navigate in the built environment. Macagno is a past president of the Academy of Neuroscience for Architecture (ANFA) and presently serves on ANFA's Board of Directors.

Thom Greving, ARCHITECT

HKS Architects



# (Eye)Tracking Users' Patterns: Visual Experience and Choice Behavior in Transition Zones of Amsterdam-Southeast

Dr. Frank Suurenbroek and Gideon Spanjar Ph.D.

Amsterdam University of Applied Sciences (AUAS), Faculty of Engineering, Research Program Urban Technology and Research Program Urban Management, The Netherlands, Europe

## ABSTRACT:

Over the next 10 years, the City of Amsterdam plans to develop major housing schemes provide 90,000 new homes within the existing urban fabric. At the same time, an urban renewal program is being launched to revitalize the most deprived neighbourhoods. Together, these challenges call for more evidence based design-principles to secure liveable places. Recent development in neuroscience, provides innovative tools to examine in a measurable, cause-effect way, the relationships between the physical fabric, users' (visual) experience and their behavior in public spaces. In neuroscience, eye-tracking technology (ET) complements brain and behavioral measures (for overview see Eckstein et al. 2017). ET is already used to evaluate the spatial orienting of attention, behavioral response and emotional and cognitive impact in neuroscience, psychology and market research (Popa et al. 2015). ET may also radically change the way we (re)design and thus, experience cities (Sita et al. 2016; Andreani 2017). Until now, eye-tracking pilot studies collected eye fixation patterns of architecture using images in a lab-setting (Lebrun 2016).

In our research project Sensing Streetscapes, we take eye-tracking outdoors and explore the potential ET may offer for city design. In collaboration with the municipality of Amsterdam and the local community, the H-neighborhood is used as a single case study. The main focus for urban renewal lies in the "transition-spaces". They connect the neighborhood with the rapidly developing adjacent areas and are vital for improving the weak social-economic status. The commonly used design principles are validated (Alexander et al. 1977; Gehl 2011, 2014; Pallasmaa 2012) and the consistency of ET is tested, alongside (walk along) interviews and behavioral observations. In the next phase, the data will be analyzed by a panel of applied psychologists and urban designers.

The initial results provide valuable lessons for the use of eye-tracking in urban design research. For example, a visual pattern analysis offers more accurate images of the spatial key-elements that matter when moving through transition spaces. More sensory-based city design research is needed to gather a full understanding of the relationships between the configuration of space, users' (visual) experience, behavioral responses and in turn, perceptual decision making.

Figure 1 – Gaze plot from a single participant taken in the transition zone at the underpass between the business district and H-neighborhood. Eye fixation on movement (cars and pedestrians), balconies and the top of buildings.

Figure 2 - The H-neighborhood in the southeast of Amsterdam. Railways and elevated roads are barriers in socio-spatial interaction. Despite these barriers, the advanced network of footpaths and strategic location of the H-neighborhood offers opportunities for revitalization.

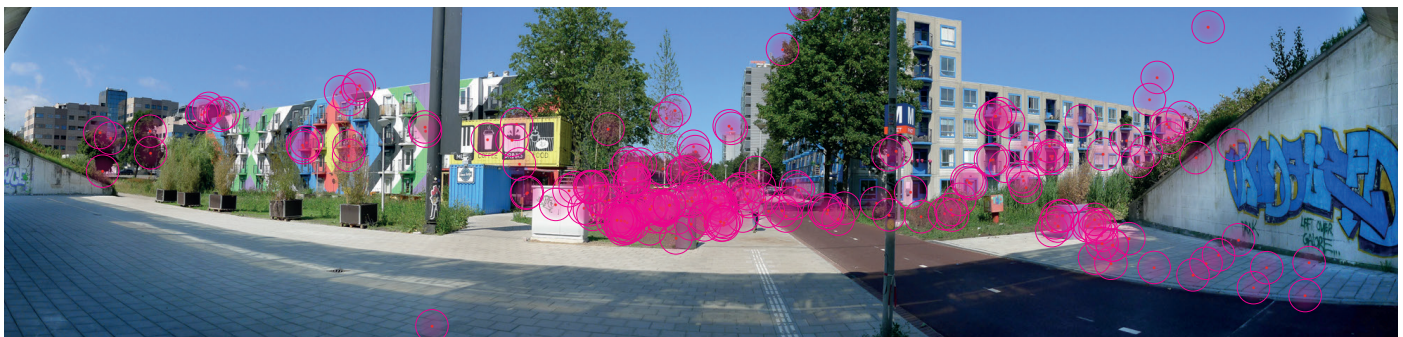


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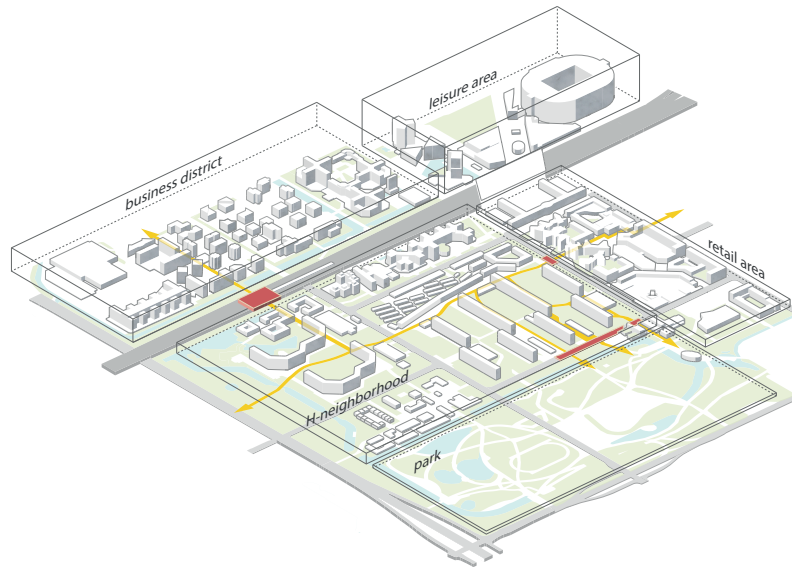


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## AUTHOR BIOS:

DR. FRANK SUURENBROEK is Professor of Spatial Urban Transformation at the Faculty of Engineering at the AUAS. The new research project *Sensing Streetscapes* is in collaboration with several universities, SMEs, housing corporations and municipalities, and aims to connect directly to the field of neuro-architecture. Frank is also responsible for the multidisciplinary research-track *Inclusive Area-development*.

GIDEON SPANJAR holds a PhD in Landscape Architecture from the University of Essex. Gideon is currently senior researcher at AUAS, member of the research-track *Inclusive Area-development* and project manager of the action-research in the H-neighborhood, Southeast Amsterdam. He is an associate fellow of the Centre for Ecomics and Ecosystem Management.

## Physical Environment and Brain Health

Larry Speck, FAIA  
Senior Principal, Page

The W.L. Moody, Jr. Centennial Professor in Architecture, The University of Texas at Austin

Sandra Bond Chapman, PhD  
Founder and Chief Director, Center for BrainHealth at The University of Texas at Dallas

Robert Doane, AIA, AHCA  
Principal, Page

Ricardo Muñoz, AIA  
Associate Principal, Page  
Lecturer, The University of Texas at Arlington

### **ABSTRACT:**

How does the physical environment affect brain health? How can architects create spaces that boost brain performance? This presentation will focus on the collaboration between the design team and client in the development of the recently completed Center for BrainHealth's Brain Performance Institute at the University of Texas at Dallas. The mission of the newly developed Institute is to educate and train people to improve brain health through scientifically validated programs and assessments that enhance individual mental capabilities. The building's design aims to create a connection between the research arm of the Center for Brain Health and the public, while providing a new front door for the Institute.

Its program focuses on outreach and community education; individual and group testing; and training for PTSD victims, NFL football players with brain injuries, autistic children and people suffering from dementia —as well as individuals who just want to improve their overall brain health. Accommodating this diverse community of individuals and groups required a design that facilitated quite intimate spaces, such as the Quiet Entry and Warrior Lounge, and with a balance of community-centric, inviting spaces, such as the "Live" Lobby and Multifunction Room, and workplace solution in support for the Institute's research.

The new facility demonstrates an instance of the increasingly important connection between university research and community application of advances created through that research. The building's location on the site allows for BPI to be connected to the Center for Brain Health (CBH) via a common landscaped courtyard, creating that connection back to the primary research arm and physically connecting the two programs. Visibility is a key component to communicating the Institute's mission to the community, which is highlighted with the north face of the building fronting a major arterial in Dallas.

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**AUTHOR BIOS:****LARRY SPECK**

Larry is well known equally for his diverse portfolio of award-winning architecture and his distinguished career as an inspiring educator. As a prolific author and influential critic, Larry also has contributed significantly to the development of ideas that have broadened the general public's understanding of the impact that buildings have on their communities and the way they live, work and play.

- Dr. Sandra Bond Chapman –

Dr. Chapman is founder and chief director of the Center for BrainHealth™ at The University of Texas at Dallas, where she holds the Dee Wyly Distinguished University Chair. She is committed to maximizing cognitive performance and improving healthy brain development across the lifespan. A cognitive neuroscientist with more than 40 funded research grants and more than 200 publications, Dr. Chapman conducts scientific studies that apply novel approaches to advance creative and critical thinking, strengthen brain resilience and incite innovation throughout life.

- Robert Doane –

As a project director and Healthcare team leader with Page for more than two decades, Robert is dedicated to fostering an office environment where collaboration results in the best solution to any problem. His understanding of sustainable architecture allows for a unique integration of technology and site producing efficient buildings while preserving the environment.

- Ricardo Muñoz –

Ricardo is currently director of design with the Dallas Page office. He specializes in a variety of project types from Civic/Government to Healthcare and Corporate/Commercial and Academic and brings an equally varied background to his work. In addition to his role at Page Ricardo has been an adjunct faculty member at the University of Texas at Arlington for the past 6 years where he teaches design studios and BIM courses.

**LEARNING OBJECTIVES:**

- Discuss how architecture and design supports the relationship and translation between research and clinical application
- Provide insight on synthesizing the needs and viewpoints of multiple stakeholders to create an environment that serves a large variety of clientele
- Consider how healthcare expertise can be applied to create informed decisions for facilities outside the traditional environment

After attending this program, participants, will be able to:

- Identify environmental strategies to increase cognitive function in all facility types

# Place, Peripheral Vision, and Space Perception: A Pilot Study in VR

Jatheesh Srikantharajah, Dr. Colin Ellard, Bob Condia

## ABSTRACT:

Through architectural design, information from the built environment has substantial effects on human thoughts, feelings, and behaviour. In recent years, theory in neuroscience has begun to investigate the influence of the location of information in the visual field. Though both colour vision and fine details are most efficiently processed in central vision, information from the built environment is largely experienced in the peripheral visual field. In order to understand the mechanisms through which the built environment elicits reactions, it is important to understand the capabilities of the visual periphery. In a pilot study using virtual reality (VR), we employ a novel method to assess the contributions of central and peripheral vision to physiological and cognitive evaluations of the built environment. Recent theory (Rooney et al., 2017) argues that central vision dictates conscious processing of fine details, while peripheral vision is involved in preconscious responses to architectural atmosphere. Our study isolates central and peripheral vision when people view stimuli over an extended period, testing their impact on experiences of architecture. While wearing VR headsets, participants view and appraise two different models of public squares designed in a classical or modern style viewed through either the central, peripheral, or entire visual field. Results demonstrated the power of the visual periphery in generating architectural experience. Cognitive and physiological experiences were largely similar in full and peripheral vision, while central vision was associated with finding the task effortful and unpleasant, along with experiencing higher initial arousal responses to the models. Using only central vision, participants had difficulty understanding visual information and they found the legibility of the models to be limited. Measurable differences between the classical and modern models were more subtle. Our psychophysiological results indicated higher arousal in central vision for both the modern and classical models when compared to peripheral and full vision. However, there were substantial differences between the two models, with the classical model producing the lowest levels of arousal. Ultimately, the most parsimonious explanation for these results is that cognitive processing and effort were the strongest influences on the psychophysiological signatures of our experimental conditions.

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## FIGURES:

Figure 1 (left to right). View of the classical plaza looking back toward the Beaux-Arts facade and, behind the chrome egg, the 'Arch of Inquires.' The middle image shows central vision only, with the rest of the scene masked. It is difficult to determine your location in this view. The right image shows peripheral vision only, with central vision obscured by an obstruction. It is much easier to see where you are with peripheral vision than with central vision alone.

Figure 2. The psychophysiological results of the main experiment - each bar represents the average value for skin conductance over a ten-second epoch beginning with the presentation of the model. The eight sets of bars arrayed on the horizontal axis show the eight different epochs of the experiment. There are separate bars for the two models (classical and modern) and for the three viewing conditions (central, control, and peripheral), as indicated in the accompanying legend.

Figure 3. (Left). Self-assessed legibility scores for the three viewing conditions. Participants found the central condition significantly less legible than the other conditions. There were no differences between the legibility

of the control and peripheral conditions. (Right graph). Effect of viewing conditions on Han's emotion subscale, plotted separately for the classical and modern models.

## **AUTHOR BIO:**

JATHEESH SRIKANTHARAJAH, Masters in Cognitive Neuroscience, Candidate  
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Department of Psychology, University of Waterloo, Director of Urban Realities Laboratory

BOB CONDIA, Architect, Professor  
Department of Architecture, Kansas State University, 2003S Perceptions Lab, AIA



# Designing Great Memories in the Hospitality and Entertainment Environments

John Stewart, AIA, DBIA

## **ABSTRACT:**

Our Company, Encompass Develop, Design, and Construct, has assembled a team of Architects, Scientists, Data Analysts, and Property Operators to study how the built environment in the Hospitality Industry impacts us and creates memories that make us want to tell the stories and come back for more of those experiences.

We are collecting sensory data about the environments and about those that experience those built environments. We then partner the data with existing behavioral data, with available neuroscience research to be able to inform architects on design.

We are working with Casinos to develop databases deeper than 'how often does someone visit and how long do they stay', to, 'what does the space smell like in an area where they stay longer? And others like: what is the ceiling height?, what is the carpet pattern and color?, what are the ambient sounds?, what is the local sound(s)? Touching on as many senses as possible. We believe that the more data that we have about the built environment, coupled with the data from the experimenter, and understanding how these impact our brain and specifically creating memories, the more we can inform the design community.

We are doing this same thing in Hotel Room Design. As our memories all have a "place" we know we can make these "places" more impactful to our experience of the world around us, but until recently, we haven't seen the research that would give us the ability to understand how these "places" actually change our brains. Architects have designed around "theories" and studies of human behavior, but because of our capability to see inside our brains more clearly, we can and should test those theories.

Design should enhance our experiences. We chose to focus on Hospitality as an industry that we are deeply imbedded in and surrounded by the teams that know it well. Ultimately our goal is to create and enhance spaces/places/touch points that couple with our senses to form great memories and inform architects using real data to shape and enhance the lives of others that anticipate, experience and then tell stories about them.

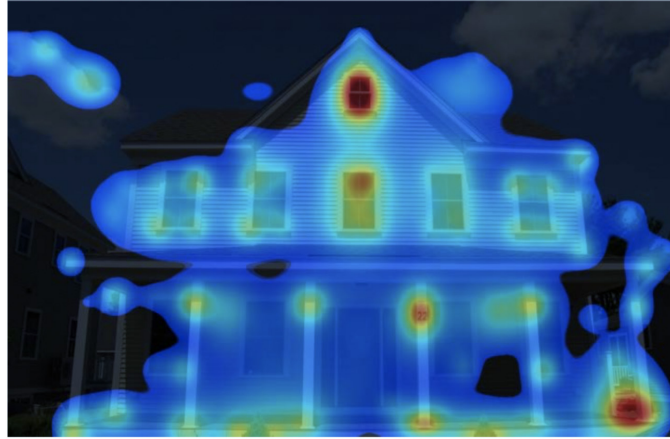
## **AUTHOR BIO:**

JOHN STEWART, AIA, DBIA is an award-winning registered architect, licensed contractor, and licensed authority in the hospitality and gaming industries across the United States, Canada, Aruba and Jamaica. He founded Encompass Develop Design and Construct, LLC in 1999 with offices in LaGrange, KY, Cincinnati, OH, and Gulfport, MS. John's experience includes project development in industries including hospitality and gaming, restaurant and food service, retail, healthcare, religious, and manufacturing. His focus is on Sensory Informed Design and developing an understanding of how Neuroscience can inform design and memory formation through human experiences in built environments.



# Using Biometric Software to Understand the Architectural Experience and Improve Design

Ann Sussman, AIA, Justin B. Hollander, PhD, AICP, Hanna Carr, Tufts '20



## ABSTRACT:

While the environmental psychology literature is rich with evidence about ideal street widths, signage and landscaping, this study is one of the first to show how biometric tools can increase understanding of how people respond to the places around them. It provides new kinds of data on hidden, 'unseen' experience that determine human behavior. This information turns out to be remarkably useful to help us understand specific things, such as how difficult it might be to find the front door of a new house, how confusing someone might find signage on an unfamiliar street and how likely it would be for a visitor go for a stroll in a new neighborhood.

In this study, we used a relatively-new off-the-shelf biometric tool, 3M's Visual Attention Software (VAS), introduced in 2011, to measure the unconscious visual responses people make when presented with images of houses and streetscapes. The results suggest new parameters for quantifying our response to buildings and more broadly indicate how biometric tools including eye-tracking emulation software, provide a means of predicting the human experience of place and helping designers create architecture more responsive to intrinsic human needs.

## STUDY PROTOCOL

We collected 70 site-specific, color images for the study of a new neighborhood. To analyze them, we used 3M's VAS (Visual Attention Software) which emulates eye tracking, a biometric tool that maps the path the human eye takes looking at something. VAS's algorithm is based on 30 years of eye-tracking research and predicts responses to visual stimuli within the first 3 to 5 seconds, or during pre-attentive processing. It assesses study images for five "visual elements" known to draw attention; these are, "edges," "faces", color "intensity," "red/green color contrast" and "blue/yellow color contrast."

The data that VAS produces for each image appears as compelling graphic representations: heat maps, which glow reddest where people look most, visual sequence diagrams, which track the most likely path eyes take and regions of interest diagrams, which with enclosed lines, delineate areas that draw the most attention. The software makes these in under a minute, once an image is uploaded to the 3M site.

## FINDINGS

The *regions of interest* diagrams suggest how front porches with white columns attract attention (Figure 1); lack of detail on garages in alley behind does not. The *heat maps* (Figure 3,4) glow brightest where viewers look most, fading black in areas ignored. The *visual sequence diagrams* (Figure 5) suggest why visitors will stroll down the street (it easily draws their attention) but not the back alley which cannot.



Figure 1. Regions of Interest diagram of Chance St.

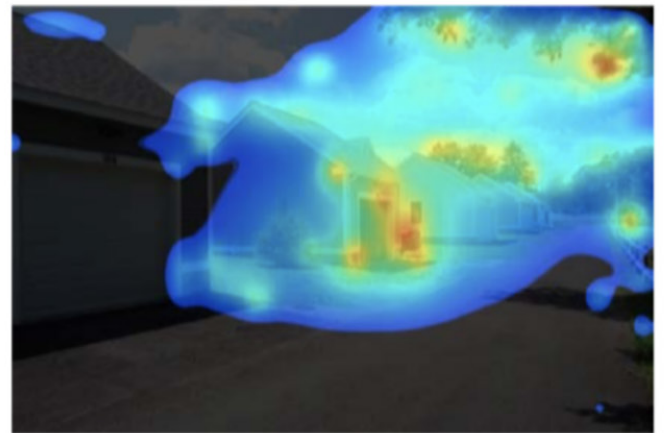
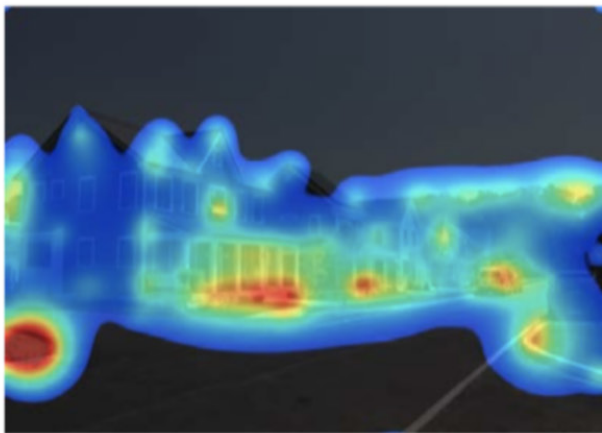


Figure 3. Heat Map of Chance St.

Figure 4. Heat Map diagram of Chance St. garages.



Figure 5. Visual Sequence diagram of Chance St.

For more information on this study, including neuroscience and architectural literature references, please see:  
[http://www.devensec.com/news/Eye\\_Tracking\\_Devens\\_1\\_11\\_18%20report.pdf](http://www.devensec.com/news/Eye_Tracking_Devens_1_11_18%20report.pdf)

Justin B. Hollander: <http://emerald.tufts.edu/~jholla03/>

Ann Sussman: <http://annsussman.com>

# Emerging Methodologies of Neuro-Urbanism: Operationalizing Neuroscience in Architecture and Urban Planning Practice

Amelia Taylor-Hochberg

## ABSTRACT:

The emergence of affordable and accessible brain monitoring technologies (e.g. EEG machines) has allowed urbanism practitioners and researchers alike to consider the built environment through neuroscientific and cognitive science models. Large architecture firms and small research initiatives alike are constituting a growing collection of institutions interested in improving the human experience of the built environment through a better understanding of its cognitive effects, building on precedents of environmental psychology and urban sociology. These organizations also recognize the demand for evidence-based design as well as the growing potential of “smart city” applications for technology to improve human wellbeing in cities. However, the construction of a “neuro-urbanism”<sup>1</sup> lacks a coherent disciplinary method and objective, and there are myriad contentious issues in a humanistic discipline such as urbanism co-opting scientific research — especially one as quickly-evolving as neuroscience. My research objective is to identify and investigate the methods being used by these institutions, to help illustrate the growing use of neuroscience and cognitive science experiments in urbanistic practice.

Through my prior experience reporting on this subject for Archinect.com and The Journal of Urban Design and Mental Health, I’ve become familiar with a variety of organizations involved in neuro-urbanism practice, and stayed professionally acquainted with them throughout my time at MIT. My research questions will focus on clearly illustrating, for the layperson, the firms’ methods for applying (and/or running) cognitive- and neuro-scientific experiments within their urbanistic practice. I plan to do this through site visits, photographic documentation and qualitative interviews. While there is no comprehensive listing of neuro-urbanism practitioners, the following covers a variety of sizes, geographies and professional intentions:

- Environmental Neuroscience Lab (Chicago, IL)
- Cloud Lab (New York, NY)
- Centric Lab (London, UK)
- Spatial Cognition Lab (London, UK)
- Human Experience Lab at Perkins+Will (San Francisco, CA)
- NBBJ (multiple locations including Boston, MA and San Francisco, CA)

My questioning will focus on the following: What are their goals for applying neuro-urbanistic research? Who precisely is in charge of these initiatives? Do they conduct their own experiments, and if so, what are their methodologies? How do they implement such research into their practice? Additionally, my research will also consider the historical context and promise of such practices within the demands of a rapidly urbanizing world. I’ll also seek commentary from neuroscience and cognitive science experts within the Boston area, and other authorities with a stead in sociological urban research.

## REFERENCES:

<sup>1</sup> [http://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366\(16\)30371-6/abstract](http://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366(16)30371-6/abstract)

## AUTHOR BIO:

AMELIA TAYLOR-HOCHBERG

Master of City Planning Candidate 2018, MIT



# Ambiance in Spiritual Spaces: Examination of Themes of Light & Nature in Student Design Proposals

Judy Theodorson, M.Arch  
Associate Professor, Washington State University

## ABSTRACT:

This research is concerned with ambiance in spiritual spaces. For the purpose of this abstract, ambiance is described as spatial and sensory qualities that shape a phenomenological experience. In the broadest of terms, spiritual spaces embody the metaphysical to deliver a higher order experience. Such experiences vary widely, ranging from a sense of connection, to a quiet moment of contemplation, to enlightenment. From a neurological perspective, the goal could be described as resetting one's mental and/or emotional state.

The method for exploring ambiance in spiritual spaces is to analyze conceptual design proposals produced for a 2018 IDEC Interior Design Student Competition titled Fundamental Atmospheres: Designing for Spatial and Spiritual Experiences.\* The brief was purposefully broad, asking student designers to provide for the empowerment of users to grow intellectually, spiritually, mentally, or metaphysically. The program could be a religious practice (traditional or emerging), a secular space of reflection or mindfulness, and/or places for commemoration. The students were to define the specific use and to develop an atmospheric intervention. Furthermore, they were encouraged to engage experiential and primary research methods and to use light as a material of design.

The top 25 projects (out of 155) were examined to uncover the presence and potency of two architectural themes that link ambiance to known neurological outcomes: light and nature. The human relationship to light is partially biological: humans are drawn to light and fear the dark. Moreover, daylight is critical in regulating our circadian system and therefore our well-being, performance, and mood (Edwards & Torcellini, 2002). More significant to spiritual spaces is the aesthetic and transformative powers of light, described by Plummer (1992) as "almost magical" with the capacity to endow "material form with the wholly immaterial force of the human spirit" (p.19). Over history of architecture, light has played a critical role in spiritual spaces, a transforming ambiance that serves as a conduit to divinity or a shift in mood / consciousness. The nature theme includes a wide array of sensory inputs including air movement, thermal variation, natural light, water and plant features, and natural materials. Exposure to nature is widely accepted as beneficial to human neuro-function, a calming influence in a modern world of cognitive overload. Theoretical foundations include the "biophilia hypothesis" which establishes that humans have the urge to affiliate with other forms of life (Wilson, 1984); furthermore, Wilson describes nature as holding the "key to our aesthetic, intellectual, cognitive and even spiritual satisfaction." Kaplan's (1995) Attention Restoration Theory (ART) suggests that certain nature experiences are restorative in that they support concentration, leading to recovery from mental fatigue.

The value of examining student proposals is to understand the processes and inputs students use in developing the ambiance of spiritual spaces. Ultimately, the data extracted from the student proposals confirms the existence and potency of light and nature themes; they were prominent in more than 75% of the projects. Did the students arrive at this direction experience, intuition, and/or evidence? Did they uncover the neurological connection? Most of the students did engage in traditional research such as precedent, evidence-based design, and theoretical foundations. Surprisingly, a minority of the students engaged in meaningful experiential research despite the fact the most of the projects aimed to achieve an experiential space. This suggests a disconnect between traditional and phenomenological methodology. On the other hand, many of the renderings indicate rich atmospheres of light and nature and materiality and nearly all of the top selections show humans in some sort of contemplative pose; this indicates the students understood how to produce an abstract representation of ambiance.

While several of the projects had a specific program (teahouse, community kitchen, spa, experiential art gallery), most aimed for a non-defined meditative space with multiple use options. What differentiates a "meditative space" from a multi-use space is a sense of ambiance. In these projects, the ambiances were produced by integrating aspects of light, nature, and / or water, and a spare palette of natural materials. This suggests a future direction for interiors, one that finds aesthetic and neurological value in the light-nature ambiances for a variety of interior programs.

## REFERENCES:

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Wilson, E.O. (1984). *Biophilia*. Cambridge, MA: Harvard University Press. \*the author was the co-author of the competition

## AUTHORS BIO:

Theodorson is Associate Professor at Washington State University School of Design + Construction where she teaches interiors studios, environmental systems, and interdisciplinary electives around light | lighting. From 2004-2009, she founded and directed the WSU Betterbricks Integrated Design Lab where she consulted and conducted research around daylight interiors and the experience of the occupant. Her interests around light | lighting range from building performance to health and well-being to aesthetics and poetics.

# The Benefits of Thermal Sequence & Variation on Comfort

Signo Jesse Uddenberg, EIT LEEDAP, Director Research, Development & Innovation  
Nate Goore, Principal

## **ABSTRACT:**

Diversity makes life interesting, and it also makes thermal sensation more interesting. Experiments show that a person putting each of their hands, one previously dipped in a cold liquid and one previously dipped in a warm liquid, in lukewarm water will experience conflicting feelings about the warmth of the water. The hand previously dipped in cold water will feel that the water is warmer. The hand previously dipped in warm water will feel that the water is colder. And over time the hand will experience no sensation as the thermoreceptors in the hand become accustomed to the steady-state environment.

The same thermal phenomena occur everyday in our buildings. We design to create static, unchanging thermal environments, rarely considering the previous environment from which occupants came and how it affects their thermal sense. Furthermore, when it comes to thermal design, we ignore our variety-seeking tendencies. Buildings create a wealth of visual and aural stimulation, but miss the opportunity to create a range of thermal experience.

Our insistence on designing for static, one-dimensional thermal sensation almost guarantees thermal discomfort instead of thermal comfort. Today's architect needs to understand how human perception is influenced by thermal experience.

We will demonstrate a process by which thermal sequencing and variation can be used to solve situations of thermal discomfort and promote improved thermal comfort perception. The result will be dynamic thermal design for the whole self -- physical, physiological and psychological -- employing an understanding of neuroscience and the tools of architecture (buildings and systems), operations management (protocols and schedules), and product design (tools and equipment) to optimize desired results through an interconnected experience design.

**AUTHOR BIO:****SIGNO JESSE UDDENBERG**

With a background in human-centered design, natural science and engineering, Signo brings a scientific research approach to projects spanning strategy and innovation. He leads the Innovation and Experience Design practices at MKThink, and has worked locally and globally for organizations including PepsiCo, Hewlett Packard (HP), the Office of Naval Research (ONR), the Hawaii Natural Energy Institute (HNEI), and International Development Enterprises (IDE); and recently has been working with HNEI to measure thermal comfort efficiency (how much comfort is delivered per unit of resource consumed) across high-performance and traditional buildings in Hawaii. He received a Masters in Sustainable Design & Construction from Stanford University, a BS in Civil Engineering from USC, and a BA in Natural Science from Pepperdine University.

**NATE GOORE**

Nate Goore's diverse work history gives him a multifaceted background spanning architecture, psychology and information technology. Throughout his career Nate has worked with many leading academic institutions relating institutional performance to the sensory experience of their environments. His primary focus is on integrating business processes, technology, and organizational changes with the physical environment to improve personnel performance, and has recently been working with Hawaii Department of Education on a comprehensive thermal comfort strategy for 256 schools across the islands. Nate received a Masters in Architecture from Harvard University and a Bachelors Degree in Psychology from Cornell University. He is a principal at MKThink.

# More Than Feelings: Examining Child and Parent Affective Responses to the Ambulatory Surgical Environment

Deborah Wingler, Ms.

## ABSTRACT:

The outpatient surgical experience can be a stressful event in a child and their parent's life that produces feelings of anxiety, depression, and fear [1,2]. For children undergoing an outpatient surgical procedure and their parents, the preoperative phase can be especially stressful, as it is the time when the child undergoes anesthetic induction [3,4]. Moreover, the healthcare environment itself can contribute to these feelings [5,6,7,8]. The operating room (OR), where the majority of children are induced, can further contribute to a child's level of anxiety due to the imposing, sterile environment [9,10]. Induction rooms are considered to reduce patient anxiety by buffering patients from the sights and sounds of the OR [11,12,13]. However, no empirical studies have been conducted, to date, that investigate the effect of using an induction room vs. the operating theatre on child and parent anxiety, respectively, during the ambulatory surgical process.

As part of a larger multiple-case study, research was conducted to examine how the use of induction rooms vs. operating theater for anesthetic induction impacts child and parent physiological, psychological, and neural responses to the ambulatory surgical environment, utilizing real-time data collection techniques that extend equal regard to both child and parent perspectives. To gain deeper insight into child and parent affective responses to the physical environment during anesthetic induction, non-invasive devices were utilized to 161 capture child and parent neural responses, respectively, during this critical juncture in the surgical process.

In this paper, findings from three child parent dyads within each environment (N=12) will be explored to understand how their respective and collective affective responses converge and diverge within and across each environment (induction room vs. OR). While analysis is currently underway, preliminary findings suggest that child and parent neural responses align in some respects within each environment, while they differ across environments. Findings from this study can be practically applied to the design of ambulatory surgical environments that more effectively support the psychological and psychological needs of both the children who experience those procedures and their parents.

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# How Does Visibility in Urban Settings Change Human Perception of Urban Design?

Semiha Ergan, Hongting Chen, Zhengbo Zou

## **ABSTRACT:**

Research on environmental psychology and neuroscience indicates that spaces designed in a stimulating way improve human performance (Oseland 2009, Haynes 2008, Raisbeck 2006, Davies 2010). Various physical design characteristics are discussed in the literature that can enhance performance and motivation to work in office spaces, such as layout, ease of access to spaces, color and texture of surfaces, sequence in spaces for common use (circulation routes, social interaction spaces) (e.g., Altman 1975, Duffy et al. 1993). Although architectural design characteristics has long been argued as enablers for motivation to work, limited studies exist in the literature on how much such design characteristics impact human experience. This study aims to identify the relationships between human experience and architectural design quantitatively from the perspective of approach motivation. This quantification is done through a novel experiment setup that integrates virtual worlds with body area sensor networks (BSN), composed of various non-invasive biometric sensors such as EEG, GSR, EMG, and eye tracking. This paper reports findings on analysis of experiment data captured from twenty participants. Different configurations of architectural spaces with variant design features (e.g., color coding, texture, space layouts, connectivity of spaces) were provided to users in virtual models for navigation and performing tasks, and data was captured from the BSN simultaneously.

Results provide evidences on the impact of architectural design on motivation to work. SCR25 scores from GSR show that stimulating environments create 19% increase in arousal level as compared to less-stimulating environments. EMG data shows that respondents show a 69.5% increase zygomaticus activity (smile) in the stimulating environment with comparison to 38.5% increase in the opposite environment. Additional data captured from participants as self-reports supports the differences in each environment captured with BSN. More than 60% of the respondents felt more engaged under the stimulating environment, found it easier to perform the task, and preferred to stay more as compared to the less-stimulating environment. Results can be used by practitioners for quantified impact of design on human experience, and utilize the design characteristics identified in this work as factors to consider for enhancing human experience in designed spaces..

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# Suppressing the Visual Sense to Enhance the Experiences of Spiritual Spaces

Diane Zoura

## ABSTRACT:

Spirituality is the quality of valuing the human spirit or soul instead of material or physical things. So how do we design a space, which is made up of material and physical "things", that enhance the experiences of spiritual spaces? A spiritual space should help the user to look within, to connect with their sense of self. "In heightened emotional states and deep thought, vision is usually repressed" (Pallasmaa 28). Imagine a space where the "other" senses are so heightened that the visual sense slowly fades out, contrary to the way that most buildings and spaces are designed today.

The way people perceive the world is through the senses. Our perception of the world is a reflection of who we are. How we perceive the world affects everything we do or say. "The things that we experience influence what we will do next" - Michael Arbib. By suppressing the visual sense, the quickest sense, we are also inviting patience - a key factor in spirituality.

Spaces should invite people to look into the world, not just with their eyes, but with their whole body. Spiritual spaces that are designed so that the user is inspired to feel, hear, smell and taste will encourage the suppression of vision. When the architectural experiences are more than just visual perceptions, the user unites with the space and the environment, thus leading them deeper into their spirituality. "Good and thoughtful design can not only awaken our senses, but reconnect us to place and to ourselves." -David Darling

There have been recent findings in the neural systems and the complexities of the brain that highlight the impact of multi-sensory experiences to our behavior, mood and knowledge of one's self. In a spiritual space, by providing a multi-sensory environment, where the senses are introduced in a collaborative and subtle way, the user can connect to themselves rather than being distracted by their environment. The environment becomes the teacher, but the answers are all within the self.

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## Cultural heritage and memories of places: convergences and divergences between the legacy of the ‘physical’ sites of memory and the memories of places evoked in the neural architecture

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Halbwachs [9] stated that there is no collective memory that does not occur in a spatial context. He argued that space offers an image of permanence and stability through signs left by social groups. These signs can assist in arousing memories and evoking the past [16] and thus represent valuable testimony since they involve the retrieval of information about people and significant social facts about the groups [11]. In this way, the ‘sites of memory’ [12] can be shaped – places that are appropriated and preserved by the existence of a shared meaning that distinguishes them from others.

At the same time, the ‘physical’ sites of memory are connected to the ‘neurophysiological’ places of memory, described by Damásio [3-5] as ‘convergence-divergence zones’. These zones can be defined as a set of neurons where a large number of handle signals make contact in *feedforward-feedback loops*, which assist the neural architecture responsible for the evocation of memories and hence the recognition of all our surroundings.

This research explores the relationships between people, place and memory and involves discussing the links between the ‘sites of memory’ [9] and the ‘convergence-divergence zone’ [5], which constitute the spaces for images and dispositions that are bound up in the perception and evocation/recognition of fleeting memories, as experienced by the residents [15] of the central district of the town of Campinas - Sao Paulo - Brazil. A field research was carried out with a sample of 266 participants from the central area of this town [1-2;10;13;14], who agreed to take part in interviews and produce drawings on the basis of which it was possible to identify the ‘memories of places’ mediated by the ‘convergence-divergence zones’.

The results [4-7; 14] show the close ties between the individual, the urban/architectural space created and the recognition of the value of the constructed urban identity that is based on the memory that the participants had of their city, cultural heritage, symbolic reference points and representations. These representations provide evidence of a lack of “resonance” [8] between the places of memory that tell the history of Campinas and the memories of places retained by the inhabitants of that city, and underpin the discussions about the way cultural heritage and memory are endowed with legitimacy and preserved in the present.

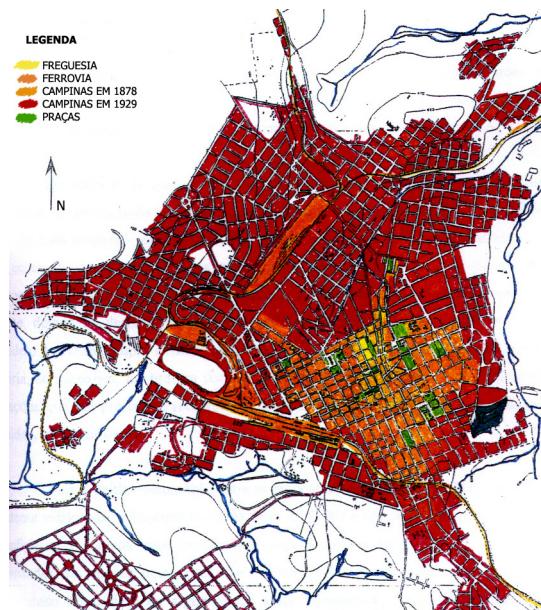


Figure 1: Campinas in 1929. Source: Oliveira, 2012 [13]

Table 1: Answers to the questions of the questionnaire that was applied in the research field study.  
Source: Oliveira, 2016 [14]

Questions	Subcategories	Specific Subcategories/ Directions
When one speaks of the center, what is the first thing that comes to your mind?	Religious buildings (18)	Cathedral (14), churches (4).
	Buildings/monuments (8)	Old buildings (4), the demolished theatre (2), the central market (2).
	Others (10)	Tradition/history/cultural heritage (7), childhood (2), trams (1).
What do you most like in the center?	Religious buildings (11)	Cathedral (11).
	Buildings/monuments (12)	Historic building (6), Fepasa Railway Station (4), monuments (2).
	Others (8)	Architecture (7), the railway (1).
What things that have been lost did you like in the Center?	Religious buildings (1)	Igreja do Rosário [Rosário Church] (1).
	Buildings/monuments (10)	Fepasa Railway Station/ passenger trains (3), the Carlos Gomes Theatre (3), the Public Library (1), historic buildings (1), the Hotel Terminus (1), monuments (1).
	Streets/squares (3)	Rua Treze de Maio [13 <sup>th</sup> May Street] (2), streets with paving stones (1).
	Others (10)	Romanticism (3), traditions (2), history (1), trams (1), the Fountain of Rua Treze de Maio (1), Ezekiel living dead dolls (1), the Umbrellas of Rua Treze de Maio (1).
What would you like to see in the Center?	Buildings/monuments (12)	Buildings/preserved history (9), things as they were in the past (9).
Which spaces/places in the Center do you make most use of?	Religious buildings (11)	Churches (11).
	Buildings/monuments (4)	Centers of culture (4).
	Streets/squares (3)	Areas with shade from trees (3).
What kind of cultural heritage is there in the Center at present?	Religious buildings (122)	Cathedral (90), Churches (20), Rosário Church (2), Universal Church (1).
	Buildings/monuments (169)	Culture of the FEPASA station (30), Palace of Azulejos [glazed tiles] (22), Palace of Jequitibás (19), Jockey Club (12), Statue of Carlos Gomes (12), monuments (11), buildings (10), the Town Market (8), Carlos Gomes College(7), The Forum (5), Museums (5), PUC Central [Catholic University](5), CCLA [Latin American Cultural Center] (4), Carlos Mendes Theater (4), the Post Office (3), MACC Building [Medical/Scientific Computing Center] (3), Health Center (3), Mogiana (2), Headquarters of the Carlos Gomes Band (1), Carlos Salles Monument 91), Giovanetti (1), Niemeyer Building (1).
	Streets/squares (64)	Carlos Gomes Square (24), Community Center (17), Squares (10), Carmo Square/ Bento Quirino Square (5), Rosário Place (3), Jequitibás Wood (2), Pará Place (2), Parks (1).
	Others (16)	Railway (10), Bars (2), Hotels (2), Pedestrian tunnel (1), Bandstand (1).

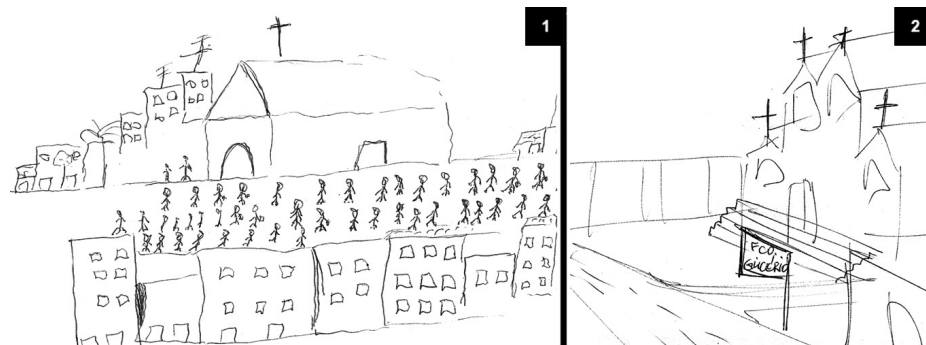


Figure 2: Glicério Avenue: skyline of tall buildings and the Cathedral tower. Source: Oliveira, 2016 [14]



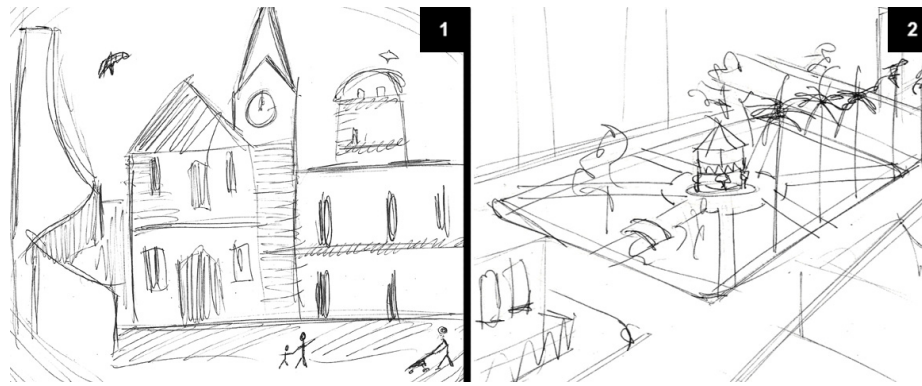


Figure 3: Building of Fepasa Station and its tower with a clock and Carlos Gomes Square with its bandstand and imperious palm trees. Source: Oliveira, 2016 [14]

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