



ANFA CONFERENCE

2014

ACADEMY OF NEUROSCIENCE FOR ARCHITECTURE

PRESENTER ABSTRACTS

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The Inter-Related Relationship Between Thermal Comfort, Indoor Air Quality and Students' Cognitive Performance in the Built Environment

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1. ABSTRACT

By focusing on the occupants' health as an endpoint and how various implications for human cognitive performance are attributed to poor buildings' design, this study is aiming to investigate the impact of thermal comfort, indoors' ambient temperature and CO₂ concentration as an indicator for indoor air quality on students' cognitive performance in educational buildings where students spend significant amount of their time. Saudi Arabia has been chosen as a case study, with reference to hot arid climates where scarce data is available. The results of a pilot study conducted on 30 female subjects in a female collage in Saudi Arabia will be presented; in which both quantitative and qualitative methods were employed, namely: monitoring classrooms' CO₂ levels, air speed, relative humidity, light intensity and sound levels, along with measuring students' activity, clothing level and cognitive performance. Eight tasks of BARS (Behavioural Assessment and Research System) neurobehavioral tests¹ were used to evaluate the students' cognitive performance. Also, thermal comfort votes were collected via self-administrated questionnaires. Students' cognitive performance was measured by a cognitive testing battery. The main scope of the experiment design has been based on repeating the cognitive tests under three different temperatures (20, 23 and 25°C). In the intervention classrooms, the concentrations of CO₂ were maintained at a pre-set level of 1200 ppm, achieved by a constant volume central air conditioning system. Repeated measures ANOVA pairwise comparisons indicate statistically significant results in almost all tasks. The speed of hands is yet evident to be impaired due to cool exposures, in line with the results of recently relevant published findings. Accuracy of memory tasks was found to be impaired at 25°C and 23°C, the reported comfortable condition, compared to the cold exposure 20°C, concurrent with the slowest response time. Accuracy of attention tasks peaked at 20 and 23°C compared to 25°C. Coordination tasks showed some discrepancy among the reversal typing and reversal learning test results which could be attributed to the few number of participants and thus further investigation is needed. Outcomes of the study can be used to reflect how much learning disability could be realistically avoided every year as a result of better educational buildings' design. The study will contribute to the development of creating environments conducive to learning as well as enhancing Thermal Comfort and IAQ guide lines for educational buildings' design.

Keywords: Thermal Comfort, Indoor Air Quality, Cognitive Performance, Built Environment

1. <http://www.nweta.com/bars/>

Museum of Memory: An Analysis of How Museum Circulation Can Help Visitors Remember a Space.

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This paper addresses perception in the museum setting; I analyzed three exhibition spaces in Europe and identified how the senses and hippocampus play a role in remembering the galleries visited. The purpose of this paper is to help fellow design students understand that user perception, memory, and space circulation is directly associated with neuroscience and should be strongly considered when designing, not just museums, but any space.

1. ABSTRACT

1.1. MUSEUM ACTIVITY, THE SENSES, AND NAVIGATION

A museum's four layers of activities:

1. Observation (a sign of curiosity)
2. Movement (multi-tasking walking + seeing)
3. Setting (we move in relationship to the artworks and walls surrounding us)
4. Art Encounter (emotional response)

An efficient learning strategy in a museum is through the design of their different circulation systems. Beyond the individual galleries in a museum, it is how we move from an understanding of place to an understanding of architectural space that helps us remember it.

Traditional sense of touch, smell, hearing, and even taste, all parallel sight and happen simultaneously as we navigate a museum. Our ability to understand where we are in space is dependent on the details of sensory cues received, such as art pieces or wall surfaces.

During navigation, our brain is influenced by our movement and by environmental stimulation, which allow us to create different types of mental maps that then contribute to the formation of memories. As we move through an environment, our brain fires populations of hippocampal cells when we reach specific locations. These are called place cells.

1.2. CASE STUDY: MERCEDES-BENZ MUSEUM (STUTTGART, GERMANY. UNSTUDIO 2006)

Prescribed circulation allows for guests to learn content of museum in chronological order as they circulate. UNStudio, it seems, wanted to impose a map of their own on our brain; they provided us with different stand-points and multiple perspectives. The automobiles were our distal stimuli; our landmarks as we navigated.

1.3. CASE STUDY: BEYELER FOUNDATION (RIEHEN, SWITZERLAND. RENZO PIANO 1997)

This museum's four facades are our brain's environmental cues. If the visitors do not know their location in the building, they can walk towards a side of the building, re-start their journey and venture again through the partitions. Researcher Robert Muller said "there may be some tendency for fields to be more common near walls. There also seems to be a tendency for fields to occur in front of prominent stimuli on the apparatus wall."

1.4. CASE STUDY: JEWISH MUSEUM (BERLIN, GERMANY. DANIEL LIBESKIND 1999)

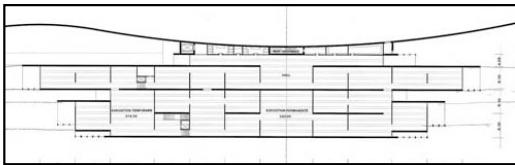
The museum's ground level is its best performing component, as it explicitly and clearly addresses directionality and turns, complemented by strong rewards at the end of the hallways. However, once upstairs, visitors have to often re-orient themselves and become too distracted to even appreciate the information being exhibited. Libeskind carried on the question of art and addressed his project as a (beautiful) sculpture itself, which became overwhelming the second the actual artwork was brought in to occupy the space.

1.5. MUSEUM CURATORS, USERS, AND DESIGNERS

Whether the building is controlling us, or the user deciding, the architecture should engage our entire sense of self when we occupy it. Environmental stimulation is what invites us to act – primarily responsible for our awareness of a space. Museum directors and curators must allow for more dynamic interactions and

interrelations of ourselves and their art pieces as we circulate inside exhibition spaces and galleries. Users of a space, when encountering a new environment, will let their emotions react to what the architects and curators have created for them. Designers must offer projects with psychologically interesting ideas of circulation and how the body can react to perceived stimulation.

FIGURES/ILLUSTRATIONS/IMAGES



Top: Mercedes-Benz Museum, Stuttgart, Germany. By UNStudio. Section (left). Interior vertical circulation (right).

Bottom: Beyeler Fondation, Riehen – Basel, Switzerland. By Renzo Piano. Exterior (left). Ground plan (right).

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3. AUTHOR BIO

Originally from the San Diego-Tijuana area, I finished high school in Hemet, CA. I currently study undergraduate architecture at Cornell University, Class of 2015. Along with an architecture professor, and ten other architecture students, I drove through Western Europe analyzing museums in nine different countries – this took place during the summer of 2013 and the trip lasted two months. My interest in neuroscience-architecture started my second year, after taking an environmental systems course that addressed design acoustics and how architects should consider, not just visual theory in design, but also how the body and mind react to the built space.

The Smart Building and Human Behavior

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This presentation will focus on smart buildings and research related to home automation, wireless networks, sensor technologies and the future of the internet of things for the built environment and how these technologies might be used to learn from human behaviors to inform future building design.

1. EXTENDED ABSTRACT

THE SMART BUILDING AND HUMAN BEHAVIOR: ACCURATE INFORMATION INFORMS DESIGN

Imagine a world where every point in space has the potential to be a sensor or display. You walk into a room and the room automatically adjusts itself to your preferred temperature. Lights turn on just how you like it, and with the wave of the hand the shades adjust to allow the right amount of lighting for the activity. Without much thought or effort, your environment has adapted itself into a peaceful and tranquil environment for productivity. Next, you walk into the kitchen and the home operating system has notified you of how much energy you have saved from unplugging unnecessary energy consuming devices and from running the dishwasher during non-peak hours. You feel good about your contribution to the environment and how your investment in technology has helped you get there.

Today, there are over 12.5 billion devices connected to the web and it is expected there will be 25 billion by the year 2015 and 50 billion by 2020ⁱⁱ. These devices are being embedded in many places, in cars, appliances, cameras, roads, pipelines, medicine and even livestock. Smart systems are transforming our energy grids, supply chains and water management systems. Our world is becoming interconnected. This area of research is being investigated as part of Frank Gehry's / Gehry Technologies SUPRASTUDIO at UCLA's IDEAS campus dedicated to cross-disciplinary research and collaboration among students, faculty and industry partners that questions, challenges and expands the future of architectural and urban design practiceⁱⁱⁱ.

This presentation will focus on smart buildings and research related to home automation, wireless networks, sensor technologies and the future of the internet of things for the built environment and how these technologies might be used to learn from human behaviors to inform future building design. This presentation will share how this area of research is being investigated within an academic context and how it is being applied in practice. Also, speakers will discuss what potential these technologies may have in learning from a building's inhabitant and how the data collected might be used to inform future building design to go beyond home automation and become active participants in our daily lives.

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3. AUTHOR BIOS

ABOUT THE SPEAKERS

All three speakers are involved in helping plan the AIACC Now Next Future Conference being held October 2014 in Santa Monica and are active in employing technology to advance design. Representing different architectural practices, they will share their perspectives on how architectural firms are using technology today, what is next on the horizon for technological innovation, and how in the future, design, enabled by technology, can influence development of the built environment on the human experience.

Brian Paul Dougherty, FAIA, LEED BD+C is a Senior Partner at Dougherty + Dougherty Architects LLP, specializing in the planning

and design of contemporary educational, institutional, military, commercial, and health care facilities. Mr. Dougherty contributes over thirty-five years of experience in providing architectural services to projects. He brings a career-long emphasis in energy conservation and sustainable design to each project, including a focus on holistic resource conservation that is shared with clients, community members, and other professionals through lectures and presentations. He serves as a practicing architect member of the California Board of the Collaborative for High Performance Schools (CHPS). His credentials in this area have led to his role as a spokesperson for the architectural profession in State and National dialogue on the subject. His service to the AIA over the years at the Local, State and National levels has included Regional Director to the National Board and National Secretary from 1996 to 1998. Mr. Dougherty served as the 1986 Orange County Chapter President, AIACC Secretary in 1988, a Trustee of the AIACC Benefit Insurance Trust, and a member of the AIA Regional/Urban Design Committee. Mr. Dougherty is currently the 2014 President of the American Institute of Architects, California Council (AIACC).

German Aparicio, Assoc. AIA, LEED AP, German Aparicio is Project Manager at Gehry Technologies and leads a seminar course on physical computing, wireless networks and sensor technologies at UCLA's IDEAS campus. He has academic, research and professional experience as Lecturer at UCLA, Cal Poly Pomona, UC Berkeley and the California College of the Arts, as research associate at SENSEable City Laboratory (MIT), scholar in residence at Autodesk's IDEA Studio and as Computational Designer at ARUP and AECOM design engineering firms. German received a Bachelor of Architecture from Cal Poly Pomona and a Masters of Science in Architectural Studies (Design and Computation) from the Massachusetts Institute of Technology (MIT).

Lucas Reames, Assoc. AIA, has been a project director at Gehry Technologies since October 2007. He has a degree in architecture and computational design from California State Polytechnic University-Pomona. Gehry Technologies is an AEC technology development and consulting company providing leading edge solutions to the industry's most challenging projects. Clients include some of the most recognized international architects, engineers, contractors, and owners working on some of the world's most ambitious projects.

The Challenge of Adapting Neuroscience to the Needs of Architecture

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This talk introduces a threefold distinction within Neuroscience for Architecture (NfA): the neuroscience of the experience of architecture, the neuroscience of design for architecture, and neuromorphic architecture. The exposition of these approaches is framed by a discussion of key aspects of neuroscience to give a sense of the levels of analysis involved, and is applied to architectural analysis within the context of library design.

1. EXTENDED ABSTRACT

1.1. THE MANY LEVELS OF NEUROSCIENCE

Brains provide not only processes within a person for perception and action, but mechanisms that have evolved (biologically and culturally) to guide social interaction. Brains function as highly parallel, adaptive computers. Synapses change with sensory, motor and “integrative” experience. The anatomy of brains melds diverse subsystems. We explore the notion that brain operating principles will inspire discovery of biologically-inspired operating principles of relevance to architecture.

Computational neuroethology studies how the nervous systems of different creatures mobilize resources differently in diverse ecological niches, but we place special emphasis on primate (including human) brains: assessing the interplay between feedforward and feedback pathways and the sharing of neural resources between perception, action, cognition and language.

1.2. THREE FORMS OF NEUROSCIENCE FOR ARCHITECTURE

Neuroscience of Architectural Experience uses neuroscience to establish a framework for understanding how people experience the built environment. The aim is to help architectural design better enhance the quality of life through reduction of stress, increased cognition, prolonged productivity, and enhanced spiritual and emotional response (Eberhard, 2008).

Neuroscience of the design process: Arbib (2013) addressed this by offering a neuroscience perspective on Peter Zumthor's *A Way of Looking at Things* (Zumthor, 2012). In reflecting on his own design process, Zumthor finds that half-forgotten memories yield images where all is new. Stressing that construction is the art of making a meaningful whole out of many parts, Zumthor notes that he must start with functional and technical requirements and thence develop an architecturally satisfying whole out of innumerable details

Neuromorphic architecture: Arbib (2012a) charts the notion of “brains” for buildings, using the term neuromorphic architecture to characterize the process whereby architects may learn from the neuroscience of interaction with the physical and social environment to develop new forms of interactive infrastructure to enable a building to more effectively meet the needs of the users.

1.3. CASE STUDY 1: THE HIPPOCAMPUS, WAYFINDING AND THE SEATTLE PUBLIC LIBRARY

We review basic findings on the role of the hippocampus in both spatial memory in rats and episodic memory in humans, stressing how the hippocampus can best be understood only within the context of a larger system of brain regions (Guazzelli, Corbacho, Bota, & Arbib, 1998). We then contrast efforts in neuroscience with efforts in cognitive science (without the neuro), paying particular attention to a study of wayfinding in the Seattle Public Library (Carlson, Hölscher, Shipley, & Dalton, 2010).

1.4. CASE STUDY 2: THE THINKING HAND

The second case study complements Juhani Pallasmaa's monograph on the role of The Thinking Hand in architectural design (Pallasmaa, 2009) and embodied cognition with my own analysis of the role of manual praxis and gesture in the evolution of the human language-ready brain (Arbib, 2012b).

ACKNOWLEDGMENTS

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the Huntingdon College Library Eric Kidwell at the annual meeting of the American Library Association in June 2014 in Las Vegas.

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3. AUTHOR BIO

Michael A. Arbib is University Professor and Fletcher Jones Professor of Computer Science, as well as a Professor of Biological Sciences, Biomedical Engineering, Electrical Engineering, Neuroscience and Psychology at the University of Southern California (USC), which he joined in September of 1986.

The thrust of his work is expressed in the title of his first book, *Brains, Machines and Mathematics* (McGraw-Hill, 1964). The brain is not a computer in the current technological sense, but he has based his career on the argument that we can learn much about machines from studying brains, and much about brains from studying machines. He has thus always worked for an interdisciplinary environment in which computer scientists and engineers (and, more recently, architects) can collaborate with neuroscientists and cognitive scientists. Arbib is now a Board Member of the Academy of Neuroscience for Architecture, with a special interest in neuromorphic architecture in the sense of supplying buildings with an "interaction infrastructure" whose design is informed by research on computational models for cognitive and social neuroscience.

Arbib's research has long included a focus on mechanisms underlying the coordination of perception and action. This is tackled at two levels: via schema theory, which is applicable both in top-down analyses of brain function and human cognition as well as in studies of machine vision and robotics; and through the detailed analysis of neural networks, working closely with the experimental findings of neuroscientists. His group prepared the first computational model of mirror neurons and conducted some of the key initial imaging studies of the human mirror system. He is using further insights into the monkey brain to continue to develop a new theory of the evolution of human language. 2012 saw the publication of Arbib's 40th book, *How the Brain Got Language: The Mirror System Hypothesis* (Oxford University Press). This was followed by the 2013 edited volume from the MIT press, *Language, Music and the Brain: A Mysterious Relationship*.

A Five-Factor Model of Human Emotional Experience of the Physical World: Insights from Environmental Psychology

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1. ABSTRACT

A synthesis of environmental psychology related neuroscience research indicates that human emotional experience of the physical environment is shaped by five factors.

- » Humans have a set of fundamental and universal emotional responses to environmental stimuli. These include reactions to color saturation and brightness, biophilic design attributes, and sound timbre and cadence, for example.
- » All human beings have idiosyncratic, place-based experiences/histories that influence how they respond to places they encounter. These include affective response to particular design elements specifically as well as interpretations of place-based experiences and design elements communicating nonverbally. They can be differentiated from fundamental spaces assessments by their foundation in unique, psychologically charged experiences.
- » Individual personality has a decided influence on our emotional response to space. The sort of coordinating psychological response provided at an individual level by personality is delivered at a group level by culture. Regularly, individuals with similar personality profiles are the most frequent users of particular environments.
- » Groups develop shared responses to life experiences, and those shared concepts influence the ways in which spaces are perceived and used. At both a micro and macro level, cultures shape our relationship to space. The fourth and fifth factors determining emotional response to place are group/organizational and national culture.

Emotional experience is important because it has repercussions for thought processing. For example, positive affect has been linked to broader (e.g., more innovative and prosocial) thoughts and behaviors, when compared to neutral or negative state processing.

The five factors that link human exposure to an environment and our completed emotional response to a place each, in some way, adds subjectivity to assessments, distorting perceptions and informing action.

Designers who are familiar with the five factors that influence a user's response to a space can create environments where desired experiences are more likely to occur.

2. AUTHOR BIO

Sally Augustin, PhD, is a practicing environmental psychologist, specializing in person-centered design, and a principal at Design With Science (www.designwithscience.com). She has extensive experience using rigorous protocols to integrate insights from environmental/design psychology, other social/physical sciences, and project specific research to develop places, objects, and services that support desired experiences. Her clients include manufacturers, service providers, and design firms in North America, Europe, and Asia.

Dr. Augustin, who is a Fellow of the American Psychological Association, holds leadership positions in professional organizations such as the American Psychological Association (past-president, environmental psychology division), the International Association of Applied Psychology (environmental psychology division), and the Environmental Design Research Association (chair, work environments network).

Sally's work has been discussed in publications such as The New York Times, The Wall Street Journal, Huffington Post, Psychology Today, Prevention, Salon, and Self and in periodicals as diverse as the Chicago Tribune, Natural Home, Gizmodo, and design publications in the United States, Canada, and Mexico. Augustin writes regular columns for Huffington Post and OfficeInsight. She is a popular online contributor to Psychology Today. Sally also writes a column titled "Places That Work" for the electronic edition of Metropolis.

As the editor of Research Design Connections (www.researchdesignconnections.com), Sally has written widely on science-based design for a broad audience of people interested in the designed world. Her Research Design Connections blog is

read by thousands of individuals each month.

Sally has discussed using design to enhance lives on mass-market national television and radio programs. She speaks frequently to audiences in North America, Europe, and Asia at events such as the annual meeting of the American Institute of Architects, the International Design & Emotion Conference, the bi-annual meeting of the International Positive Psychology Association, NeoCon/IIDEX, the American Psychological Association's annual meeting, the Environmental Design Research Association annual conference, Healthcare Design, and Applied Brilliance.

Sally is a graduate of Wellesley College (BA), Northwestern University (MBA), and Claremont Graduate University (PhD).

Dr. Augustin is the author of Place Advantage: Applied Psychology for Interior Architecture (Wiley, 2009) and, with Cindy Coleman, The Designer's Guide to Doing Research: Applying Knowledge to Inform Design (Wiley, 2012).

In Search of Beneficial Distractions: Exploring Restorative Environmental Distractions in Workplace Design

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This study examines how visual stimuli presented during task performance, and during breaks between tasks, can function as a positive distraction on task performance and emotional regulation. Two parallel studies were conducted in an office environment in order to test whether restorative nature image presentation would impact performance and emotional regulation during a creative reasoning task (Remote Associates Test [RAT]) and a directed attention task (visual Backward Digit Span [BWDS]). Thirty-two office workers were shown counterbalanced sets of nature images, urban images, and no images during three fifteen minute intervals of RAT. Before and after each interval, Positive and negative affect scale (PANAS) ratings and BWDS tasks were interspersed. A separate set of thirty-two office workers were shown counterbalanced sets of nature images and urban images before and after each task set. A within subjects analysis of task performance, PANAS ratings, and tonic hrv are discussed for each study. Workplace design implications are also addressed.

1. EXTENDED ABSTRACT

Workplace design and furniture specifications are often aimed at preventing disruptive distractions in order to facilitate inhibition and sustained attention. Distractions have been linked to a decrease in the cognitive mechanisms of inhibition and sustained attention, demonstrated by decreases in perceptual speed, reaction time and cognitive processing. Attention can be driven by external stimulation (bottom-up from the environment) and by internal mechanisms (top-down). When inhibitory control is compromised, a person is more prone to sensory interference and distraction, and to decreased "interference control", the ability to free behavior from being controlled by the immediate environment (Brocki and Bohlin, 2004). We aimed to investigate whether there may be receptive distractions (our term) linked with increased productivity and protective health benefits in the workplace. Attention Restoration Theory (ART) suggests that directed attention processes, such as focused concentration, are fatigable, but can be restored by facilitating bottom up/involuntary attention processes captured by stimulating features, particularly nature, in the environment (Kaplan, 1995; Kaplan & Berman, 2010). This differs from harshly fascinating stimulation such as bright lights and loud sounds which also capture attention automatically, but do so in much harsher and more consuming ways. Additional studies have indicated that ART persists in restoring creative reasoning processes after exposure to nature (Atchley et al, 2012). Others have linked exposure to green space with a reduction in stress (Thompson et al, 2012) suggesting that interaction with nature may mediate the effects of stress and enhance coping mechanisms in the presence of distractions. Thus, we hypothesized that softly fascinating features, implemented as moving nature images, introduced directly into the work space would serve as receptive distractions which would restore directed attention, improve creative task performance, and improve emotional regulation.

This research was conducted in an operational office setting. Participants performed three 15-minute self-paced RAT task sets (Bowden & Jung-Beeman, 2003; Mednick, 1962) across three counterbalanced distraction conditions: no images/distraction (control), receptive nature images, and neutral urban images. Between task sets, participants completed a PANAS scale and performed a directed attention task associated with attentional fatigue (visual backwards digit span). In order to test if there was a restorative advantage above any observed effects from the distraction-version, a second study was conducted in which images were presented during breaks between tasks sets. In each study, measures of HRV were analyzed as indicators of emotional regulation (Appelhans and Luecken, 2006; Thayer and Lane, 2009), i.e., the ability to self-regulate in response to changing environmental demands (Thayer et al, 2012).

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3. AUTHOR BIOS

Meredith Banasiak is a member of the Program in Environmental Design faculty at the University of Colorado. In 2012, she launched Humans and Buildings Laboratory (HabLab), a research group committed to studying interactions between people and environmental settings established with funding from an Innovative Seed Grant Program award.

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Brian Green M.S. Tech. Mgmt. and his team gather information about behaviors, like workplace collaboration, and convert data into real world solutions by studying people, places, and the ways they work. Part of this work includes the study of the role of distractions in the office environment and their effect on productivity.

Marc G. Berman, Ph.D. is an Assistant Professor of Psychology at the University of Chicago and the director of the Environmental Neuroscience Laboratory. Marc's research examines the interactions between individual neural, cognitive and affective processing with the social and physical environment to improve human mental and physical health.

fMRI Study of Architecturally-Induced Contemplative States

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Within the context of contemporary neuroscience and clinical research in meditation, this pilot study uses fMRI scans to gauge and compare the neurophenomenological response that contemplative and ordinary buildings elicit from 12 subjects. The result indicates not only that there are clearly different reactions to the two types of built environments but also, and more significantly, that the phenomenological and neural correlates of the architecturally-induced contemplation share many similarities with internally-generated meditation while displaying important differences that have more in common with peak/flow/aesthetic psychosomatic states than with meditative conditions

1. EXTENDED ABSTRACT

This interdisciplinary investigation tests whether the perception of environments designed for contemplation elicit brain activations similar to those found under contemplative states. If architecture is shown to be an effective 'external method' to facilitate contemplation, then the beneficial effects of internally-driven contemplative practices (e.g., prayer, meditation) shown by recent neuroscience and clinical research [1] could be extended to long term exposure to buildings designed for that purpose. In this sense, this effort addresses a missing dimension in today's contemplative neuroscience that focuses overwhelmingly on meditative experiences gained through internally-induced (self-directed) methods, while also helping to construct an empirical foundation for evidence-based design. Our long-term goal is to investigate cognitive, emotional, and health effects of contemplative/sacred architecture on the wider population.

In order to test the hypothesis that buildings designed for contemplation elicit neuro-signatures associated with meditative states, we devised a pilot project combining a functional Magnetic Resonance Imaging (fMRI) based experiment and current neuroscience literature on meditative states. We recruited 12 architects and asked them to view images of ordinary buildings ('Control' Block = school, office, house, etc.) and contemplation-inducing ('Experimental' Block = temple, retreat, church, etc.) edifices while their brains were being scanned. A building was depicted through 4 images at 20 seconds each (totaling 80 sec) separated from the next set by a 40 sec recovery period (gray plate). Each Block started with a Baseline period in which a gray color plate was presented for 60 sec. There was a short questionnaire after each Block and a 20-minute Exit Interview intended to collect behavioral/psychological data. A second Control came from the published record of neuroscience research on meditation-related practices.[2]

Our data, based on regression analyses and activation contrasts between Control and Experiment in coordination with psycho-behavioral responses, show that contemplative buildings (a) induce markedly distinct phenomenological states and neural activations than ordinary buildings (measurable in the differential engagement of the Whole Brain, Frontal Lobe, Orbitofrontal Cortex, Inferior Parietal Lobule, Insula, and Cingulate Gyrus); (b) allow subjects to enter into a meditative state with diminishing levels of anxiety and mind wandering ; and (c) activate subjects' cortical regions of sensory-motor and emotional integration, non-judgmentality, and embodiment. Additionally, we found that depth of contemplative experience was correlated with the deactivation of major cerebral regions, noticeably the Prefrontal Cortex. This indicates that while the phenomenological and neural correlates of the architecturally-induced contemplation share some similarities with internally-generated meditation (particularly of the Open Monitoring type), they also exhibit considerable differences that find better correspondence with peak/flow psycho-somatic states and profound aesthetic experiences.[3]

This research project (a) extends our understanding of alternative means to foster contemplation at an individual and collective scale; (b) opens new avenues of investigation in neuroscience; (c) advances the scientific investigation of architecture (contemplative and otherwise); and (d) provides an empirical foundation for the impacts of centuries' old architectural traditions on human phenomenology.

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3. AUTHOR BIOS

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Spatial Manifestations of the Human Psyche: Architecture Based On Neurological Theories Of Aesthetic Experience & Environmental Preference

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A cognitive approach towards architecture could unleash a new frontier in contemporary architectural discourse - the emergence of a sensory environment designed to stimulate the human senses and provide neurological nourishment for building occupants. This research aims to revive the fractured relationship between mind, body and space through an exploratory study of architecture driven by neurological theories of aesthetic experience and environmental preference. With the foregoing in mind, a conceptual project was created using a spatial narrative derived from psychosocial values of space, coupled with a responsive exterior facade that generates sensory variability of light, form and movement using human computer interaction technologies. With the intent of furthering the dialogue between architecture and neuroscience, this investigation demonstrates how architects could manifest theories of psychology and neuroscience into built environments, and in turn, foster occupant well-being through spatial agencies in tuned with the human psyche.

1. ABSTRACT

Architecture's fractured relationship with the human psyche deprives occupants from satisfying their needs and desires in the built environment. Architects continue to design static unresponsive objects deemed insensitive towards the dynamic nature of inhabitants. Yet, human beings favor an empathetic infrastructure that perceives, adapts, and changes in relation to their individual idiosyncrasies. A cognitive approach towards design must be implemented within the conceptualization and formulation stages of architecture, allowing for a revitalized relationship between the mind, body and space. The aforementioned method is applied towards a theoretically based visual arts studio located within the downtown core of Toronto, Canada. The design aims to spur neurological nourishment using both static and responsive architectural gestures based on neurological theories of aesthetic experience and environmental preference. The building embraces passive modes of architectural interaction coupled with active modes of emotive spatial adaptation intended to enhance the occupants' well-being and fulfill their corporeal desires.

On a macro level, the architecture reveals a spatial narrative embodying the psychosocial values of space including perceptual problem solving (V.S. Ramachandran & W. Hirstein, 1999), biophilia (Wilson, 1993), the creation of a hearth (Konner, 1982), coherency, mystery, enticement (Kaplan & Kaplan, 1982), prospect and refuge (Appleton, 1975). The micro level bares the sensory variability of light, form and movement articulated by a responsive exterior envelope - a facade comprised of sensing, actuation and control systems that acknowledge the occupant and change in real-time. The active skin consists of autonomous pneumatic silicone modules that expand and contract in response to body temperature, fostering the inhabitant's increase or decrease of stimulus levels depending on the variation of light and form within the environment (Heerwagen, 2000, 2008a). Adaptive floors capable of reconfiguring itself for individual, collaborative work and exhibition are allocated in designated regions for the occupants to control. As the spatial agencies of both the macro and micro level converge, a multi-sensory space that is in tuned with the human psyche is unveiled. The intelligent building embraces a user-centric approach towards design that ignites human senses and encourages occupant well-being. As architects, we must revolutionize our soulless buildings into landmarks for the senses, imparting neurological nourishment for the mind and body in a newfound sensory architecture.

1.1. ILLUSTRATIONS

Figure 1: The six diagrams below illustrates a design form-finding tactic executed on a macro scale. Each architectural gesture forms a spatial narrative based on the following psychosocial values of space:

- A. Perceptual ProblemSolving & Ambiguity
- B. Connection to Nature
- C. The Hearth
- D. Legibility/Coherency
- E. Mystery/Enticement/Peril
- F. Zoned Spaces for Prospect & Refuge

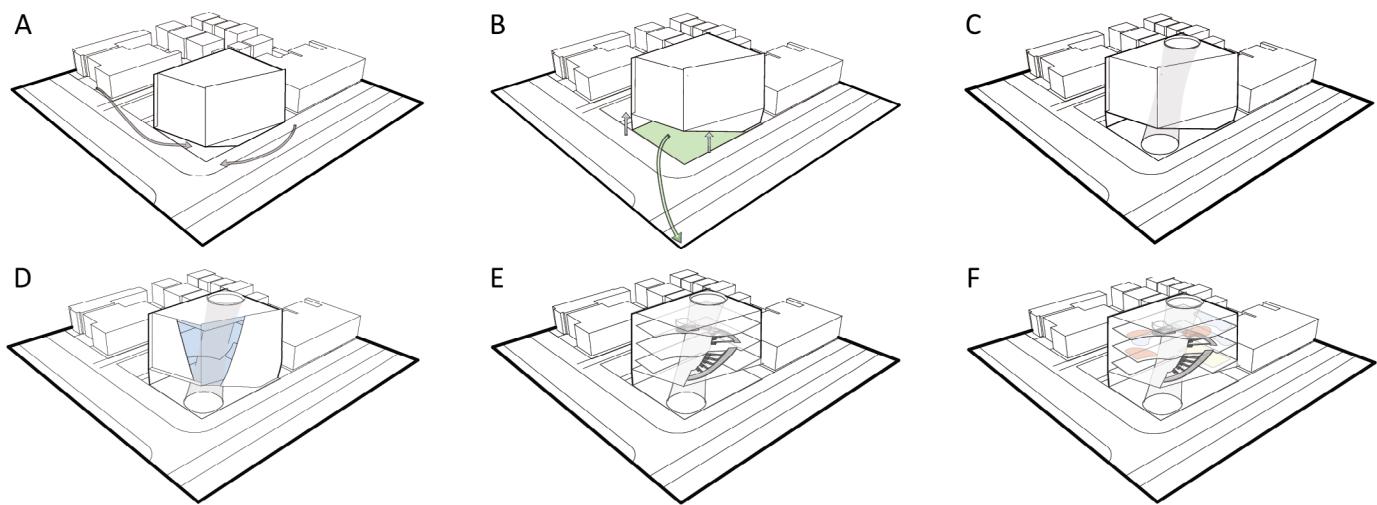
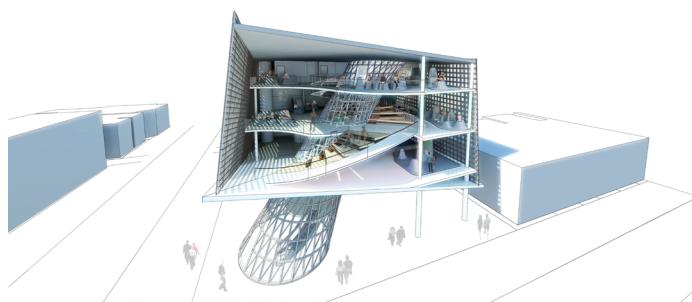


Figure 2: The interior perspective on the bottom left showcases the implemented architectural gestures on both a macro and micro level. The interior visualization on the bottom right illustrates sensory variability, moderate degrees of complexity, and a sense of refuge coupled with high prospect in the building's atrium.



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3. AUTHOR BIO

Ashley Brooke Biren is an architecture graduate student at Ryerson University where she earned a undergraduate degree in architectural science in 2011. During her bachelor studies, she held positions of AIAS Ryerson President as well as AIAS FORUM Sponsorship Chair at the American Institute of Architecture Students. Prior to attending graduate studies, Ms. Biren worked on a wide variety of projects within the retail and residential sector at Kasian Architecture and Interior Design, an award winning international firm located in Toronto, Canada. As a current graduate student, she is engaging in research that investigates responsive and interactive architecture catered towards enhancing occupant well-being. Ms. Biren's thesis will concern neuromorphic architecture that embodies human kinesis, specifically targeting the physical and psychological effects of kinesthetic empathy. As a former dancer and choreographer, she aspires to enrich the experience of architecture through the potential of dance.

The Urban Grid, the Hippocampus, Savannahs and Real Property

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1. ABSTRACT

Once discarded by many American architects, the urban grid has found favor in the context of The New Urbanism. Nonetheless, skepticism about the relevance of the grid remains among those who see the grid as part of another architectural fad, a form of architectural determinism or another assault on the architect's authority over urban design.

Were the grid placed in the context of neurological research on spatial-visual perception, cognition and movement, its broader social and economic relevance to urban life might be better understood. Particularly salient is a characteristic of urban settlements that has persisted from the earliest times: one so obvious it seems unrecognized. In small hamlets and in large cities since the beginnings of civilization 5000 years ago, the everyday space of settlements has been arranged orthogonally into two primordial elements, uninterrupted or continuous linear spaces we call streets and discrete usually rectangular built forms we call buildings. These public linear spaces and private bordered spaces cells are the equivalent of prospect and refuge (Appleton 1975) which appear to be instrumental in human evolutionary success.

Recent neurological research (Plumert & Spencer 2005, Solstad et al. 2008) gives credence to linking mechanisms in the hippocampus with human evolutionary success and urban form. This paper reviews landscapes of evolution, the development of patterns of sedentary space, relevant neurological knowledge and spatial thought in architecture. It suggests human evolution underlies the urban grid, which, in turn, offers optimal tradeoffs of generality with specificity (Gigerenzer 2000) not only in route selection (wayfinding) but also in structuring the social and economic relationships affected by private and public space and property.

2. AUTHOR BIO

Dr. Brown formed Space Analytics in 1989 and uses spatial network models to analyze dysfunctional buildings and urban designs and in state and federal court testimony on eminent domain access takings, architectural copyright, premises liability, and First Amendment public forum issues. He is a Fellow of the Royal Institution of Chartered Surveyors, was an Academic Fellow of the Urban Land Institute and ALDAR Dean of Business at the Higher Colleges of Technology in the UAE. Before that, he was Head of the Real Estate Management and Development Group at Eindhoven University of Technology in The Netherlands. Earlier, he taught architecture at the University of Colorado where he was Associate Dean, the Illinois Institute of Technology and Arizona State University. Access, Property and American Urban Space, his book on urban regime shifts, published by Routledge/Taylor & Francis, will be available in late 2014.

On Mood and Aesthetic Experience in Architecture

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Mood is the medium of artistic exchange between architects and their audience. In architecture, embodiment allows us to have an aesthetic experience when encountering an atmosphere, where the physiological result is mood. Architects know buildings are measured with the whole body, with empathy. Embodied simulation, the new empathy, is the aesthetic experience of real architecture that is tacit as mood. Architecture (the art of building) and neuroscience (the biology of the brain) converge in aesthetic experience as a re-creative act. This presentation navigates phenomenological and scientific views of aesthetic experience demonstrating that the intersection of architecture and neuroscience is the re-creative experience known as mood.

1. EXTENDED ABSTRACT

Mood is the medium of artistic exchange between architects and their audience see Figure 1. In architecture, embodiment allows us to have an aesthetic experience when encountering an atmosphere, where the physiological result is mood. Architects have long known buildings are measured with the whole body see Figure 3; it is called empathy. Embodied simulation, the new empathy, is the aesthetic experience of real architecture that is tacit as mood, the pervading tone of a person's state of mind. Architecture's creative desire and neuroscience's biology of experience meet in mood, where the audience can participate in the re-creative act.

Artists tap into such awareness, as Arthur Koestler demonstrates in *The Act of Creation*, by managing characteristics of our ability to feel and think to achieve aesthetic affect (1964). Architectural design, as a creative act, relies on the mechanism of embodied simulation to achieve re-creation in its audience. Meaning that, the ability to comprehend space aesthetically can exist only when our perception is manipulated through an embodied dialogue with the environment leading to a re-visioning of the work, much like getting a joke, a theory, or a dramatic character. Architecture (the art of building) and neuroscience (the biology of the brain) converge in aesthetic experience. Two architects can give perspective to the art of embodiment. Juhani Pallasmaa's buildings and theory of the seven senses each convey a phenomenological portrayal for experiencing architecture (Pallasmaa, 2009). Harry Mallgrave in *Architecture and Embodiment* surveys the sciences and humanities concerning our human natures, and traces the path of scientific existentialism from utopian experiments of the early 1900's to the present discussion of aesthetics in neuroscience (2013). The application of these tactics is to return architectural design to its biological foundation. Vision expert Semir Zeki claims that no new understanding of the biology of aesthetics can come without the assistance of neuroscience, to wit, he invents neuro-aesthetics (Zeki, 1999). Allied, Vittorio Gallese is led by how mirror neurons work to a Merleau-Pontyian view of the nature of perception; showing that we are present in the world as a multisensory bodily whole, a mobile nervous system perceiving the world through simultaneously glittering 'consciousnesses' (1999). It is instructive that when perceiving architectural space, scientists and architects converge in a phenomenological, multi-sensory hypothesis.

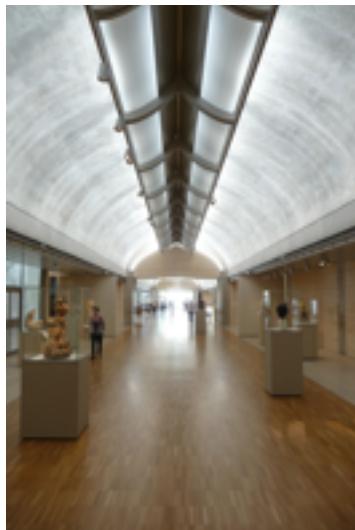
This presentation navigates phenomenological and scientific views of aesthetic experience demonstrating that the intersection of architecture and neuroscience is the re-creative experience of mood see Figure 1, which is the measurable physiological component of aesthetics.

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FIGURES/ILLUSTRATIONS/IMAGES



From left to right: Figure 1: Diagram of the aesthetic experience of architecture, cycling between a created atmosphere, to a re-created mood. Figure 2: A recognized masterpiece of aesthetic atmosphere is Louis Kahn's Kimbell Art Museum (Fort Worth), where the architect sought to establish a "silver light from above." Figure 3: At the birth of architecture's aesthetic purpose, circa 4000 BC, on the Irish Burren, stands Poulnabrone Dolmen (County Clare): a portal tomb built to impress, that ostentatiously proclaims tribal boundary and magical powers. It continues to astonish to this day.

3. AUTHOR BIOS

Prof. Bob Condia, AIA, is an architect and design partner with Condia+Ornelas Architects (1983 – present). A professor of architecture at Kansas State (1989 – present), he teaches architecture as an art form with due considerations to: beauty; coaching expertise; structural determination; the ancient works of man; a building's terrestrial and celestial alignments; phenomenology of perception; poetics of space; and the perception of constructed space from neuroscience. In 2008 he received the Kansas State's Commerce Bank Distinguished Teaching Award. His publications range from monographs on progressive architects; theoretical articles on the experience of space (focusing on Louis Kahn and Alvar Aalto); to a catalogue of his own surrealist illustrations; and discussions of creativity and expertise. His advanced seminars in perception combine architectural theory, analytical philosophy and the neuroscience of aesthetic experience. Prof. Condia earned his Master in Architecture and Building Design at Columbia University 1983, and a Bachelor of Architecture at California Polytechnic State University, 1980.

Michael Luczak, MArch. Kansas State University, 2014. He has spent his academic career exploring issues of tectonics in architectural design through construction and experimentation with concrete and through sculpture with wood. As a parallel study, questions of event segmentation and neuroscience have surfaced to inform how the body interacts with architecture. Philosophical inquiry engaging Roger Scruton, Peter Zumthor, and Paul Ziff (to name a few) has led him to a concern for the role of architecture as it defines human experience from the banal to the sublime.

Design and Somatic Experience: An Empirical Approach to Drawing Through Experiential Anatomy

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1. ABSTRACT

We can activate different parts of the brain to stimulate creativity in drawing and design. While most pedagogy has focused on right brain-left brain differences, we stimulated different levels of the brain -- cortical and sub-cortical. "Experiential anatomy," "somatics," and neuroscience provide the theoretical framework. This quasi-experimental research compares and contrasts 136 sets of drawings of handles and lamps produced in 7 trials after stimulating the neo-cortex with those produced after stimulating sub-cortical parts of the brain. The two different cognitive states produced predicted design differences: straight, small, two-dimensional drawings morphed into curvilinear, large, and three-dimensional drawings of the same objects. Implications for design pedagogy and the history of "organic architecture" are discussed.

Keywords: design pedagogy, architectural pedagogy, somatics, drawing, organic design, quasi-experimental research in design.

2. AUTHOR BIOS

Galen Cranz is Professor of Architecture, a Ph.D. sociologist, designer, author, lecturer, and certified teacher of the Alexander Technique, a system of body-mind postural education. Her research specialties are urban parks, chairs and body conscious design, and qualitative research methods. She teaches courses in social and cultural processes in architecture and urban design, including research methods. Current research activity includes body conscious design, the sociology of taste, ethnography for design, and post-occupancy evaluation. Professor Cranz is author of *The Chair: Rethinking Culture, Body and Design*, which received the Achievement Award from the Environmental Design Research Association (EDRA) in 2004. She is a founding member of the international Association for Body Conscious Design and lectures worldwide on this topic.

Leonardo Chiesi is a professor of sociology at the School of Architecture, Florence. He has been visiting scholar at the Department of Architecture, University of California, Berkeley. He is interested in research methods for design, architecture and planning. He has been involved in several architectural design and city planning projects. He has a strong interest in the subjects of local identity, community processes and participation methods.

He has written a book on the construction of scientific discourse (*Retorica nella scienza. Come la scienza costruisce i suoi argomenti anche al di là della logica*, 2009) and a book on the relationship between social sciences, architecture and planning (*Il doppio spazio dell'architettura. Ricerca sociologica e progettazione*, 2010). He has edited a collection of research material on community identity and its relationship with the rural environment (*Identità sociale e territorio. Il Montalbano*, 2009).

<http://sociology.and.architecture.googlepages.com/>

Using Visual Neuroscience and Perception to Design Daycare Centers in Belgium

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1. ABSTRACT

In the last decade, there has been renewed interest in the effects of the environment on mental health and well-being. In recent years, this interest has broadened from a focus on the external environment to include the internal environment of personal and community spaces. In a unique international collaboration between experts in visual neuroscience/perception, child development, and design, we are creating a set of visual interiors for child daycare centers in Belgium. Our designs are inspired by visual development data (including our own), showing that 1) the visual system of infants/children has a restricted range of visual sensitivities, responding best to patterns that are coarse and of high contrast, and 2) infants/children prefer to look at certain visual patterns, for example, those that are symmetrical, consist of primary colors, are textured, and contain social meaning (for example, faces). Our daycare designs are also inspired by a large body of work documenting which types of overhead lighting, colors, and visual patterns enhance mental well-being (for example, scenes from nature). Then, using industrial and product design methods, the scientific ideas are translated into practical and intuitive spaces. To test the effectiveness of these interior spaces, the well-being of infants/children will be tested before and after exposure to these spaces. Well-being will be assessed using the Vineland Adaptive Behavior Scale (VABS), a parent questionnaire that scores adaptive behaviors in infants/children (ages 6 months to 3 years), including daily living skills and socialization. For older children in the daycare center (ages 4 – 5 years), we are developing a questionnaire in which the children themselves can answer questions about aspects of their own well-being, such as their level of energy, happiness and confidence. This assessment is an adaptation of the standardized and validated Warwick-Edinburgh Mental Well-Being Scale used in adults. In addition to promoting engagement, well-being and visual development, these designs and their implementation in Belgium raise cultural awareness regarding the impacts of the environment, including community spaces, and facilitate interaction and integration between experts in the field of visual neuroscience, mental health, child development and design.

2. AUTHOR BIOS

Dr. Karen Dobkins got her PhD in Visual Neuroscience with Dr. Thomas Albright. For her thesis, she used neurophysiological methods in rhesus monkeys to investigate how the primate visual system encodes different aspects of visual stimuli, including color and motion. Since obtaining her PhD in 1992, she has been conducting studies that elucidate neural mechanisms underlying visual development in infants and children, as well as the effects of visual experience on visual development. Most relevant to the current paper, in 2002, she led a team to design Tailored Visual Environments for the “MC Corporation” based in Tokyo, Japan.

Roy Verbakel: Born in Eindhoven, the Netherlands, Roy Verbakel obtained his degree as an industrial and product designer at Design Academy Eindhoven in 2012, well known as the spill of the Dutch Design movement and mentioned by the NY Times as the most important design school in the world. He started his design business in the Netherlands and now designs products and services in Antwerp, Belgium. Roy Verbakel's work combines principles from design and embodied cognition, inspired by the idea that “poetry moves and science evolves”. His designs touch the relationship between a product and its user and the position of the user in its environment, highlighting the poetic meaning behind the primary function of design.

Dr. Gail Heyman is an expert in child development who is on the faculty at UC San Diego and at Zhejiang Normal University in China. She has investigated the roles of a wide range of environmental factors in shaping psychological outcomes among children in different cultures, including factors associated with academic success, moral reasoning, and positive relationships. She collaborated with Dr. Dobkins in designing Tailored Visual Environments for the “MC Corporation” based in Tokyo, Japan.

Making Architecture for the Multi Sensory Impaired: Presentation of Three Projects

PROFESSOR ALAN DUNLOP FRIAS FRSA

1. ABSTRACT

"Hazelwood School exceeds expectations. There is really so much to admire about it; the way the design is adapted to the site, the choice of materials, the linking of interiors to the exterior and much more. For me the complexity and avoidance of straight lines ensure constant interest and variety while still maintaining intimacy and human scale. It is the most exciting new school building in Scotland" Keir Bloomer, Curriculum for Excellence, Chair of the Higher Order Excellence Skills Group, Education Scotland

When our children leave this school, they will not go into jobs or go and live in their own flat or house- they will always need to be supported. Adults who are blind and have learning difficulties can lead passive lives. But the more independence they have, the more choices they will be able to make and the more stimulating their lives will be. The pupils move around as though they have been here for their whole life and they adapted to the school quicker than I did". Monica McGeever, Client and Head Teacher, Hazelwood School

"Alan Dunlop was commissioned as the architect for Hazelwood School following a very thorough and rigorous selection process. Hazelwood has been highly successful for children and young people with severe and complex needs and in developing their confidence and independence. I would highlight the following: the use of tactile materials to provide orientation references; the variation of wall and floor design to indicate different areas; the emphasis on maximising opportunities to allow natural light in to the building; the flexibility of internal learning spaces which allow for individual and group learning; the creation of an integrated but external garden which provides a range of activity and learning opportunities" Margaret Orr, Client and Head of Service, Glasgow City Council

"One boy had been trying to trail for years, and within a week of being here, was doing it naturally. It is a visual and tactile school". Jayne Eyre, Teacher, Hazelwood School

"A beautiful well thought out design. Every school should be like this." "This architecture takes care of the environment...takes care of the students, the children, the teachers, the parents, and contains all of them. This is a school with heart and soul" Judges Comments, Design Share: Honor Award

"If I had to pick just one highlight it would be the day I spent at Hazelwood School. The pupils at Hazelwood all have sensory impairments and pronounced support needs. We've had young people from Hazelwood in the LAB making a radio podcast and I've previously made a film about the design of their beautiful building, which is a marvel of architecture and really empowers the pupils to be independent" Claire O'Gallagher BBC

"Staff have researched methods and practice in other similar establishments and are continuing to develop methods to involve children and young people in their own learning. Young people are moving around the school with increased confidence and independence. A few children in the nursery are now walking independently and have far exceeded expectations in terms of their mobility." Maureen McKenna, Executive Director of Education Glasgow City Council

HAZELWOOD SCHOOL, GLASGOW, UK

Hazelwood is a state school for the teaching of life skills to children and young people with severe and highly complex needs. It sits in a park land setting within a clearly defined neighbourhood and building conservation area, to the south of Glasgow. A competition to select an architect was organised by Glasgow City Council and six were invited to submit initial ideas for the design of the school and present their approach to its development on the parkland site. The shortlisted architects had to show clearly that they understood that this was a special project, for a particular client group which was also likely to generate much interest from the local community. GCC considered that the commission demanded a full time commitment from the chosen architect, who could design with sensitivity and imagination and meet the needs of the teachers, pupils and parents but also respect the amenity of the surrounding neighbourhood. The competition was won by Alan Dunlop.

The school caters for 54 students with multiple disabilities, aged from 2 to 19. Each student has a combination of two or more of the following impairments: acute visual impairment, hearing impairment, mobility or cognitive impairment. All the pupils are autistic, they will never be able to lead totally independent lives and each will require lifetime support. This range of complex clinical needs made Hazelwood an extremely challenging project, involving detailed pre-build analysis, development and discussion with client groups, teachers and children over a period of 14 months.

That said, the pupils who attend the school have the same social needs as others and have parents, carers and educationalists determined to support their aspirations. As the architect, I was committed to the idea of a building that could promote a real sense of independence for the pupil and a design of a place of safety and ambition that would support the child and free the teacher.

The Hazelwood school design focuses on creating a safe, stimulating environment for students and staff. I set out to eliminate any institutional feel and worked to avoid conventional thinking on school design. My aim was to create a bespoke building that designed out long dark corridors and maximised levels of natural light and incorporated visual, sound and tactile clues. I believed that even the smallest feature of the architecture could also be conceived as a learning aid.

Ease of navigation and orientation through the building was critical for the pupils. Internally the concept of a trail rail was developed, which doubled as a storage wall. This allowed the children to move around the school with a greater level of freedom and independence. The wall is clad in cork, which has warmth and tactile qualities and provides signifiers or messages along the route to confirm the children's location within the school. The school has been designed to deal with very specific issues whilst ensuring an architectural quality. It is a building that will not only support the senses but act as an environment that stimulates the imagination.

Classrooms lie along the northern quiet, edge of the site, overlooking verdant play spaces. The school steps and curves around the existing beech trees to create a sequence of safe, landscaped teaching gardens. High level clerestory glazing forms a substantial part of the façade of the north-facing classrooms, allowing for maximum daylight to penetrate deep into the spaces and ensuring even distribution of light. Storage boxes, two and a half metres tall, create a solid wall below the clearstory glazing; this reduces external visual distraction, highlighted by teaching staff as a significant cause of loss of concentration levels in some visually impaired students.

Hazelwood School has been a real success. The pupils respond well to their new environment and make the most of the school and its facilities. The children are thriving and this is testimony to the love of their parents and the dedication and expertise of their carers and teachers. The building represents a successful conclusion to an intense four-year design, consultation and construction process, involving parents, teachers, clinicians and the children themselves. It is the built embodiment of this care and the aspirations of all who responded to the need of the pupils.

Lessons learned in Hazelwood have been carried through in the design of new projects for young people with special needs, including autism and particularly designing to encourage free movement and to establish a sense of independence for the pupils while ensuring a safe and secure learning and living space. The response from teachers, educationalists, clinicians, support staff, parents and the pupils to the design of Hazelwood confirm that young people with severe and complex needs and who can be disoriented and confused easily and whose behaviour can deteriorate with boredom and anxiety to the point of aggression, can be helped to manage these negative characteristics by a supportive physical environment provided by sensitive architecture and careful design.

2. AUTHOR BIO

Alan Dunlop is a leading architect, urban designer and a respected educator. He is a Fellow of the Royal Incorporation of Architects in Scotland and the Royal Society of Arts. Professor Dunlop has an international profile and has completed a successful term as the Distinguished Victor L. Regnier Visiting Chair in Architecture at Kansas State University and as the Mahlum Endowed Lecturer at the University of Washington. He is currently Visiting Professor at Robert Gordon University, Scott Sutherland School of Architecture and External Examiner at XJTLU School of Architecture, Suzhou, China. He has taught at schools of architecture in USA, UK, China and in Germany and also lectured internationally.

Diffusion Of Innovation: Neuroscience & Architecture From Pedagogy To Practice

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Introducing instructional strategies for linking neuroscience and architecture resulted in willingness by students in several postsecondary architecture programs to consider these principles in their own work. Post-course discussions and surveys indicated that learning in the context of a neuro-architectural conceptual framework and using universal design objectives offered opportunities for students to think and create their designs in a more comprehensive way that incorporated sensory processing, space perception, and cognition. Using the diffusion of innovation as a model to examine how individuals and organizations begin to practice in new ways, offers a lens for examining change and building a community of practice.

1. EXTENDED ABSTRACT

1.1. BACKGROUND

The intersection of neuroscience and architecture offers to build a community of practice who support, encourage and teach each other to use rigorous research from neuroscience, informing design innovations for the benefit of all. Individuals and organizations make the choice to adopt an innovation based on their perception of the merits of the innovation itself, communication, time, cost, risk or limitations, and the social system (Cheng, Kao, & Lin, 2004). We looked at a process that includes innovation, teaching, and adoption as a change phenomenon, exploring those qualities most likely to successfully spread the use of neuroscience and architecture in professional practice, research and pedagogy. Neuroscientific principles relating to sensory processing, space perception, and cognition are applied to design projects for learning and health in clinical populations including those with autism, multiple sclerosis, and sensory or learning disorders.

1.2. PEDAGOGIC PROTOCOLS

Pedagogic studies in design studios and architecture, planning, or landscape lecture courses at four universities or colleges, and the Berkeley Prize study incorporated a pragmatic approach that integrated neuroscience and 'research-based design'. A practice-based protocol for critical analysis and translation of rigorous findings into human-centered design principles merged disciplinary frameworks (Edelstein, 2013). Examples include analysis of clinical and physiological studies of the environmental responses of people with multiple sclerosis, autism, and those with specific hearing, ambulatory, visual, or learning needs (Edelstein & Sax, 2013).

1.3. SURVEY FINDINGS

Surveys and discussion groups revealed how student attitudes changed as a result of the pedagogical strategies. A post-course survey was completed by the Berkeley Prize 'neuro-universal' studio by 17% (11 of 63) of the students. Using a 5-point scale (Strongly agree = 1; Agree = 2; Neither Agree or Disagree = 3; Disagree = 4; Strongly Disagree = 5), eight questions probed how students thought about design, and how the experience of the class influenced their thinking. Ninety percent (n=10) of the students strongly agreed or agreed that "These experiences made me think about designing for people with a broad range of abilities." Seventy-two percent (n=8) strongly agreed or agreed that "These experiences made me think about how my senses, movement, emotion, and thinking change with design." Eighty percent (n=8) strongly agreed or agreed that "These experiences influenced the design of my studio projects." Ninety percent (n=9) strongly agreed or agreed that "These experiences will influence how I design in the future. Students revealed the positive impact of the neuro-architectural conceptual framework, and universal design objectives in their responses to open questions: "I had a much broader range of considerations after these experiences; I began thinking about all the senses and not just physical mobility or blindness." Another student commented "UD is no longer an afterthought... the goal is now imbedded into initial sketches... before any hard lines are drawn."

1.4. CONCLUSIONS

We examined this approach in the context of a strategy for change, exploring qualities most likely to make innovation spread successfully. Professional adoption of a 'neuro-architectural' approach is discussed, based upon efforts to change the 'design product or process' rather than 'persuading individuals' to change. Strategies for the adoption of such principles in accredited architectural courses and professional practice is considered in the context of the United States, Canada, China, and Ireland. The importance of peer-to-peer conversations, networking, and iterative interaction among architecture students, educators, and individuals with disabilities are explored. In undertaking an approach that yields a diffusion of innovations, "it is not people who change, but the innovations themselves" (Robinson, 2009).

ACKNOWLEDGMENTS

We wish to thank colleagues from the University of California Berkeley Prize, the Academy of Neuroscience for Architecture, the American Institute of Architects, and collaborators at the Interwork Institute, College of Education, San Diego State University, the University of Arizona, University of California San Diego, and the NewSchool of Architecture and Design for support and partial sponsorship of this work.

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3. AUTHOR BIOS

Eve A. Edelstein, MArch, PhD, EDAC, AssocAIA, F-AAA, Associate Professor, University of Arizona (UA), Tucson AZ

Dr. Edelstein is a Teaching Fellow for the 2013 Berkeley Prize in Universal Design. She holds degrees in Anthropology (UC Berkeley), Architecture (NewSchool of Architecture & Design) and Neurophysiology (University London), and conducted clinical research at the National Hospital for Neurology & Neurosurgery, London UK, the Harvard/MIT Hearing Lab, the US Naval Medical Center, and California Health Services. Her work as Senior Vice President, HMC Architects, President of Innovative Design Science and Principal Investigator, 2005 Latrobe Prize, informed built projects for the Canadian Ministry for Health, University of California San Diego, and a 2.4 million square foot hospital in China, winner of an AIA AAH International Award. At UC San Diego, her research yielded novel intellectual property for eye-tracking, and real-time sound and visual CAVE simulations focused on medical error. At UA, Dr. Edelstein is developing professional / degree programs and cross-disciplinary courses in neuro-architecture and healthy design for architecture, landscape architecture, planning AND real-estate development.

Caren L. Sax, Ed.D., CRC, Professor/Chair, Department of Administration, Rehabilitation, & Postsecondary Education (ARPE), Co-Director, Interwork Institute, San Diego State University

Dr. Sax teaches about assistive technology, disability policy, interagency/interdisciplinary collaboration, and educational leadership. Her research is based on providing access and opportunities for persons with disabilities and non-traditional learners. The Interwork Institute serves as the organizational structure for extramural funding related to diversity, transition from school to adulthood for individuals with disabilities, systems change, rehabilitation and higher education leadership and administration, and access to employment and postsecondary education, at local, state, national, and international levels. Dr. Sax has chaired the International Technology and Persons with Disabilities Conference in San Diego for the past two years, highlighting work in universal design for learning and access to postsecondary education.

The Psychology of Architectural and Urban Design: Sensor-Based Field Methods Based on Guided Walks

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New tools using smart phones and simple non-invasive sensors provide opportunities for the exploration of person-place interactions in field settings. In several experiments employing such tools, we have explored the physiological and emotional reactions of participants walking through the urban scale built environments in several different types of cityscapes. Our main findings suggest that both collative variables such as complexity and more molar elements of urban design such as views of nature and façade permeability exert considerable influence on both our state of arousal and our affective reactions to place. We conclude that field-based methods using such tools provide a powerful method by which built designs can be assessed for psychological impact.

1. EXTENDED ABSTRACT

The advent of new types of tools for exploring person-place interactions at deep biological scale presents many opportunities to advance theory in areas of environmental psychology closely allied with neuroscience. These tools can also provide powerful new applied methods for enhancing the fit between built settings and human biology and brain function. In the Urban Realities Laboratory at the University of Waterloo, we have been developing a set of tools that can be applied to a wide range of design problems at a scale extending from building interiors (Dzubic & Ellard, 2013) to urban streetscapes (Ellard & Montgomery, 2013). These tools include both location-aware smart phone applications that can be used to poll an observer's psychological state by means of a battery of self-assessment questions, and physiological instruments that can record geo-tagged indices of arousal and engagement such as heart rate, skin conductance, EEG and patterns of eye movements. In our presentation, we will illustrate the power of this approach by means of several case examples in which participants were led on guided walks through urban settings in Waterloo, New York City, Berlin and Mumbai. The walks were designed in such a way as to explore the influence on human response of collative environmental properties such as complexity and mystery, and also to assess the impact of commonly considered elements of urban design such as views of nature and façade permeability. Views of nature produce decreased levels of arousal and increased levels of positive affect even when such views are fragmentary and when they are embedded within greater contexts that might be expected to produce negative associations (cemeteries and hospital grounds). Closed facades containing low levels of complexity and activity produce low levels of arousal and negative affect, whereas open facades with higher levels of complexity and activity produce higher levels of arousal and of positive affect. Generally, increased complexity appears to be associated with higher arousal and positive affect. Interestingly, in some cases the response to the appearance of a built setting is mitigated by a participant's familiarity with the narrative of a setting. Specifically, visitors seeing a setting for the first time show responses that differ from those who have long familiarity with a setting. Overall, our findings suggest that many of these variables, even in a complicated and dynamic field setting, exert an influence on preference and emotional state and also have a profound impact on physiological response. We will argue that an integrated approach, based on ecologically valid field methods, can not only bolster laboratory findings from simulated environments (Valtchanov et al., 2010), but can also offer a useful approach to practical problem-solving in architectural design.

ACKNOWLEDGMENTS

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3. AUTHOR BIOS

Colin Ellard: The presenting author is a cognitive neuroscientist in the Psychology Department at the University of Waterloo and director of its Urban Realities Laboratory, which employs a combination of field methods and laboratory methods using immersive virtual reality to problems and questions in environmental and architectural design.

Vedran Dzebic: The second author is a senior graduate student in the Urban Realities Laboratory with expertise in field methods in architectural psychology and the use of immersive simulations. Dzebic was a presenter at ANFA 2012 and his work was subsequently selected for publication in Intelligent Buildings International.

Investigating the Effects of Sensory Cues on Sustainable Decision-Making and Pro-Environmental Purchases

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The subconscious effects of architectural factors on human behavior have rarely been examined. The results of three experiments suggest that subtle auditory, olfactory and tactile stimuli in a built environment affect the decision-making process by means of the mere exposure effect. It is shown that exposure to pleasing sensory cues associated with nature and undesirable cues associated with industrialization leads to an increase in occupants' tendency to act sustainably and to choose pro-environmental consumer products.

1. ABSTRACT

Recently, there has been growing literature on the effects of environmental factors on individual's behavior and factors in the built environment that exert subconscious influence on human behavior (e.g., Williams & Bargh, 2008; Ackerman, Nocera & Bargh, 2010; Ulrich, 1984; Dijksterhuis, et. al, 2005, Meyers-Levy & Zhu, 2007; Schnall, Roper & Fessler, 2010; Schnall, 2011). Such factors may, in fact, have a large impact on judgments and decisions because they are often beyond conscious awareness and people typically cannot block out, control, or avoid them (Krishna, 2009, 2012; Wansink & Chandon, 2014). However, there is little research on the role of such factors on pro-environmental judgment and decision-making. Identifying such factors would be crucially important in understanding people's behavior and decision processes in real-world circumstances. Towards this means, the current research project draws on literature in cognitive science, marketing research and architectural studies. Motivated by current research across these fields, we argue that subtle sensory attributes in a physical environment may affect the decision-making process by means of the mere-exposure effect - the phenomenon that exposure to a stimulus affects preference for the stimulus (Zajonc, 1968). Here, it is proposed that individuals exposed to subtle sensory cues associated with sustainability will misattribute perceptual fluency to preference for sustainable products when they are not aware that the fluency is, in fact, the result of exposure to the sensory cues. The empirical research investigates three aspects of sensory environment using auditory, olfactory and tactile stimuli.

In study one, it was hypothesized that being exposed to pleasing natural sounds (e.g., bird's singing), due to a positively-valence association with sustainability is more likely to subconsciously nudge users to choose pro-environmentally compared to pleasing man-made sounds (e.g., Opera vocals) or no sound (control condition). All sounds were pretested for affective valence and associations with nature versus industrialization. Negative natural versus man-made sounds were also studied. It is argued that undesirable sounds associated with industrialization (e.g., construction noises), due to negatively-valenced association with unsustainable behavior, may also promote pro-environmental behavior more than undesirable natural sounds (e.g., annoying animal noises) or no sound. 150 students at a large public university participated in this experiment; 30 participants were randomly assigned to each of the cells in a 2 (valence: positive or negative) x 2 (source of stimuli: natural or man-made) and control condition.

A two-way analysis of variance demonstrated that the average amount of budget allocated to green products was higher for those in the pleasant sound condition ($M = 12.1$, $SD = 2.8$) compared to those in the unpleasant sound condition ($M = 9.6$, $SD = 2.7$; $F(1, 145) = 4.61$, $p < .05$). The main effect of source was non-significant ($p > .2$). However, there was a significant interaction between valence and source $F(1, 145) = 13.01$, $p < .001$, indicating that pleasant sounds led to more green purchases when they were natural, and unpleasant sounds led to more green purchases when they were man-made. Two follow-up studies replicated this interaction effect between affective valence and source using olfactory and tactile stimuli.

The main intention of this project is to demonstrate that sustainable behavior is more tightly connected to our physical surrounding than previously thought. Emphasizing subtle environmental attributes in this project will also provide insight into multimodal sensory interaction mechanisms that affect sustainable behavior. By understanding these mechanisms, spaces may be designed favorably to alter the sensory input and thus create an environment conducive of pro-environmental decision-making.

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3. AUTHOR BIO

Sina Esteky is a multidisciplinary researcher with expertise in design research and consumer research. He has spent time as a practicing architect, an economic consultant, an autism scholar, and most recently as a researcher and doctoral student in both Architecture and Business Administration at the University of Michigan. He received a M.Sc. in Architecture with a minor in psychology from the University of Michigan in 2011 and a B.Sc. in Architectural Engineering in 2009.

Sina's work mainly focuses on the influences of architectural design on consumer behavior. On a broader horizon, he is interested in studying how contextual and sensory factors influence human perception, cognition, judgment and decision-making.

Posttraumatic Understanding: The Connections Between Posttraumatic Stress and Environmental Design

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Memories of a traumatic event are processed and stored uniquely in the mind, disassociated from all other memories. Stimuli reminiscent of a person's trauma can trigger a unique response in a person suffering from PTSD, however, psychotherapeutic treatments can facilitate restoring the mind to health. This research hypothesizes a correlation between principles of sensory processing and principles of environmental design to improve efficacy of cognitive-behavioral treatment for veterans with PTSD.

1. ABSTRACT

Veterans of the U.S. Armed Forces are ethnoculturally, socioeconomically, and geographically diverse, but unified by the military's standardized training, which affects perception as well as emotional reactions. Posttraumatic stress disorder (PTSD) can be caused by any trauma, but is particularly acute in military veterans. PTSD causes semi-permanent changes in perception and memory recall resulting in altered reactions to environmental stimuli. Design of the built environment has the potential to support comprehensive rehabilitation by being both sympathetic to this altered state and conducive to healing.

In the broadest sense, a trauma is a learning event that affects one's perception of the world and their perceived ability to function within it. When a person is experiencing PTSD symptoms, their brain is over interpreting real-time stimuli and associating it with the context of their trauma, which only exists as a memory (Schiraldi, 2009).

PTSD is a psychological disorder for which the primary treatment for permanent resolution is psychotherapy. The objective of treatment is to change the patient's reaction to the trigger of their symptoms and/or memory of their trauma. The two most widely-accepted therapies are Prolonged Exposure Therapy (PET) and Cognitive Processing Therapy (CPT). Both involve cognitive-behavioral restructuring and controlled exposures to one's trigger and/or traumatic memory. Treatment can be very taxing on the mind and body, but ongoing practice reduces the anxiety reaction over time. Furthermore, Vega (2013) argues the built environment has potential to aid the caregiver in administering treatment by helping focus the patient's efforts in the right areas, with less wasted effort.

Existing related theories include human-centered design, which Greenhouse (2012) defines not as a style, but a process for designing based on the physical and psychological needs of the human user, enabling the user to function at the highest level possible. Furthermore, considering the pursuit for higher return on physical and mental efforts, Kirsh (1996) theorizes we have only three options: adapt ourselves to the environment, migrate to a new environment, or adapt the environment.

This research hypothesizes a correlation between principles of sensory processing and principles of environmental design to improve efficacy of cognitive-behavioral treatment for veterans with PTSD.

Research Methods

1. Review of existing literature on related design theories, PTSD, PTSD treatments, and cognitive processes of perception, processing, and reactions to environmental stimuli.
2. Collaboration with experts in the fields of psychology and human factors engineering.
3. Hands-on review of United States Marine Corps (USMC) observational techniques for identifying and prioritizing threats in indoor and urban environments.

To adapt the environment for improving outcomes of PTSD treatments, we must start by acknowledging that PTSD is highly complex and multifactorial, involving many psychological and physiological processes. Further still, all of the body's systems require appropriate amounts of energy to function efficiently; to attain balance, we want to reduce the amount of energy consumed by processes that are unnecessarily overactive. Efforts made to facilitate recovery should make efficient use of the patient's energy and be considered part of a comprehensive treatment plan. With this in mind, we can explore how to facilitate healing by reducing the energy required to process and navigate the therapeutic environment, allowing

more resources to be available for undergoing psychotherapy.

USMC observational techniques provide a highly refined, thorough, and systematic approach to how a person's natural abilities can be utilized to gather information about their surroundings. These are most likely the same behaviors exhibited by a person experiencing hypervigilance from PTSD and should be considered during the design process.

The built environment can't solve PTSD on its own, but it can help. A reduction in the cognitive load of an environment moderates the energy required to process, orient and navigate within a space. Reducing environmental complexity may help prevent the patient from becoming easily distracted and reduces the probability of being unnecessarily exposed to one's trigger, as this would ideally occur initially in a controlled, deliberate, and constructive manner. The cumulative effect of these design decisions stands to help the patient achieve their best mental state for psychotherapeutic healing.

This research represents the first step of a larger investigation into the connections between posttraumatic stress and environmental design. Because this topic is highly complex, this study primarily focuses on visual contributing factors. Non-visual cues, such as olfactory, tactile, and acoustical sensations, must be incorporated to make this study comprehensive. Future development of this research must also incorporate further collaboration with experts in the fields of psychology, neuroscience, and human factors.

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3. AUTHOR BIO

Matthew Finn is a licensed architect and recipient of Perkins+Will's competitive research grant program Innovation Incubator. Matthew is professionally driven to pursue his passion for design and research to facilitate socially responsible works for the welfare of society and the environment. Matthew is an active member of the Atlanta architectural community, volunteering regularly with his alma mater and serves on the Board of Directors of the Architecture Foundation of Georgia. Outside of work Matthew enjoys spending time with his wife, Stephanie; personal interests include living a fulfilling and balanced life, soccer and photography.

2013 Hay Award Team Presentation: Vision Science for Dynamic Architecture

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Salk Institute; University of Southern California; University of California at Los Angeles

1. ABSTRACT

The relationship between the person and the built environment is dynamic. This dynamism unfolds over many spatial and temporal scales. Consider the varying viewing distances and angles of observation, and also the built environments that contain moving parts and moving pictures. The architect wants to predict human responses for the full range of these possibilities: a daunting task. We study how this challenge can be reduced using the systematic understanding of perception by sensory neuroscience.

Our starting point is the basic fact that human vision is selective. It is exceedingly sensitive to some forms of spatial and temporal information but is blind to others. A comprehensive map of this selectivity has been worked out in the tightly controlled laboratory studies of visual perception, where the subject responds to stimuli on a flat screen at a fixed viewing distance. We translate this map from the restricted laboratory conditions to the scale of large built environments.

Using a pair of industrial robots carrying a projector and a large screen, we created the conditions for probing the limits of visual perception on the scale relevant to architectural design. The large dynamic images propelled through space allowed us to trace boundaries of the solid regions in which different kinds of visual information could or could not be accessed. For this initial study, we concentrated on several paradoxical cases, such as the diminished ability to pick visual information as its source approaches the observer, and the abrupt change in visibility following only a slight change in the viewing distance.

In summary, we created a versatile measurement platform for mapping the spatial and temporal boundaries of perception in large spaces, for the forthcoming case studies in architectural and urban design, and for experiments in virtual architecture, mixed reality, and immersive cinema. Against the backdrop of a long and venerable history of “rationalization of space,” from the early drawing systems to the invention of perspective and moving pictures, our study makes a case for the transition from research of representations of space to research of space that contains representations.

2. AUTHOR BIOS

Sergei Gepshtein, Ph.D. is a scientist at the Salk Institute for Biological Studies, trained in neurobiology, cognitive psychology, and vision science. Before joining the Salk Institute, Sergei investigated stereoscopic vision and the interaction of vision and touch at UC Berkeley. He studied the computational principles of perceptual organization (a modern incarnation of the inquiry originated in the Gestalt movement) at RIKEN Brain Science Institute in Japan. His current research concerns visual norms (whose role in perception is similar to the role of laws in physics) and the question of how vision is used for prospective control of action. Sergei is increasingly involved in developing new methods of perceptual continuity for immersive environments and cinema.

Alex McDowell is one of the most influential designers working in narrative media, with the impact of his ideas extending far beyond his background in cinema. With over 30 years of experience in narrative design, he advocates an immersive design process and the key role of world building in storytelling. Alex is teaching at the USC School of Cinematic Arts, Interactive Media Division and Production, with classes on world building and transmedia, and he was a Visiting Artist at MIT's Media Lab. He is a co-founder and the creative director of the 5D Institute - a global series of distributed events and an education space for an expanding community of storytellers in industry and academia - and the 5D Organization, which is devoted to building tangible worlds and immersive narratives.

Greg Lynn is an architect well-known for redefining the medium of design with digital technology and pioneering the fabrication of complex ergonomic forms using numerically controlled machinery. Because of his early combination of degrees in philosophy and architecture, Greg has been involved in combining

the realities of design and construction with the speculative, theoretical and experimental potentials of writing and teaching. He is a Studio Professor at the UCLA School of Architecture and Urban Design, where he is developing an experimental research robotics lab. He has been the Davenport Visiting Professor at Yale University for more than a decade.

A Study of a Neuro-Architectural Approach to Create Salutogenic Environments for Children Diagnosed with Autism

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M PHIRI, AND M L ROBINSON

1. ABSTRACT

1.1 BACKGROUND

The rationale for neuro-architecture acknowledges the latest developments in neuroscience and their potential architectural applications. Creating suitable environmental conditions architects may design stimulating places, which provide the sensory experiences that produce optimal brain responses as evidenced by improved memory and strengthened cognitive functioning.

1.2 RESEARCH QUESTIONS:

What are the environmental stimuli that produce optimal brain responses to improve the quality of life of children diagnosed with autism? How can stimuli be established to aid the design of learning environments for these children?

1.3 METHODOLOGY

The first of three studies identifies and structures knowledge from published studies on neuroscience/neuro-architecture. For example, neuroscience shows that the constant noise, harsh lighting of healthcare environments can interfere with the early development of a baby's visual/auditory systems. The critical literature review and comparative analysis are conducted to discover primary research, which indicates the impact of the neuro-architectural interventions on outcomes. The first study identifies architectural stimuli that support health/wellbeing as opposed to those that cause disease. Using recently purpose-built schools (Lahore Oasis School for Autism and Jeddah Autism Centre), the second study conducts an empirical investigation of the key architectural factors. The third study develops a framework to help designers evaluate the extent to which learning environments meet needs of autistic children.

1.4 FINDINGS

The research identifies variables, which represent the different types of environmental stressors that inhibit learning or affect cognitive functioning in children diagnosed with autism.

1.5 CONCLUSIONS

The research develops a framework for helping designers to create and maintain sustainable learning environments with improved outcomes for these children. Specifically, the neuroscience-informed "salutogenic" model emphasises the interrelationship between health, stress and coping.

1.6 KEYWORDS

Neuroscience, neuro-architecture, autism, environmental stimuli, cognitive functioning

2. AUTHOR BIOS

Ayesha Ghazanfar has a bachelor's in arts from the National College of Arts (1999), in Lahore, Pakistan, and a professional diploma in interior design (2005), from International Academy of Design and Technology, in Toronto, Canada. Having worked on several healthcare projects in Pakistan and Canada, she is currently perusing her PhD studies at Sheffield University, in England, and also teaching at Daral Hekma University in Jeddah, Saudi Arabia.

At Sheffield University, her studies are being conducted with the Healing Architecture Research Group, directed by Dr. Michael Phiri. The title of her thesis is "A study of neuro-architectural approach to architectural design, and creation of sensory-rich salutogenic environments for neurologically dysfunctional children diagnosed with autism."

Ayesha was the recipient of honors award for outstanding interdisciplinary research & concept design at the National College of Arts, for her final project "Therapeutic Learning Environment for Autistic Children." In Canada, she received the Health Care Design award from ARIDO (Association of Registered Interior Designers of Ontario) in 2005, and was also chosen for the Academy's President Honor award. In April of 2009, the American Association of University Women (AAUW) awarded her a doctoral fellowship.

Acoustics in Architecture: Are We Thinking Too Simplistically?

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1. ABSTRACT

Research in architectural acoustics and the auditory system is usually oriented toward quantifying aspects of our perception, mostly related to speech intelligibility and spatial perception. The parameters so derived underpin our present understanding of concert hall acoustics as well as LEED, ANSI, and ASHRAE standards. Acoustic fundamentals (reverberation, background noise, and sound isolation) are expressed in simple metrics which have brought meaningful gains in the quality of our buildings, at least those to which the standards apply. Yet there remains an unexplored world of subtlety in the aural/auditory realm, our means of keeping track of tiny, unseen events that, in an evolutionary context, might mean either the next meal or an abrupt departure from the gene pool – the stakes were (and are) high, and the resulting acuity impressive.

LEED, ANSI, and ASHRAE all promote speech intelligibility, or clarity, in rooms that also minimize distraction and noise-induced stress. In the world of music acoustics, however, we also regard intimacy, presence, and immersion as the foundations of a strong performer/audience connection. These lesser-known characteristics surely enhance any form of human interaction but are largely absent from our evaluation of the classrooms, living rooms, and offices where we spend the greatest portion of our lives. If acoustics are considered at all in these spaces, it is usually in the vocabulary of absorption. Acoustical tile, acoustical plaster, and fabric-wrapped fiberglass absorb problematic sound, but do they perpetuate a simplistic architectural language that ignores a primal, physiological craving for complexity?

This presentation compares modern interiors with the outdoor environments where our hearing evolved. The differences are stark and beg greater understanding: In the context of LEED -compliant spaces, to what physiological needs are we still not responding? For example, would mimicking the forest canopy in a classroom ceiling (it would not be that difficult) heighten attentiveness or cognition? How might neuroscience help investigate the role of architectural complexity in our aural well-being? How might material science and new fabrication technologies translate that knowledge into buildings that enhance the clarity, intimacy, and presence of our everyday communication and, thereby, the quality of our lives? There is so much to learn and so much room for improvement.

2. AUTHOR BIO

Carl P. Giegold could be found haunting construction sites at the age of seven and by high school had settled on architecture as his pursuit. He earned a Bachelor of Architecture with honors from Virginia Tech in 1982 and specialized in acoustics in 1995 after exploring restoration, residential, and institutional architecture. This broad background in design and technical architecture adds great depth to his consulting in acoustics. He has carried design responsibility for scores of music and theater performance and educational spaces in the United States and internationally.

He is a Fellow of the American Institute of Architects and has presented his work and writings at conferences held by the Acoustical Society of America, Illinois Chapter of the Green Building Council, the Institute of Acoustics in the United Kingdom, and Ryerson University in Toronto. He has lectured architectural and acoustics classes at Rensselaer Polytechnic Institute, Virginia Tech, Illinois Institute of Technology, The University of Illinois, and Cambridge University.

Visualizing the Invisible: Spatial Manipulations of the Olfactory Sense

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1. ABSTRACT

Over the past three decades, architecture has become a product of advertising. Instead of stimulating through spatial experience, buildings have been reduced to a stream of visual images flattened by the speed of modern technology. As a result, the profession has become marginalized as nothing more than art, suited purely for the pleasure of the eyes.

This research aims to challenge this obsession with the eye by refocusing on the nose. As an Architect and Cognitive Scientist, we seek to explore collaboratively the relationship between our "hidden" sense of smell and the spaces we inhabit.

The olfactory sense is oftentimes mysterious due to its intangible properties and a lack of proper and descriptive vocabulary. However, it is also the sense that is tied most strongly to memories and emotions due to the direct connection between the primary olfactory cortex, where olfactory information is first processed, and the limbic system of the brain, where memories are formed and emotions processed. Thus, odorant stimuli are better able to conjure up an array of memories and emotions, compared to visual or auditory stimuli.

This unique, close association between olfaction and emotion provides a possible, promising method to improve or even manipulate people's emotional and cognitive states using their sense of smell. As scent is ever-present when we navigate spaces, we aim to examine the association between olfaction and the perception of space. Architects are often concerned with choreographing a spatial experience that is memorable and desirable. In doing so, they pay particular attention to light, color, and sounds present in a space, overlooking our most emotionally connected sense. In this research, we study the neurological effects of a series of scents along with investigating methods of containing and dispersing these aromas in relation to building form, in order to spatially manipulate our sense of smell and compose a desired cognitive experience.

2. AUTHOR BIOS

Avideh Haghighi. Avideh is an architectural designer interested in the intersection of science and architecture. She seeks to explore the overlapping relationship between human factors, sustainability and building science in architecture. As a student at Woodbury University School of Architecture, she was often intrigued by the concepts of perception of space and the neuroscience associated with it. Her research on this topic began as a part of her undergraduate thesis and since then has developed into a more focused exploration of sensory spatial experiences. Currently working on educational and civic projects at PJHM architects, Avideh hopes to develop a career equally rooted in practice and multi-disciplinary research.

Anousheh Haghighi. Anousheh is currently a junior researcher at the UCI Computation of Language Laboratory, where she studies linguistic cues to authorship and the relationship between language acquisition and neuroscience. In the past, she has worked with the team at the UCSD Research on Autism and Development Laboratory, where she has conducted EEG experiments and various cognitive tests on children with ASD (Autism Spectrum Disorder). She is interested in researching the effects of different sensory stimuli on our emotional and physical health. Her study is focused on the cognitive science of perception and sensation, especially as it relates to the neuroplasticity of behavior and cognition and the ways in which it can help people with particular cognitive disorders, such as Autism Spectrum Disorders. This research has enabled her to study the specific neuroscience of olfaction and the effects of different olfactory stimuli on mood and emotions.

Urban Sound Planning And Design – An Emerging Transdisciplinary Field Of Research And Practice

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Today, creative and design-oriented strategies for working with the qualitative aspects of urban sonic environments are an underdeveloped knowledge-field and hence an unused source of information in the working hands of architects, urban planners and other environmental experts. The interacting co-existence of sound, space and the human mind is still a neglected topic of inquiry in our visually dominated world. Specific tools, tactics and strategies needs to be defined, developed and further refined to enhance the conditions for managing supportive, restorative and sustainable urban sonic environments where the life-quality and well-being of urban dwellers are increasingly taken into account. It is certain that a transdisciplinary knowledge development is required to proceed in this direction; from the broad field of architecture, planning and design to the specifics of neuroscience.

1. EXTENDED ABSTRACT

1.1. BACKGROUND

On an academic and practice-based level research and professional competence have hitherto mainly dealt with the physical and measurable aspects of sound. The focus has often been on the negative effects of noise and how to protect us from hazardous sound-exposure through the construction of aural fences and buffer-zones of different scales, from ear mufflers to sound-absorbing construction elements or protecting walls, in order to hinder the transmittance of unwanted sound waves to reach our ears, bodies and minds. One prominent tendency of our time is that we continuously extend the knowledge of how to deal with the problems of both indoor and outdoor sounds but do not have the equivalent competence in regard to how to work with the complexities and qualities of urban sound from a creative and design-driven perspective. We still lack important insights and means to deal effectively with this subject matter in architecture and urban planning practices on an everyday basis.

Some scholars claim that we need acoustic city-planners who are responsible for the overall sound-planning of a city; an expert who is active in developing and implementing concrete action-plans to improve the sound quality of urban environments and raise the general sonic awareness among inhabitants (Hellstrom, 2003). This is not only an intriguing thought but actually is a scenario that doubtlessly will be realized in a near future just because our steadily urbanizing world is getting louder every day and requires stabilization. But still, practical and specific guidelines are needed that includes a profound and transdisciplinary competence concerning the sonic material itself and its connection to the complexity of human experience, if we want to get operational.

1.2. METHODS FOR QUALITATIVE SOUND ANALYSIS - A STEP TOWARDS URBAN SOUND DESIGN

One entry point to this topic of inquiry is through the exploration of means of communication as a way to understand the particularities of sound, space and perception. Being able to share a communicative platform is central to the field as this emerging field of research and practice in the long run will gather competences from diverse professions.

In my doctoral research-work I have sought for and explored various methods for describing urban sonic space with the intention to develop strategies for thinking and action that may have relevancy for spatial and design-driven practices (architecture, urban planning, landscape design etc.). The work has an interdisciplinary approach as it blend various categories of information; qualitative and quantitative, visual and aural, written and non-verbal descriptions in an elaborative and unconventional manner where a great deal of emphasis is put on the communicative aspect (see illustration below of some of the active tactics used in the project) of the spatial and sonic characteristics of an urban district in Stockholm, Sweden.

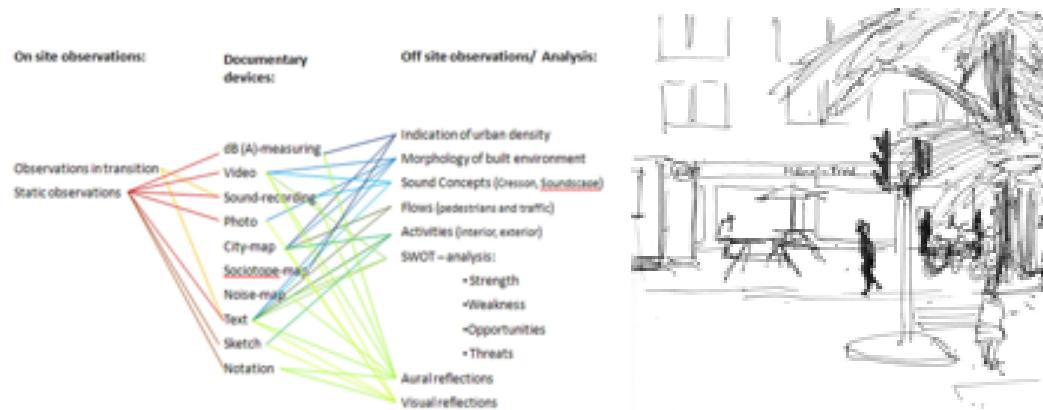
1.3. FUTURE RESEARCH

The fact that we are neurologically affected by the character and quality of the everyday spaces we continuously are moving through is today unquestionable. The question is: in what way? One challenge, as I see it, is to connect studies on urban sonic space with studies of neurological processes in order to find

out more about how we react on complex sonic stimuli while experiencing contrasting and various sonic environments of a given urban context.

For example; which are the neurological reactions and processes in the brain of a person exposed to disparate sonic qualities of a dense urban situation while moving through that particular space, compared to someone experiencing a homogenous and unchanging sonic entity of that same dense urban situation? In short, can we study the intricate relation between sound, urban space and the human mind by eliminating the boundaries between architecture and neuroscience?

1.4. ILLUSTRATIONS



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3. AUTHOR BIO

Nina Hallgren holds a Master in Architecture from The Royal Institute of Technology, KTH School of Architecture and the Built Environment in Stockholm, Sweden. She graduated from KTH in 2008 with the diploma work Transforming Urban Space - the loss and reconstruction of sound and identity, in which she explored the intersection between architecture, sound, identity and cultural meaning in relation to an extinct neighborhood in the outskirts of Barcelona, Spain. In 2009 she began her doctoral studies at KTH School of Architecture in collaboration with Konstfack University College of Arts, Craft and Design. Her dissertation project Urban Sound Design – methods for qualitative sound analysis, search an integrative understanding of urban sonic space by developing methods for qualitative sound analysis as well as proposing creative strategies for urban sound planning and design.

Will ‘Good’ Architecture Make Us More Creative? Examining the Role of Place in Creative Cognition

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1. ABSTRACT

What role does architecture play in creativity? Jonas Salk sought to create majestic landscapes and contemplative architecture at the Salk Institute to inspire the type of creative insight he experienced at the St. Francis of Assisi monastery in Italy. Florence, Athens, Paris, and Vienna are places known for periods of spectacularly high creativity — and cities today incorporate urban and architectural designs intended to emulate their success. Famously creative people, like Proust, Kipling, and Kant, describe how rooms, tools, and inspirational objects are instrumental for their creativity. In an attempt to capture in time the essence of creative workplaces such as these, the art studios and offices of the eminently creative are often carefully preserved at time of death and converted to public museums. There is, however, a lack of empirical investigation into the relationship between architecture and people's creative processes. Creativity researchers who examine the environmental impacts on creativity focus almost exclusively on social environments. My research draws from empirical knowledge in the fields of neuroscience, psychology, and cognitive science to addresses the conflicting beliefs between creativity researchers who feel the physical environment is unimportant for creativity and architects who create settings with the specific intention of inspiring creativity.

As architects spend considerable time and money designing places to foster creativity, they do so with no common empirically derived theory to guide their practice. In this presentation I present a new theoretical model of creativity that begins to bridge the gap between creativity research and architectural design. First I will illustrate how creativity may to be comprised of five physically-situated and interrelated modes of creative cognition. Next, I will use the theoretical model to evaluate common architectural design strategies used to promote creativity in order to demonstrate how it may be used as a preliminary framework to hypothesize why some architectural design strategies are more successful at fostering creativity than others. Finally, I present some implications for practice and recommendations for future research needed to refine and extend the model into a more fully developed theory about the relationship between human creative cognition and architectural design.

2. AUTHOR BIO

Dr. Malinin is a registered architect, cognitive scientist, and Assistant Professor of Interior Design at Colorado State University. Her research interests generally encompass the relationship between cognition and the designed environment, including how workplace and educational settings may support creativity, health/wellbeing, and environmental stewardship.

A Preference Study Among Four Interior Architectural Geometries in a Semi-Immersive Virtual Environment

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The present study tested preference levels, using six sets of bipolar adjectives in what was called the vSubjective Survey, of four different architectural geometries and building forms in an innovative semi-immersive virtual environment ("CAVEtte"), designed and built by the author and a collaborator. All four buildings chosen in the study were built "Maggie's Centers" (cancer care centers) around the United Kingdom designed by different architects, all of whom were given the same architectural brief. The designs were digitally modeled in Rhino based on available plans, sections, elevations and images, and presented to 65 students and employees (19 females and 46 males) at NewSchool of Architecture + Design. Each participant watched four walk-through videos, one of each building, in a randomly selected order. After each video, participants filled out a subjective survey; four surveys in total. After running an Analysis of Variance (ANOVA) on the data collected, the immersive experiment findings suggest people prefer curved buildings to other geometric architectural interior environments.

1. EXTENDED ABSTRACT

Problem. As technology advances, architectural design methodology changes in response; most significantly the design process in recent years has been bolstered by computer technology, and digital fabrication. As this process often gives rise to non-rectilinear buildings, scrutiny continues over the appropriateness of the resultant architectural forms. In turn, this gives impetus to study the new forms generated for their effects on the inhabitants' wellbeing.

Neuroscientific studies show more positive responses to curved contoured objects than to sharp contoured objects (Bar and Neta 2006; Leder, Tinio and Bar, 2011), and more activation in the amygdala when subjects view images of sharp objects versus curved objects (Bar and Neta 2007). Nanda and Pati (2009) explored the relevance of the aforementioned studies to architecture and made a case for further research. A subsequent architectonic study suggests participants viewed curved architecture as more beautiful than its rectilinear counterpart (Vartanian et al., 2013).

Method. The present study tested preference levels, using six sets of bipolar adjectives, of four different architectural geometries and building forms in an innovative semi-immersive virtual environment ("CAVEtte"), designed and built by the author and a collaborator. All four buildings chosen in the study were built "Maggie's Centres" (cancer care centers) around the United Kingdom designed by different architects, all of whom were given the same architectural brief. There were currently 15 Maggie's Centres at the time of the development of the study and were vetted with individual thesis committee members in a three-stage process. The selected Maggie's Centres were: (curved) Southwest Wales by the late Kisho Kurokawa; {mixed} Aberdeen by Snohetta; [rectilinear] Cheltenham by MJP Architects; and <angled> Fife by Zaha Hadid. All testing models were built and later rendered out for walk-through videos in Rhinoceros (a 3D modeling and rendering program) based off of available plans, sections, elevations, and photographs of the buildings. The following alterations were made to control for uncontrollable variables: models were generated without textures and furniture and walls were all given the same neutral color throughout.

65 students and employees (19 females and 46 males) at NewSchool of Architecture + Design (NSAD) participated in the main study (Experiment 1), watching four walk-through videos, one of each building, in a randomly selected order. After each video, participants filled out a subjective survey. The subjective survey helped define "preference" by using six sets of bipolar adjectives of semantic differentials with an added "neutral" between each bipolar word. The words chosen for each set were adopted from Hesselgren (1987) as referenced in Madani Nejad's 2007 Ph.D. study. In order, the word set were: 1) pleasant, neutral, unpleasant; 2) exciting, neutral, depressing; 3) relaxing, neutral, stressful; 4) friendly, neutral, unfriendly; 5) like, neutral, dislike; 6) beautiful, neutral, ugly. Positive preference was noted as the first set of words, while negative preference, the last word.

Results. Due to limitations in Experiment 1, a second similar study was conducted to ensure the limitations found did not affect the results. An Analysis of Variance (ANOVA) was conducted to compare the results

between the two immersive studies and found there was no statistical difference among the curved, mixed and angled walk-through videos. Based on the ANOVA results, the immersive experiment findings suggest people prefer curved buildings to other geometric architectural interior environments. While these findings are consistent with the aforementioned contour-focused studies, there were some intriguing novel results when the data were parsed demographically along the lines of age, gender, education level, designers versus non-designers and years in the profession. These results demonstrate the need for future studies in a highly-immersive virtual environment to continue examining the effects of architectural contours at a physiological level.

ACKNOWLEDGMENTS

This study was made possible in part by the support of NewSchool of Architecture + Design faculty, staff and students. Additionally, I would like to acknowledge Kevin Sullivan for financial and developmental support of the CAVEtte, in addition to providing aid during the testing phase.

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Ms. Hobbs graduated Summa Cum Laude and was awarded the AIA Henry Adams Medal and Certificate of Merit in 2014 for her completion of a Master of Architecture degree from NewSchool of Architecture + Design (NSAD) with a focus in Neuroscience. During her tenure at NSAD, Ms. Hobbs served as a research assistant in both NeuroArchitecture and Parametric Design. Additionally, she assisted in visualizations at the StarCAVE at UCSD, gaining working knowledge of the technology and digital programs needed to simulate architectural environment.

THESIS COMMITTEE MEMBERS (NON-PRESENTERS):

Kurt Hunker, FAIA: Professor Hunker collaborated with Ms. Hobbs before the study began. He provided insight to relevance in today's architectural debates, along with expertise in building case studies, final building selection and fresh ideas on relating the findings back to architecture.

Vuslat Demircay, Ph.D.: Dr. Demircay provided constant feedback in the study topic, methodology of the study, final building selection, data analysis, and conclusions. Additionally, Dr. Demiracy helped to elevate the study's comprehensiveness through a critical eye and challenged each step of the process.

Tiffany Rodriguez, Ph.D.: Dr. Rodriguez has a Ph.D. in Motor Neuroscience with an emphasis in Biomechanics and has worked on several scientific studies testing various aspects of the neural control of movement. She currently works as a Manager of Institutional Research for Laureate International Universities (the parent company of NSAD). Dr. Rodriguez provided constant feedback and support during the testing phase and the data analysis phase of this study.

Rajaa Issa: Mrs. Issa is one of the developers of Rhino, the program used in the study to model the four buildings. Additionally, she provided a critical eye for detail and challenged all ideas to ensure a well thought-out study.

Beneficial Effects of Design Applications Using Environmental Illusions

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Our sensorial system receives the environmental cues that are later processed in our brain, forming our reality. However, the objective world is often blurred by the lenses of these brain mechanisms that are responsible for our subjective experience. There is no one-to-one correspondence of the outside world with what we perceive due to misjudgments and malfunctions of our sensory systems that are susceptible to mistakes. But what if we could use this so discussed imperfection as beneficial knowledge to design environments?

1. EXTENDED ABSTRACT

We focused on possible applications concerning vision as it is the sensory system that has been mostly studied. The optical mechanisms combined with previous experience are responsible for visual illusions that cause misinterpretations of things we see and their relations to each other (Macknik & Martinez-Conde, 2013). In our research, we try to use illusions as a medium to "trick" the brain depending on the desired environmental type of use. For example, the finding that distance or depth is indicated by the distribution of light and depth (Luckiesh, 1922) could be used as a possible application in restricted spaces, as the room of a hospital, by providing specific lighting conditions (or other space qualities like geometry) in order to create the illusion of spaciousness when there is no other alternative to do so. Of course, the formation of illusions could expand to other senses too, and even combine them for a greater effect, creating multisensorial environments.

This research is part of a wider investigation on how our surroundings can adapt to our needs and update if the need changes (like in crisis alleviation in the example of the hospital). The main goal of this presentation is to review the illusions that could be used in environmental interventions and present the context of use by demonstrating possible applications. The ongoing research and the series of experiments that we are implementing will be analyzed with their potential benefits in real environments such as hospitals, work places and confined spaces. The general goal is to combine neuroscientific findings on perception for the creation of user friendly, and specially therapeutic and proactive environments. The line that inspires us is the use of a "deficiency" in interpretation of the objective world as a beneficial subjective experience which is the milestone of our reality.

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3. AUTHOR BIOS

Anna Kelesidi graduated with a Bachelor of Science in Psychology from the Aristotle University of Thessaloniki (2010). She continued her education with a MSc degree in Cognitive Neuroscience at the University of Sussex (2010-2011) where she studied the influence of the unconscious. Currently she is a PhD candidate at the TUC School of Architectural Engineering. Her research interests at the TIE Lab focus on the study of the interaction between space and perception aiming toward the creation of human-centered environments with the use of interactive systems. She is also working as a psychologist in the non-profit organization "Ksenios Dias" in collaboration with the Municipality of Chania and is responsible for the psychosocial support of vulnerable populations and is a mediator between social structures against poverty. She implemented research on schizophrenia in the context of the Psychiatric Clinical of Aiginition Hospital of Athens (2011-2012). She has also worked at the non-profit organization "Arsis", offering psychosocial support and vocational guidance to vulnerable populations and was also responsible for the acquaintance of children with art at the Central Museum of Contemporary Art in Macedonia. Moreover, she is practicing contemporary dance and has obtained the first degree of sign language. Her work at the TIE Lab has been presented at the 9th International Conference on Intelligent Environments (IE 2013), in Athens, Greece and the 64th International Astronautical Conference (IAC 2013), in Beijing, China.

Marianthi Liapi holds a Diploma in Architecture and Engineering from the Aristotle University of Thessaloniki/AUTH (2002) and a MSc degree in Design and Computation from MIT (2005). For her studies in the US she was awarded scholarships from the Fulbright Foundation, the Michelis Foundation, the Gerontelis Foundation and the MIT Department of Architecture.

During 2006-2007 she was a research associate at AUTh investigating the impact of digital design tools and techniques on contemporary architectural education. During 2008-2011 she was an adjunct lecturer at the Technical University of Crete/TUC teaching courses in architectural design, architectural technology and digital design media, as well as supervising diploma projects. Currently she is a Research Associate at the TUC Transformable Intelligent Environments laboratory. She has also been accepted as a PhD candidate at AUTh. She is focusing on the study of transformable intelligent environments, extreme environments and learning environments. She is interested in the concept of spatial experience and particularly in the process of learning within playscapes, with the meaning of the word 'learning' spanning from acquiring new knowledge to adapting into a new environment. She is credited for coining the term experiential ergonomics. So far, her research work has been presented in international architecture (SIGraDi, ACADIA, eCAADe, EAAE/ENHSA) and interdisciplinary conferences (ICCMSE, EPA, ICSC, IAC, IPA), in refereed journal publications and books. She is annually involved with the organization of international architecture workshops and exhibitions. On a professional level, she is a registered architect in Greece. She is co-founder and principal at 124 | SKG Architects, a research and design office formed in partnership with Kostis Oungrinis to explore transformable, technology-mediated environments in various scales and building types. In 2008 she received the Europe 40 under 40 Architecture Award.

Dr. Konstantinos-Alketas Oungrinis is an Assistant Professor in Architectural Design and Innovative Engineering at the Technical University of Crete (TUC) in Greece. He is also the Director of the Transformable Intelligent Environments Laboratory (TIE Lab) at the same university. During 2004-2005 he was a Visiting Research Associate at the Harvard GSD. He holds a Professional Diploma in Architectural Engineering and a PhD degree in building morphology and kinetic structures in transformable spaces from the Aristotle University of Thessaloniki. His work on dynamic, human-centered architecture involves research on kinetic structures, smart materials and responsive control systems for the creation of intelligent environments that can respond actively with 'sense' to the needs and wishes of people. His research specializes in transformable environments, activity-based design methods, time-space relationships, user-experience design, educational environments and spaces within extreme environmental conditions. He has developed two specific approaches for the successful implementations of IT in design titled Spatial Economy and Responsive Architecture. His work has been presented and published extensively through international conferences and also through design and fabrication workshops. His thematic areas of study are interdisciplinary, rooted in the field of architecture and from there branching out mainly into the domains of psychology, neuroscience, electrical engineering and computer science. He is the author of two books: 1) Transformations: Paradigms for Designing Transformable Spaces (2006) Harvard GSD Design and Technologies Report Series, Cambridge, MA and 2) Transformable Architecture: Movement, Adaptation, Flexibility (2011) ION Publishers, Athens. He is co-founder of 124 | SKG Architects research and design office. In 2008 he received the Europe 40 under 40 Architecture Award. He also writes sci-fi novels.

The Design of an Urban Park in the City of Patras, Greece: Towards the Development of an Enriched Environment

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1. ABSTRACT

The term environmental enrichment is associated with stimulation of the brain by its physical and social surroundings. Creating environments that stimulate and enhance human perception and skills, falls within the professional agenda of both practicing and academically oriented architects.

The paper presents an architectural design project that is directly related and based on research findings on neuromorphic architecture which was conducted prior to the design development. The discussed project in essence constitutes an experiment in applying an enriched/enhanced environment in a real city context, the city of Patras. The main purpose of this effort was to attempt a spatial translation of relevant research in Neuroscience into an urban space that will make possible the experimentation with EEG. The paper describes the followed design procedure starting from the main design directions to the details that satisfy the requirements of an enriched/enhanced environment in practice. Two different age groups, the elderly and the children, who are more sensitive to such environments, are selected as target groups. The common potential benefits of both groups from an enriched/enhanced environment determined the design objectives that dictated the main circulation, accesses and paths as well as the main function allocation in the design field. The differences of the two target groups suggested the development of two distinct and contrasting activity areas a) a static one and b) a continuously transformable field. Specifically, the key elements of the expected experience of the users, namely navigation, exploration, multi-sensory experience, cognitive stimulation, social interaction, physical action, suggested a design approach that involved three space organizing principles: the polycentric system, the exploration/navigation experience, the social and sensory interaction. At a following, smaller scale design development phase; the same key elements were spatially translated into architectural features. It is hoped that the design method that has been will serve as an example of how sensorial and motoric actions as well as anticipated social activities can be integrated and become the driving theme in the design of urban spaces. Of course future studies are needed to test the effectiveness of this approach in areal world setting.

Keywords: City of Patras, neuromorphic architecture, enriched/enhanced environment

2. AUTHOR BIO

V.Kondyli obtained her Diploma in Architecture Engineering, in University of Patras Department Of Architecture, Greece with honors (8.55/10). In her graduation research (14ECTS), she delved into topics of perception theories and relevant studies in neuroscience research as well as in experimental research on the perception of space. She continued in the same direction in my Design Thesis. During her Design thesis project (30 ECTS), the research guided her to design an enriched urban environment as an appropriate place for experimentation with EEG systems and human interactions. Towards this effort she was advised by acclaimed researchers in the field, like Dr M. Cooley, P.Mauros, Ryan Dooley, who initiated her to the prospects of this new field of cooperation between neuroscience and architecture.

Wearable Neuroimaging and Emotion: Investigating Emotional Responses to Architectural Environments with Functional Near-infrared Spectroscopy (fNIRS).

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1. ABSTRACT

Supported by contemporary theories of architectural aesthetics and neuro-aesthetics this paper presents a case for the use of portable fNIRS imaging in the assessment of emotional responses to spatial environments experienced by both blind and sighted. The aim of the paper is to outline the implications of fNIRS for spatial research and practice within the field of architecture, thereby suggesting a potential taxonomy of particular formations of space and affect.

Empirical neurological study of affect and spatial experience from an architectural design perspective remains in many instances unchartered. Clinical research using the portable non-invasive neuro-imaging device, functional near infrared spectroscopy (fNIRS) is proving convincing in its ability to detect emotional responses to visual, spatio-auditory and task based stimuli, providing a firm basis to potentially track cortical activity in the appraisal of architectural environments.

Additionally, recent neurological studies have sought to explore the manifold sensory abilities of the visually impaired to better understand spatial perception in general. Key studies reveal that early blind participants perform as well as sighted due to higher auditory and somato-sensory spatial acuity. For instance, *face vision* enables the visually impaired to detect environments through skin pressure, enabling at times an instantaneous impression of the layout of an unfamiliar environment. Studies also report pleasant and unpleasant emotional responses such as 'weightedness' or 'claustrophobia' within certain interior environments, revealing a deeper perceptual sensitivity than would be expected.

We conclude with justification that comparative fNIRS studies between the sighted and blind concerning spatial experience have the potential to provide greater understanding of emotional responses to architectural environments.

The Role of Visual Attention in Architectural Design

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Although the visual system can process some aspects of the environment efficiently, such as spatial layout, the visual system is quite limited in its ability to process specific details or relationships between elements in the environment. To help users overcome these limitations, we argue that visual cues are critical for guiding attention toward important elements in the built environment, allowing users to understand more complex design goals. We review three examples of design goals that can benefit from attentional guidance, describing architectural techniques that support these goals and highlighting the cognitive and neural mechanisms associated with each technique.

1. EXTENDED ABSTRACT

In a flash of an instant, people can rapidly categorize their environments, a phenomenon often referred to as rapid gist extraction (Potter, 1975; Oliva & Torralba, 2001). In contrast, it takes time and effort to notice specific details or relationships between elements in the environment (Treisman & Gelade, 1980; Logan, 1994). Although gist extraction is one important component in architectural design, more complex design goals may require this more limited, effortful type of processing. Thus, how a user attends to an architectural space may be critical for understanding the deeper meaning of the design.

We argue that a major role in architectural design is to provide guidance or visual cues to help the user focus on critical elements in a space, and that such guidance is especially important for helping users grasp more complex design goals. Here we review examples of three such design goals, describing how architectural design techniques can guide the user's attention in specific ways and highlighting the cognitive and neural processes associated with each technique. For instance, certain design techniques can help users relate separate regions of a space to one another, highlight the overall spatial structure of a space, or evoke different modes of thinking (i.e., focused versus unfocused attention).

To help users connect separate regions of the built environment, symmetry and repetition are often used to emphasize cohesion among disparate elements. In symmetric designs, the spatial alignment of separate elements may facilitate comparison, allowing the brain to quickly extract similarities and differences among multiple elements (Gentner, 1983; Michal et al., in preparation). Repeating elements (e.g., arches in the Kimball Museum) may evoke cohesion across different spatial regions because attending to an element in one location allows for other neurons to simultaneously respond to that same element in other locations (Treue & Trujillo, 1999). Several visual cues such as symmetry, spatial alignment, and perspective (e.g., the Salk Institute) can be used to define a focal point, which draws attention to one important region by enhancing the visual saliency of that region (Itti & Koch, 2001). In addition to having aesthetic value, focal points can also clarify the overall organization of an architectural space by orienting users to landmarks or principal axes (e.g., the Philbrook Museum; Cheng & Newcombe, 2005; Xu & Franconeri, 2012). Finally, varying the openness or enclosure of a space (e.g., the Kravis Residence) may elicit unfocused/creative or focused thinking by activating bottom-up versus top-down attentional networks in the brain (Berman et al., 2008).

Although these examples highlight an important relationship between visual attention and architectural design, further research is necessary to clarify this relationship. For instance, are there other design techniques in addition to focal points that can help users develop mental maps of built environments? Can visual cues aid in other complex spatial processes, such as transitioning between 2D and 3D representations of built environments? What other design principles other than openness and enclosure can evoke different modes of attention? Additionally, how can architects' use of visual cues inform our understanding of the visual system?

In conclusion, to maximize the architectural experience and fully understand the effect of the environment on attention, we believe it is important for architects and neuroscientists to further explore how attention affects the architectural experience and vice versa.

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3. AUTHOR BIOS

Dr. Audrey Lustig Michal is a cognitive neuroscientist with a background in neuroimaging and visual attention. She completed her B.A. in Biological Basis of Behavior at the University of Pennsylvania and her Ph.D. in psychology at the University of Illinois. Dr. Michal's current work focuses on the role of attention in understanding spatial relations and relational reasoning more generally. She uses fMRI, eyetracking, and psychophysical techniques to address these issues.

Michael Lustig began his architectural practice in 1976 in Chicago after attending Ohio State University, Cornell University, and the University of Illinois, where his research centered on artificial intelligence applications to architecture and he received a Master of Architecture degree in 1974. He was an Adjunct Assistant Professor at the University of Illinois, Chicago and was editor of the Chicago Architectural Journal. His buildings have been completed throughout the US and Europe and include residences, commercial buildings, and the Philbrook Museum of Art. His projects have been awarded several AIA design awards and have been exhibited at several museums and universities in the U.S. and Europe. He was the American Institute of Architects/Chicago recipient of the Young Architect Award and his work has been published in several books and journals including 150 Years of Chicago Architecture, Progressive Architecture, Abitare, L'Architecture D'Aujourd'hui, and Ottagano.

Neural Responses to Restorative Environments: An Eye Tracking and fMRI Study

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With the aim of measure the neural responses to restorative environments, it has been developed and tested an experimental paradigm of psychological restoration suitable for neuroimaging environments. The paradigm includes conditions of psychological stress and environmental restoration. Additionally, we use fMRI coupled with the eye tracking technology to ask whether visual perception differs between scenes that are highly restorative and scenes that are less restorative. The findings support the evidence of several cognitive and emotive physiological indicators related to the stress and restoration condition.

1. EXTENDED ABSTRACT

1.1. INTRODUCTION

The neuro-architecture perspective proposes a new discipline that unites neuroscience with the experience of built environments (Edelstein & Marks 2007). The neuroscience research in restorative environments constitutes an approach useful to understand the neural basis of human-environmental transactions that promote human wellbeing. To date, little is known about the neural circuitry involved in the process of psychological restoration; so more studies are needed in order to investigate the neural correlates of psychological restoration in combination with other physiological restoration measures. These kinds of measures are useful to document this phenomenon through multiple levels of analysis and methodologies; which are convenient to ensure validity criteria for this research (Campbell & Fiske, 1959). Psychological restoration is the result of the recovery from an antecedent deficit (e.g. stress or attentional fatigue) following the exposure to a restorative environment (Kaplan & Talbot 1983). According to attention restoration theory (Kaplan 1995), restorative environments must offer a serie of perceived qualities that facilitate the restoration of attentional fatigue. These environments, usually naturals, offer a particular kind of soft stimulation that does not requiere directed attention contrary to some chaotic urban environments where the stimulus complexity represent a higher demand in the attentional resources. With the aim of explore and validate the neural basis of a psychological restoration process we proposed a fMRI methodology coupled with eye tracking. Our design considers three basic assumptions: (1) the antecedent condition from which a person might restore (e.g. affective and/or cognitive deficit); (2) the environment which the person enters during the time available for restoration (high vs. low restorative potential environments; HRP and LRP respectively) and (3) the outcomes that reflect on actual or potential changes in resources and/or components of the experience which mediate those changes (brain responses during the view of this environments and patterns of eye movements as physiological indicators of cognitive and emotional process related to psychological restoration). A paradigm suitable for neuroimaging environments, which includes a psychological stressor (stressful video) and the exposition to pictures with low and high restorative potential (LRP and HRP respectively) was developed and tested. According to this design, it was expected the activation of brain areas related to stress response. Given the exploratory character of this study, no specific predictions were made toward the brain activations involved with the exposure to LRP and HRP environments. Finally, we use fMRI coupled with the eye tracking technology to ask whether visual perception (saccades, fixations and pupil size) differs between scenes that are highly restorative (HRP, e.g. natural settings) and scenes that are less restorative (LRP; e.g. urban settings without nature).

1.2. METHODS

Participants include 24 clinically healthy male volunteers (18 to 40 years old) residing in urban communities of the Mexican state of Querétaro. They were assessed at the magnetic resonance unit of the Institute of Neurobiology, UNAM. MRI acquisition and image processing methods were recorded with the participants before and after the exposure to HRP and LRP environments. A ViewPoint EyeTracker® was used to record the eye movements (right eye) of the participants during the exposure to HRE and LRP. The restorative

influence of these scenarios was tested before and following a period of acute psychological stress induced by means of aversive movie watching with a self-report stress scale.

1.3. RESULTS AND DISCUSSION

Brain functional connectivity analysis confirmed the successful stress induction considering the psychological stressor. On the other hand, the results in general suggest the activation of different brain areas during the view of LRP and HRP scenes. Briefly, brain areas relating to novelty seeking behaviour-exploration (e.g. frontal lobe; Dafner et al. 2000), spatial information (middle frontal gyrus; Leung, Gore, and Goldman-Rakic 2002) and awareness of emotionally charged stimuli (Phillips et al. 1998) were predominantly activated during the view of HRP environments. In the case of the LRP category, the results showed brain areas activation related to approximation-avoidance emotion (right superior frontal gyrus, Paradiso et al. 1999), episodic memory, visual attention processes (precuneus, Fletcher et al. 1995), processing the geometric structure of built environments (parahippocampal gyrus; Epstein 2005) and organization of behavior (Pearson et al. 2011). Significative differences were found in the eye patterns (saccades, fixations and pupillary size) during the view of HRP vs. LRP environments. Atributed eye pattern to HRP environments (saccades and pupillary size) are referred to exploration movements evoked by fascinating environments as suggested by the Kaplan's attention restoration theory. Conversely, more fixations occurred in the LRP than in the HRP condition, suggesting a major attentional effort during the visual process of LRP stimulus.

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3. AUTHOR BIOS

Joel Martínez-Soto. Professor and Researcher at the Psychology Department of Universidad de Guanajuato, México. Professor Martínez-Soto is an environmental psychologist who studies the transactions to the built and natural environments that are beneficial for the human development. His main focus of interest is the application of neuroimage fMRI techniques to assess human brain responses to restorative environments.

Synapsis at a “Capitalist Square”

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1. ABSTRACT

Objectives: The buildings that stand out in our contemporary great cities have long ceased to be those of political and power symbol. Our urban landscape is now crowded and mostly dominated by office buildings, apartment buildings and headquarters of large companies.

Through the activity of consumerism - deeply installed on such models of Capitalist Cities spreaded all over the world (Manhattanism spatial models) - we examine interactions between people and buildings (Zakkyo Buildings rhythmanalysis - Tokyo). Furthermore, the study investigates how the brain shapes its activations in response to its environment.

Methods: The following research follows a multidisciplinary approach through the domains of Architecture, Psychiatry and Neuroscience.

Results: All behaviour is learnt from our environment. Each and every day (although we may not be aware), we receive subconscious programming from our cities landscape. From an architectural point of view, were identified urban space issues that are dictating a specific control on social mind and feeding the development of psychological diseases, by instance, stress and anxiety. At the level of human response to places, becomes clear that architectural experience matters. The attributes of space, from shapes to colors, thermal conditions, light (both natural and artificial) and sound are perceived by our sensory systems, processed through the thalamus and midbrain, and sent to the cortex to be recognized in a conscious way. The connections between neurons can be increased or decreased based on the experiences of individuals. Even the total number of synapses may change in certain areas of the brain due to various experiences, as well as interaction with the physical environment.

Conclusion: It was well established that crowding, sudden loud noise, bright lights, multiple choices and lack of land-marks are all potent triggers of the physiological stress response. At the scope, we claim the importance of an urban environment that is readily navigated: a more consciously and balanced organization of our cities can create feelings of comfort and a reduction in anxiety. The research concludes in that responsive architecture can positively contribute to the creation of a more human environment helping people to improve their psychological health and preventing them from irrational use of drugs.

2. AUTHOR BIOS

Anabela Martins was born in Oporto city (Portugal) in the year 1982. Holding intuition and observation as attributes that can easily define her personality, she became an architect focused on human and society needs (both physical and spiritual).

In the year 2001 she started to attend her architecture course. By January 2010, she concluded it with an integrated master degree developed in Tokyo and presented at Oporto Lusíada University. While an Erasmus student at Aristotle University (Thessaloniki-Greece, 2007/2008), Martins built the foundations of her researching project with professor Janis Chatzigogas being the first guider challenging view points at the scope of contemporary architecture and its evolution (within different places and political systems).

Winner of a scholarship assigned by the Portuguese Cultural Ministry, she arrives at one of the largest world's metropolises, (Tokyo), in the beginning of 2009 with two different purposes: to release her first internship as an architect and to develop her research project 'in situ'. At the Architecture and Phenomenology conference held in Kyoto during June 26-29, she first met Dr Julian Worrall, Assistant Professor of Architecture and Urban Studies Institute for Advanced Study, (Waseda University, Tokyo-Japan). Between October 2009 and January 2010 they often met in order to brew her particular curiosity and viewpoints on Tokyo's urban space. Back in her hometown, she presented her thesis work entitled Shift of Scales and Privatization of the Public Space: Tokyo 2010 - moment in which she concluded her master degree.

Committed to its professional role as an architect on society's service, since 2010 she has been working as an independent researcher. Her intuition is now responsible for her architectural study developed throughout neuroscience and psychiatry fields. Currently, she lives in Thessaloniki (Greece) and she is a co-foundress of Synolonepitopou Project - a social project that,

by connecting different fields of knowledge, is searching the creation of a new (sustainable) system.

Sofia Gomes was born in Guimarães - Portugal, in 1983. She joined the Medicine Faculty at Coimbra University in the year 2003 and she concluded her graduation in 2009 with a master degree entitled "Neurodevelopmental disability by anomaly of proximal region of the long arm of chromosome 15 (q11-q13) - genotype - phenotype relationship". Gomes is currently working at Magalhães Lemos Hospital (Porto-Portugal) as psychiatrist Dr (Psychiatry trainee). Along her career she has presented papers at national and international congresses (20th and 21th European Congress of Psychiatry).

Mesopic Vision in Architecture: Exploring Connections Between Visual Comfort and Heightened Awareness

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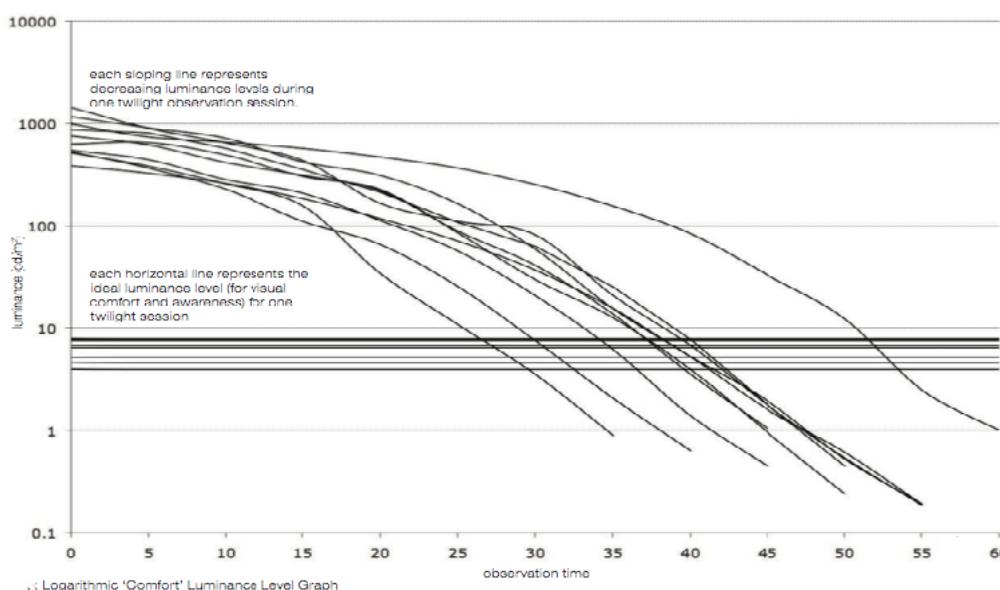
This study explores the existence of a particular quality of light that provokes a heightened sense of perceptual awareness. Perhaps because light is such a dominant stimulus in our experience of the world, we tend to be less familiar with its subtleties. For example, visual signals tend provoke less comfort reaction than the way our skin quickly judges thermal or tactile comfort. Yet based on observational experience, this study speculates that our visual perception does trigger these similar precise value judgments; it is just that they are too often ignored. A refined knowledge of perceptual visual awareness is in our evolutionary blood. It may be that only in recent years, with the advent of electric lighting, we have been able to live without it -- but not without experiential sacrifice.

1. ABSTRACT

The study of light, particularly since the invention of the electric variety, has had a strong connection with production. For good reason --we need light to do most things. We need light to bath, cook, read, work, play, etc. A Lot of effort has been put into finding the most appropriate light levels to facilitate productive efficiency. Organizations like the IESNA (Illuminating Engineering Society of North America) have published recommended light values for tasks ranging from grooming to ironing to casual reading in bed. This particular investigation, however, is set apart from the tradition of lighting for productive tasks --and instead focuses on lighting environments suited to moments when we are introspective or social --time when we are more engaged with thinking than with doing. An environment which is tuned to the ideal comfort level of our senses may also be one that opens our mind to free and creative thinking.

Twice a day, at dawn and dusk, photoreceptive cells in our eyes reach a 'crossover' point of equal efficiency in response to ambient daylight. At these low light levels (around 1 cd/m²), color and detail sensing cone cells share responsiveness with shape and contrast sensing rod cells. This perceptual phenomenon within the 'mesopic vision range' marks a potentially unique moment of visual awareness and the starting point in the search for the 'right' kind of light.

To test the relationship between perceptual response and ambient light levels, a method was created for objectively recording light along a smooth gradient from intense to subdued. The transitioning sky during twilight was selected as an ideal environment for doing this because the sky offers a uniform field of light which eliminates potentially distracting detail. To record light level, images from a calibrated digital camera were processed by a software program to measure accurate luminance (visual power per unit area, measured in candelas/m²) values for each pixel of the image. The advantage of this method over using simple light meters



measuring illuminance is that the record of the light is more closely matched the light we perceive in the environment. Luminance values were then recorded at regular intervals during the twilight period and associated with the perceptual observations oriented toward finding the particular moment when the light quality was most comfortable

After multiple sessions of twilight observation, this study revealed that the 'most comfortable' light

level was remarkably consistent (hovering somewhere around 7cd/m²). The physiological experience at these low light levels simultaneously created a heightened sense of environmental awareness – almost a condition where my sensing powers were amplified. In turn, there was a stimulant effect on my thinking – both calming and energizing.

The speculation here is that something neurological is happening at these light levels that might warrant further investigation. I am curious to expand this study to gather more data from more participants to find if there is a degree of consistency among us of what luminance levels we consider to be ideal – and how our mental state during that moment is affected. A refined knowledge of perceptual awareness is in our evolutionary blood. It may be that only in recent years, with the advent of electric lighting, we have been able to live without it - but not without experiential sacrifice. The recovered knowledge of visual perception may be able to be used in architecture to tune the behavior of light in space to maximize both our comfort and our creative intensity.

2. AUTHOR BIO

Ben McDonald is an architect in Los Angeles with 15 years of experience and is always inspired to apply principals of light and perception to the design process and ultimately the material realm. The study presented here stems from his mid-career graduate thesis exploration at the University of Arizona under the guidance of Alvaro Malo.

Smell and the Architectural Experience

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1. ABSTRACT

Although the visual, somatic, and auditory input have a dominant effect, the sense of smell can have stronger additional influence on the architectural experience. Olfaction may not be have an instantaneous impact on one's perception of a building but can have a more memorable or emotional effect. In addition to this effect, some evidence exists that olfaction can improve spatial navigation and augment the dominant visual experience. There are positive and negative effects of smell that alter one's emotional response to a space or can be used to change the visual "opinion" of a space. We will discuss how certain natural and unnatural scents can manipulate the experience of architectural environment as well as improve spatial navigation through spaces for both the general population as well as patients with certain neurological disorders.

Familiar Environments Enhance Object and Spatial Memory in Both Younger and Older Adults

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1. EXTENDED ABSTRACT

Wayfinding and spatial navigation abilities are known to decline with ageing. Although few studies have considered the role of familiarity of the environment on object or spatial memory, some evidence suggests that older adults have preserved spatial recognition for familiar environments learned in the remote past. Here, we investigated whether familiarity with an environment affects spatial memory in younger and older adults. A realistic virtual model of a local environment (i.e., Trinity College Dublin) was used to create videos of two routes taken through the west and east end of the environment in a first-person perspective. Forty-eight younger (mean age = 23 years) and 23 older (mean age = 69 years) took part in the study. Prior to testing, all participants provided familiarity ratings for the east and west ends of the real campus environment. Based on these ratings, there were two groups of (24) younger participants: one group was familiar with both areas and the other was more familiar with the west end. The older adults all rated the west end as more familiar than the other. During the experiment, participants viewed videos of two routes and were asked to remember the route taken and the objects embedded into the environment. Following learning, spatial memory was tested using 4 separate tasks: a landmark recognition test (a measure of object memory), a direction judgement task (a measure of egocentric spatial processing), a proximity judgement task, and a landmark location task (measures of allocentric spatial processing). We found relatively worse performance for the older than younger adults across all spatial tasks, although allocentric memory was more compromised in the older than younger adult groups. Importantly, area familiarity within the environment was associated with improved landmark recognition and egocentric spatial processing in younger adults who were familiar with one area and in older adults. These results suggest an important facilitatory role of environment familiarity on object recognition and spatial memory and may have implications for enhancing spatial memory in older adults.

2. AUTHORS

Niamh Merriman is a PhD Student in School of Psychology and Institute of Neuroscience whose research interests include the study of multisensory integration and spatial cognition in healthy older adults and fall-prone older adults under ecologically valid conditions using virtual reality. The over-arching goal of this research is to inform rehabilitative interventions for those with impaired spatial cognition.

Jan Ondrei is a postdoctoral research fellow in GV2 group at Trinity College Dublin. His research interests are in computer graphics and virtual reality, especially in a realistic simulation and animation of autonomous virtual humans.

Eugenie Roudaia is a post-doctoral fellow in the Trinity College Institute of Neuroscience and is interested in visual and multisensory perception and how perceptual function changes with ageing, as well as the interaction between perceptual function and balance in older age. She is also interested in perceptual learning and brain plasticity across the lifespan.

Prof. Carol O'Sullivan is the Coordinator of the VERVE project. She is the

Professor and Chair of Visual Computing in Trinity College Dublin. Her research interests encompass computer graphics, animation, perception, human and crowd simulation.

Fiona Newell is a Professor in the School of Psychology and Institute of Neuroscience, Trinity College Dublin. Her research interests are in human sensory and perceptual processes. The main goal of her research is to provide a better understanding of how information is shared across the senses and to elucidate the brain processes involved in the perception of objects, faces and places across the main human sensory systems. Her recent research has focused on a more life-span approach, particularly on how the ageing process affects multisensory perception and spatial cognition.



Blue Sounds, Black Smells

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ANA PINTO-ALEXANDER, RID, IIDA, EDAC¹; CARINA CLARK, EDAC, LEED AP BD²

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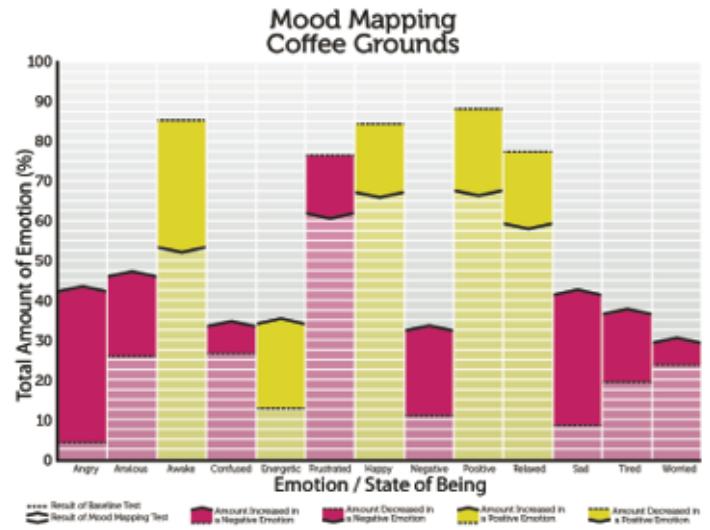
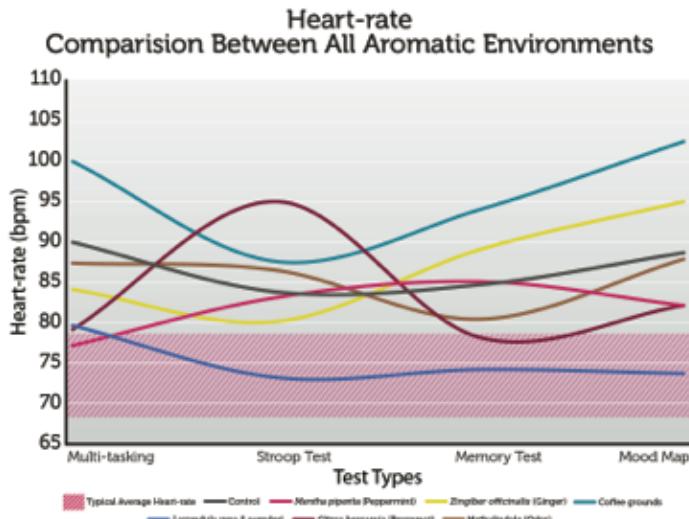
HKS INC.; Center for Advanced Design Research and Evaluation

Sensory design has been an under-utilized element to architectural design. Traditionally the approach to senses has been static, passive, treating each sense modality as independent, and treating auditory, tactile, haptic, gustatory and olfactory senses as secondary to the visual. In this presentation we will compare the traditional approach of "sensory orders" (supported by anthropology) to the more current notion of neural "plasticity"- a constant dialogue between the senses, that craft our perceptions and shapes our experiences. We will, in this first presentation, focus on the sense of smell and how it blends with the other senses.

1. ABSTRACT

Architecture is fundamentally about crafting the human experience- and the human experience is not just visual- it is multi-sensory. Traditionally the approach to senses has been static, passive, treating each sense modality as independent, and treating auditory, tactile, haptic, gustatory and olfactory senses as secondary to the visual. In this presentation we will compare the traditional approach of "sensory orders" (supported by anthropology) to the more current notion of neural "plasticity"- a constant dialogue between the senses that craft our perceptions and shape our experiences. We will start with a single sense- Smell, and share a case study in a simulated Emergency Department where caregivers (nine total; seven RNs, one technician, one physician) were exposed to different smells, and their physiological feedback (heart rate and bio-feedback) were used to measure the physical stress response, while mood mapping indicated the individual's emotional state of being at the start and end of each aromatic environment. These tests demonstrated that some aromas were indeed more "therapeutic" than others, while others may cause more harm than good. We will then discuss where smell falls in the sensory order- including the differentiation between the "human" and the "animal" senses by Aristotle, Hayek's theory of sensory linkages, and culturally defined sensory orders. Findings from a pilot study (17 responses) that investigated the sensory orders of common architectural spaces will be shared.

Finally, we will discuss the relevance of synesthesia, a neurological condition where stimulation in one sense triggers a perceptual experience in another. We will discuss the neurological basis, and the theoretical significance to architecture. Findings from a case study asking people to link smells and sounds to colors will be shared. The presentation will conclude on how under-utilized senses, sensory orders, and sensory "cross-connections" can affect how we design. Hypothesis for neuro-architecture will be shared with the audience- calling out the need for synesthetic approaches to research that bring together designers, neuroscientists, and philosophers/theorists.



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Architecture student response to the hierarchy of senses in different places (n=17)

cross-modal approach to sensory design has been published as a book on "Sensthetics."

Ana Pinto-Alexander: Principal and Senior Vice-President and Director of Healthcare Interior Architecture with HKS, Ana Pinto-Alexander has more than 25 years of experience designing interiors for the country's most progressive health care facilities. Ana has a Bachelor of Arts degree in Interior Design from Purdue University and has been a guest lecturer there. She is a member of the International Design Association and holds a certificate from the National Council for Interior Design. In 2013 Ana was recognized as the Legends IN Design recipient with the Indiana Interior Design Coalition. Ana has spoken nationally and internationally on the importance the built environment in the healing process. The recipient of numerous awards for her interior design projects, she has also been featured in several national publications, including a cover story for Interiors and Sources and as one of the "25 Most Influential People in Healthcare Design" by Healthcare Design Magazine.

Carina Clark: Carina received her undergraduate degree at Arizona State University with a Bachelor in Interior Design as well as her graduate degree in Design in Health and Healing Environments. Her research focuses on how sensory perception affects an individual's performance, specifically within a healthcare environment. Carina's most recent research explored the potential of emergency caregivers' performance being directly linked to pleasant and unpleasant olfactory stimuli through testing physical, mental, and emotional attributes. Her expertise includes work in the healthcare interior design field at HKS, Inc. as well as contributing to research focusing on the effects of user experience based on positive influential and unconventional methods.

ACKNOWLEDGMENTS

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2. REFERENCES

Nanda, U. (2008). Sensthetics: A Crossmodal Approach to Sensory Design. VDM-Verlag.

Rosso, R. (2007). Scents of place : defining the interior environment through our sense of smell.

3. AUTHOR BIOS

Upali Nanda: Dr. Upali Nanda is the Director of research for HKS, responsible for designing, spearheading and implementing research projects domestically and abroad for the firm. She is also the Executive Director for the Center for Advanced Design Research and Education (CADRE), the research arm of HKS committed to original research that advances the design industry. Dr. Nanda's research focuses on the impact of the designed environment on human and organizational health, with a focus on perception. Her work has resulted in numerous publications (including architectural and medical peer-reviewed journals), presentations, invited talks, and CEUs. Her doctoral work on a

Case for an Architectural Singularity Through Robotically Actuated Motion and Neuro-Sensory User Interaction (or how to become a building)

GUVENT OZEL

Technology Director, UCLA Department of Architecture and Urban Design, IDEAS Platform, USA

1. ABSTRACT:

By fusing neuro-sensing technology, robotics and coding in unison with architectural form designed to move and reconfigure itself, a new kind of architecture that goes through a formal transformation in interaction with the user can be imagined and devised. Aiming to merge human presence with space through technology, this new architecture defines space as an extension of the human consciousness rather than one that regulates and controls it. Similar to terminology in the discipline of Artificial Intelligence, where human consciousness merges with computation, such a condition can be called Architectural Singularity, where architecture becomes the host rather than the body itself.

Through historic examples, theoretical vantage points from art, architecture and media theory as well as built design experiments, in particular the "Cerebral Hut"; the first spatial scale experimental architecture that goes through formal transformation based on data from EEG, this paper aims to problematize the conclusive notion of architectural form and agency. In Cerebral Hut, as the user concentrates, the EEG device activates an electromechanical system that changes the formal configuration of the space physically. This transformation influences the source of the EEG data in return, creating a symbiosis between space and consciousness. Therefore the user becomes architecture, code becomes form and robot becomes the user in continuous feedback loops.

2. AUTHOR BIO:

Güvenç Özel is an architect, artist and researcher. He is the Technology Director of IDEAS, a multidisciplinary research and development platform at UCLA Department of Architecture and Urban Design; and the principal of Özel Office Inc., an interdisciplinary design practice located in Los Angeles, working at the intersection of architecture visual arts, technology and research on urban culture. A native of Turkey, Özel studied architecture, sculpture and philosophy in Bennington College. In addition, he holds a Masters of Architecture degree from Yale University, where he graduated with multiple awards. Prior to establishing his own practice and research, he worked in the architecture offices of Rafael Vinoly, Jürgen Mayer H. and Frank Gehry, among others. His projects and experimental installations were exhibited worldwide, including Istanbul Museum of Modern Art and The Saatchi Gallery in London. He formerly taught at Yale University, Woodbury University and University of Applied Arts in Vienna, where he was teaching with visionary architect Greg Lynn. His recent work has been heavily published in online and print media such as CNN, Wired, Huffington Post, Boston Globe, Architectural Digest, Gizmodo, Creators Project/ Vice, Dwell, Designboom, and others. At UCLA IDEAS, Besides determining the overall pedagogical objectives and technological trajectories for the master's program, he continues his experimental research on robotics and sensing devices as they relate to Art and architecture for the creation of reactive, intelligent environments.

Empathic and Embodied Imagination: Intuiting Life and Experience in Architecture

KEYNOTE: JUHANI PALLASMAA
Juhani Pallasmaa Architects
Helsinki, Finland

Architectural projects are products of imagination. In addition to a projective imagination, an empathic and embodied imagination is needed to grasp the experiential and emotive qualities of the designed spaces, as well as their resonance with life. The designer places herself in the imagined setting in the role of the future occupant.

1. EXTENDED ABSTRACT

Contemporary architecture is often accused of emotional coldness, exclusive and restrictive aesthetics, and a distance from life. This criticism suggests that architects have adopted a formalist attitude instead of tuning their buildings with realities of life. Architectural spaces are not lifeless frames for human activities; they guide, choreograph and stimulate actions, interests and moods, or in the negative case, stifle them. They also give our experiences of being specific perceptual frames and horizons of understanding. Every space, place and situation is tuned in a specific way, and it projects an atmosphere promoting distinct moods and feelings. We live in resonance with our world, and architecture mediates this very resonance.

There are two levels of imagination; one that projects formal and geometric images, and another that also simulates the actual sensory, emotive and mental encounter with the projected entity. The first category projects the material object in isolation, the second as a lived reality in the life world.

True qualities of architecture are not formal or geometric, intellectual or even aesthetic properties; they are existential, poetic, and emotional experiences, and they arise from our embodied encounter with the work. Artistic images are not "pure" formal configurations, they are images that are embedded in the soil of human historicity, memory and imagination. Poetic images are new and ancient, at the same time. Like the archetypes, architectural images evoke recollections, feelings and associations. Existentially meaningful architectural spaces are not mere formal inventions, as they need to echo our mental world, and thus artistic experiences are essentially exchanges. They are not metaphors or symbols of something else; they are a reality in their own right.

A talented architect constructs the entire edifice in her imagination; every great building has thus been built twice, first in the immaterial realm of imagination, and then in the material world under the laws of physics. Every profound building has been imaginatively inhabited by its maker. It is usually understood that a sensitive designer imagines the acts, experiences and feelings of the occupant, but human empathic imagination does not work that way. The designer places herself in the role of the future dweller and tests the validity of her ideas through this imaginative exchange of roles and personalities. Thus the architect is bound to conceive the design essentially for herself as the momentary surrogate of the occupant. Without being aware of it, the designer also turns into a silent actor.

The design process is a vague and emotional process, alternating between internalization and projection, thinking and feeling, trial and error, which eventually becomes increasingly concrete and precise. The projected reality is internalized, or "introjected", and the self is simultaneously projected out into the space. A gifted architect feels and imagines the building, its countless relationships and details as if it were part of, or an extension of her own self and body. The designer does not project the building into her current reality of life, she imagines the future reality of the building and places herself there.

The most ephemeral and complex of these subconscious mental simulations is the instantaneous grasping of the entire atmosphere, ambiance, or mood of the space. This imagination of ambiance is demanding, because an atmosphere or ambiance is not an object, but something suspended between the setting and the subject. Imagination can rightly be named our most human and important mental faculty. Neurological and philosophical investigations have established that imagination is crucial even for the processes of perception, thinking and memorizing. It is high time, indeed, to give imagination its due role in our mental lives, self-understanding and education. I propose the topics of imagination, empathy and empathic imagination as a course in architectural education, as well as a subject matter for research in the neurosciences. Altogether, we create the world in which we live through our imaginative capacities, and it

is evident that we could not even have an ethical sense without being able to imagine the consequences of our alternative choices and actions.

2. AUTHOR BIO

Juhani Pallasmaa (b. 1936), Architect SAFA, Hon. FAIA, Int FRIBA, Professor Emeritus, Helsinki, has practised architecture since the early 1960s and established his own office Juhani Pallasmaa Architects in 1983 after having collaborated with a number of architects during twenty years. In addition to architectural design, he has been active in urban, exhibition, product and graphic design.

He has taught and lectured widely in Europe, North and South America, Africa and Asia, and published books and numerous essays on the philosophy and critique of architecture and the arts in over thirty languages.

Pallasmaa has held positions as e.g. Professor and Dean at the Helsinki University of Technology (1991-97), State Artist Professor (1983-88), Director of the Museum of Finnish Architecture (1978-83), Associate Professor at Haile Selassie I University, Addis Abeba (1972-74), and Rector of the Institute of Industrial Arts, Helsinki (1970-71).

He has held visiting professorships at The Catholic University of America in Washington D.C. (fall term 2011); University of Illinois in Urbana-Champaign (fall term 2010); the Washington University in St. Louis (1999-2004); University of Virginia (spring 1992) and Yale University (spring 1993), and taught and lectured in numerous universities, conferences, and symposia around the world including around fifty universities and architecture schools in the US.

His thirty-five books include: Encounters 2: Architectural Essays, Helsinki 2012; Understanding Architecture, London 2012 (in collaboration with Robert McCarter); The Embodied Image: imagination and imagery in architecture, London 2011; The Thinking Hand: existential and embodied wisdom in architecture, London 2009; Alvar Aalto Through the Eyes of Shigeru Ban, co-editor, London 2007; Raimo Utriainen – The Resonant Line, Helsinki 2007; Encounters: Architectural Essays, Helsinki 2005; The Aalto House, Helsinki 2004; Juhani Pallasmaa: Sensuous Minimalism, Beijing 2002; The Architecture of Image: Existential Space in Cinema, Helsinki 2001 and 2007; Alvar Aalto: Villa Mairea, Helsinki, 1998; The Eyes of the Skin, London 1996 and 2005; The Melnikov House, London 1996; Animal Architecture, Helsinki 1995; Maailmassaalon taide [The Art of Being-in-the-World: essays on art and architecture], Helsinki 1993; Alvar Aalto Furniture, Helsinki/Cambridge, Mass. 1987; The Language of Wood, Helsinki 1987, and; Alvar Aalto 1898-1976, co-editor, Helsinki 1978.

Pallasmaa has received three honorary doctorates: University of Industrial Arts, Helsinki, 1993 (in the arts); Helsinki University of Technology, 1998 (in technology), and; Estonian Academy of Arts, 2004 (in the arts). He is also Academician of the International Academy of Architecture, 2012, and member of the Pritzker Architecture Prize Jury, 2008-.

Pallasmaa has received several Finnish and international awards: Dean's Medal, Washington University in St. Louis 2012; Alfred Kordelin Prize for Lifetime Achievement, Helsinki 2010; Arnold W. Brunner Prize for Architecture, American Academy of Arts and Letters, New York 2009 (USA); Silver Plaque of the Museum of Finnish Architecture, 2006; Finland Prize, 2000; The International Union of Architects' Award for Architectural Criticism, 1999; Fritz Schumacher Prize (Germany), 1997; Russian Federation Architecture Award, 1996 (Russia); Helsinki City Culture Award, 1993; Finnish National Architecture Award, 1992.

Designing Healthy Daylight into Buildings

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1. ABSTRACT

Architects and designers rely on light as a fundamental tool in the creation of functional and inspiring spaces but light can be provided from both natural and artificial sources which can often have very different characteristics. The impact the design of the building has on our response to daylight is something that architects and researchers are just beginning to address; whether the quality and quantity of light is important to human health, more specifically maintaining the human circadian system.

This paper will present work that investigates the use of daylight by architects in order to provide internal environments that support health and well-being. In particular, it ascertains possible implications of improvements to the thermal performance of glazing on this resource and whether specific types of glazing system allow an appropriate quality and quantity of light transmission to the internal environment.

As well as considering how we evaluate the daylight available we also need to consider the transition of light to internal environments. Glass and glazing system design has developed significantly in response to requirements of improved thermal performance altering the reflectance, absorbance and transmission of light through these glazing systems. As the threshold between external natural light levels and internal lighting environment, glazing systems are the primary determinant of the quality and quantity of daylight that the building occupants receive.

These findings could have a significant impact on the design of buildings, in particular those where their occupants spend substantial time inside, such as hospitals. The apparent connections between health and natural light suggest that the design of these buildings particularly ought to take this into consideration as a major design driver.

2. AUTHOR BIO

Caroline Paradise's current role involves supporting the valuable integration of Design Research & Innovation across the IBI Group network. She is engaged in projects across the education, healthcare and science sectors, driving innovation through evidence based design. A qualified architect, Caroline previously worked for the Design Research Unit Wales (DRUw) at the Welsh School of Architecture where she was intensively involved in a range of Government funded research and construction projects, which cemented her understanding of the vital link between research and design. She is currently working towards the completion of her PhD in Daylight design and its affect on the building occupant at the Welsh School of Architecture, Cardiff.

The Sense of Presence: Utilizing Emotional Feedback

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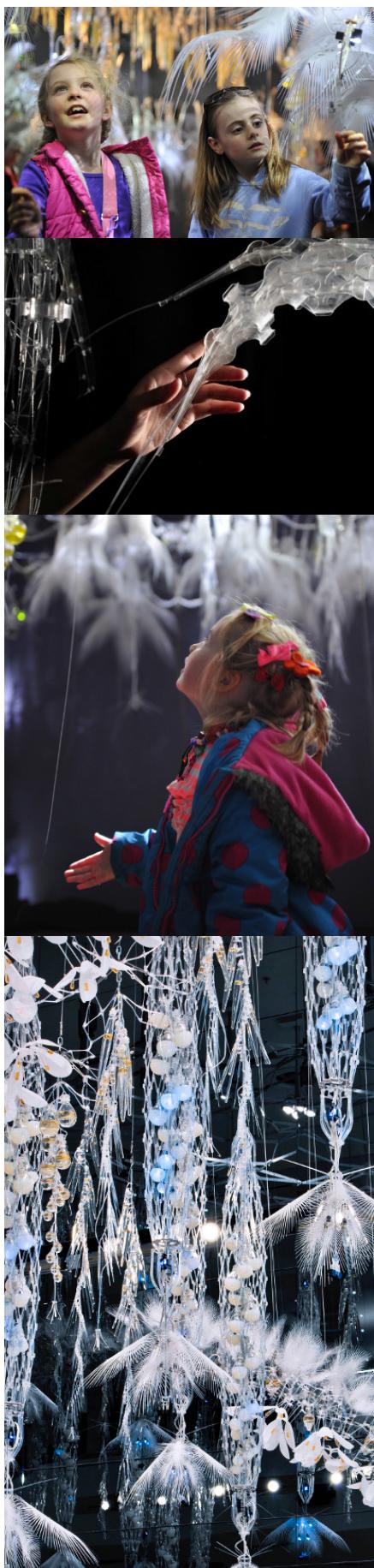
Ideas are prototypical until they occupy a presence that moves and excites the senses. Although architects desire to create idyllic places, the traces of ideas need to be present before spaces can become ideal responses. That is to say, the function of place is not rhapsodic, it is the transformation of space in conjunction with the trace of emotion. Architects spend a great deal of time determining functional requirements in order to designate the formation requirements of the project, but they do not spend equivalent efforts deriving the emotional requirements that partition them. Architects habitually profess that form follows function, but it is as imperative to state in the same sentence that function follows emotion. The natural starting point for this progression is the right temporal lobe: this is where the 'sense of presence' is at work, processing the stimuli tied to experience itself. This is contrasted by the processes of the left temporal lobe's 'sense of self', which determine how experiences are labeled, also referred to as the proto-experience. The projected environment is, thus, inherently tied to the sense of presence: its form, function and emotion must be addressed in terms of feedback signs, mechanisms and loops.

1. EXTENDED ABSTRACT

The interdisciplinary collaboration between Neuroscientists and Architects has the potential to generate more approaches for mitigating anxiety, independently of pharmaceutics and therapy, through the renegotiation of perturbations in the occupant's surroundings. The effects of environmental-stresses on physical and mental well-being have been adequately studied in laboratory research. Certain aspects of genetic expression and cellular regeneration have likewise been proven to be shaped by environmental conditions. It is the responsibility of architects to begin actively integrating the insights yielded by neuroscience into future conducive milieux. The flowering fields of Neuro-Behaviour and Enviro-Design have great potential for their cross-pollination to bear fruits that benefit the public's health.

Dr. Persinger's research into 'the sense of presence' has proposed ways for architects to consider how this brain function is specifically stimulated by elements set within the occupied landscape, such as spatio-temporal relationships, audio-visual stimuli, or analogo-digital signifiers. More importantly, his experiments provide precedents for how the 'sense of presence' may be engaged artificially through electromagnetic actuators, inspiring the conception of immersive therapeutic milieux. The responsive landscapes conceived by Arch. Philip Beesley provide fertile ground for developing these testbeds. More than merely being rich sculptural work and expansive multi-media installations, his investigations posit architectural methodologies for interfacing occupants with surroundings of verisimilitude to living ecosystems; he has developed organisational strategies for projecting material into spaces, constructing meaning into places and detecting traces of presence. Ultimately, the degree to which occupants sense presence in their surrounding can impact how much meaning they draw from the experience, overturning emotional depression and lowering anxiety-related stresses.





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Carlo Pasini is a graduate student at the University of Waterloo's School of Architecture with integrative capacities. Carlo's interest in the overlap between neuroscience and architecture stems from his personal experiences with cognitive therapy, neurological testing and neuropsych assessments due to his history with head-injuries. His on-going research explores how ideas are individuated through the heuristic iterations of autotelic acts. His Graduate thesis focused on the Hellenic Architekton's role as the astute, lucid and obstinate intermediary of principles. Carlo is in the process of editing five independent research papers for publication: The 'Anarchitecture' of Way-finding via the Information Communication Network; The Tektology of the Working Body; Framing the Experience of the Basilica Santa Maria in Trastevere; Monumental versus Ephemeral Concrete Casting.

CPsych, Dr. Michael Persinger is a professor at Laurentian University. His Masters of Physiological Psychology is from the University of Tennessee and his Doctorate of Behavioural Neuroscience is from the University of Manitoba, Canada. A relative of Frank Lloyd Wright, Architecture has always been one of Dr. Persinger's keen interests. He has carried out studies on the mental health effects that acoustic and lighting perturbations have over the cognitive performance of students during lectures and examinations at Laurentian University.

His personal practice and research is interdisciplinary. He has conducted a vast number of experiments using extremely low frequencies, testing its effects on the circadian patterns of the mind and on neural stem cell proliferation. Dr. Michael Persinger has been published in numerous scientific journals, peer reviews, and books as well as featured in documentaries.

MRAIC OAA RCA, Philip Beesley is a professor at the University of Waterloo's School of Architecture. A practitioner of architecture and digital media art, he was educated in visual art at Queen's University, in technology at Humber College, and in architecture at the University of Toronto. At U. Waterloo, he serves as Director for the Integrated Design and Manufacturing Group, as well as the Director for the Riverside Architectural Press. He also holds the position of Examiner at the University College, London. Philip has authored and edited eight books dealing with alterity and the chthonian definition of space. He has also been featured in an extensive selection of academic and popular publications. His Toronto-based practice PBAI is an interdisciplinary design firm that provides architectural services for public buildings, exhibition sets, lighting displays, and theatre stages. His designs focus on emotion in search of alternate paradigms to Modernism. PBAI has also experimented with proto-cellular growth as carbon sequestration strategies for interior spaces.

How Do You Feel Architecture? Heartbeats Induce Affinities with Virtual Interiors

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Several notions of embodiment are known in architecture. While embodiment is a well-studied phenomenon in cognitive neuroscience, little is known about the impact of architecture on human behavior and bodily self-consciousness. Here, we present a series of studies based on empirical scientific methods suggesting that the environment modulates the subjective experience of the body. We argue that our findings can be implemented into the architectural design process to improve and enhance the user's experience of space.

1. EXTENDED ABSTRACT

The Vitruvian ideal inscribes the architectonic module into embodied perception, and by associating the architectonic experience of material space to the human bodily senses, it became a lasting frame of reference. Particularly architects of the Quattrocento and the 19th century highlighted the embodied experience of space as a relevant criterion for the scientific conception of architectonic form (Pasqualini & Blanke, 2014). Embodiment unveils great potentials for immersive Virtual Reality (VR), where – like in Merleau-Ponty's phenomenological space – the body is introduced as the 'third figure' in the artistic figure-ground scenario. What are the effects of virtual architectonic shapes on the user, and, reversely, of the user on the virtual architecture? Is there a mutual interaction between architectonic space and the observer's experience of herself in space? In the past decade cognitive neuroscientists have studied embodiment by focusing on the concepts of body ownership (or self-identification with one's own body or body parts) and self-location. That is, bodily self-consciousness has been defined as the unity between the highly subjective feeling to own a body and to exist at a unique position in space (Blanke & Metzinger, 2009). Scientists have found ways to manipulate bodily self-consciousness in the laboratory and to interfere with the unified conscious experience of one's own body or body parts through multisensory illusions, such as the Rubber-Hand-Illusion or the Full-Body-Illusion: visuo-tactile synchronous stimulation of one's own body and of an artificial body induces body ownership for the artificial body and a shift in self-location towards the artificial body (Lenggenhager, Tadi, Metzinger, & Blanke, 2007; Serino & Haggard, 2010). More recently, similar paradigms and illusions have been extended to the field of interoceptive sensations, by applying visual stimulation to an artificial body synchronized with the participant's heart-beat (cardio-visual stimulation) or respiration (pneumo-visual stimulation) (Aspell et al., 2013; Rainville, Bechara, Naqvi, & Damasio, 2006). Could it be that, if architectonic elements are subjected to similar multisensory manipulations, architectonic space itself is perceived as if it were part of one's own body and integrated as a whole in the perception of one's body, in a similar manner as shown for external objects (Armel & Ramachandran, 2003; Hohwy & Paton, 2010)? In our previous research we have applied the Full-Body-Illusion in virtual rooms of large and narrow size (Pasqualini, Llobera, & Blanke, 2013; Pasqualini et al., in preparation). We have shown that the size of the room significantly affects the way participants self-identify with their virtual bodies, and, reversely, that altered self-identification and self-location modulate the way in which the interiors are perceived based on the position of the surfaces near or far from the body. In addition to the responses of self-identification with the avatar, we have also found architecture specific effects, such as touch illusion with the walls; sensations of drift in space and the feeling of walls retracting towards ones own body. In the present study we placed 18 participants into an immersive virtual interior of which surfaces randomly displayed three-dimensional human bodies or blob shape objects in a VR mini-Cave (Figure 1). We recorded the participants' heart rate (ECG), and we used the signal to project the bodies or the blobs shapes within the virtual interior, either in real-time (synchronous) or with a delay (asynchronous). After each condition (Bodies or Blobs, synchronous or asynchronous) participants answered to a questionnaire adapted from previous experiments to assess the subjective bodily experience in the virtual interiors (Aspell et al., 2013; Pasqualini et al., 2013) and rated their emotional states. We also tracked the participants' head position to measure the participant's movements. When participants saw the Blobs, they felt "as if they were touched by the flashing volumes".

Such effect was even stronger when the Blobs appeared synchronously with the participant's heartbeat. Viewing the Blobs also induced the sensation that "the interior was drifting towards them". On the other hand, when Bodies or Blobs appeared synchronously with the heartbeat, participants reported, "as if they were drifting towards the interior". When the Bodies were presented synchronously with the heartbeat, participants showed the tendency to oscillate back and forth (shape*synchrony, $p=0.08222$). Viewing the Bodies also induced stronger changes in the participants' actual heart rate, and such effects were more frequent in case of asynchronous cardio-visual stimulation. Participants reported higher degrees of fear and less comfort when viewing the Bodies. Overall, our new results show that both, shape and architectonic interior affect the subjective experience of one's own body in space. The integration of body-related stimuli (interoception) and visual stimuli related to external objects strongly contributes to such effects. We discuss the links between embodied, self-conscious experience of architectonic space and novel experimental designs. We argue bodily feelings and sensations are fundamental in the design process and the user's experience of space.

ACKNOWLEDGMENTS

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Isabella Pasqualini graduated as an architect at the Swiss Federal Institute of Technology in Zürich (ETHZ). After professional practice in Switzerland and abroad she founded a design firm in 2004. Since 2012 she holds a PhD degree in architecture and cognitive neuroscience from the Swiss Federal Institute of Technology in Lausanne (EPFL). She has been visiting Professor at the Art & Design Academy of Tsinghua University in Beijing and is currently a lecturer at the EPFL. In 2013 she received the Cogito Fellowship grant to pursue scientific practice in architecture. Her works were presented at the Swiss Art Awards in 2008 and 2010, the Espace d'Art Contemporaine 'Les Halles' in 2011, the Beijing Design Week and Beijing Triennale 2011, as well as the Shanghai International Science & Art Exhibition where she received the SAST award in 2012. Isabella Pasqualini has won several international competition prizes and worked as an expert for the City of Helsinki and the City of Rome in Italy.

Olaf Blanke is founding director of the Center for Neuroprosthetics, Bertarelli Foundation Chair in Cognitive Neuroprosthetics at the Swiss Federal Institute of Technology (EPFL). He also directs the Laboratory of Cognitive Neuroscience at EPFL and is Professor of Neurology at the Department of Neurology at the University Hospital of Geneva. Blanke's research is dedicated to the neuroscientific study of multisensory body perception and its relevance for self-consciousness by using a broad range of methods such as neuropsychology, invasive and non-invasive electrophysiology, and brain imaging in healthy subjects, neurological and psychiatric patients. Most recently he has pioneered the joint use of engineering techniques such as robotics and virtual reality with techniques from cognitive neuroscience and their application to systems and cognitive neuroprosthetics and neuro-rehabilitation.

An fMRI-Based Exploration of Neural Correlates of the ‘Formal’ Environmental Attributes of Healthcare Settings

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This study explores neural activation in adult brains in response to visual stimulus containing formal environmental attributes. This study focuses on emotional impact of visual stimuli, and bridges the evidence between environmental psychology and neuroscience, to identify specific visual properties that elicit emotional responses. This study investigates a particular visual property “contours” and explores it within the theoretical paradigm of neuro-architecture to generate specific hypotheses for architecture and neuroscience.

1. EXTENDED ABSTRACT

The aim of this study was to explore brain activation in response to visual stimuli containing formal environmental attributes. Architecture relies on visual stimuli to conceive, design, present, and even experience built environments. Currently, very little is known regarding the impact of these formal environmental attributes on human perception and cognition, much less their subsequent impact on behavior. More specifically, little is known regarding the relationship between a primary attribute of the physical environment – e.g., contours – and neural activations.

Contours represent one of the fundamental environmental attributes relating to form – a major decision taken by designers of the physical environment. How does the human brain react to different contours? The focus of this study was on the “rapid” initial, arguably pre-cognitive responses that may shape the emotional affordance of an environment. Bar and Neta (2007) conducted a preference study on everyday objects with curved or sharp edges and found that respondents preferred objects with a curved contour compared with objects that have pointed features and a sharp-angled contour. This bias was hypothesized to stem from an implicit perception of potential threat conveyed by sharp features. Human neuroimaging was used in a second study to test this hypothesis, and it was found that the amygdala was significantly more active for sharp objects compared with their curved contour counterparts.

Our study extends Bar and Neta (2007) by exploring the potential influence of the contour information of meaningful healthcare settings on amygdala activation. Thirty six subjects were exposed to four classes of images (exteriors, interiors, objects, and landscapes), in three contour types (sharp, curved, and balanced). The images were presented to subjects while in a 3T fMRI scanner and the magnitude of activation of the amygdala to each image type was compared. Amygdala activation while viewing objects and landscapes confirmed the Bar and Neta (2007) findings – sharp contours were associated with significantly higher activation. However, the pattern was reversed in the case of built forms (exteriors and interiors) – a finding of substantial importance to healthcare design. This session will present the methodology and findings, and offer some plausible hypotheses to explain the reversal.

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3. AUTHOR BIOS

Debajyoti Pati: Dr. Pati chairs the Rockwell Professorship in the Department of Design, Texas Tech University. He has written and published extensively on healthcare design research, internationally. He was twice voted among the 25 most influential people in healthcare design in the United States, and is a three times recipient of the best international research project award from the International Academy of Design and Health. He served as the vice president and director of research at HKS Architects, before moving to Texas Tech in 2011.

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Jiancheng Hou: Dr. Jiancheng Hou is the post-doctoral fellow at Department of Human Development and Family Studies, Texas Tech University. He finished his doctoral program and got Ph.D. from State Key Lab of Cognitive Neuroscience and Learning, Beijing Normal University. He mainly focuses on cognitive neuroscience, with the skills of neuroimaging such as task-based and resting-state functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI).

Hessam Ghamari: Hessam Ghamari serves as a Teaching/Research assistant in the Department of Design at Texas Tech University, where he is pursuing a PhD with emphasis on healthcare design. His doctoral dissertation focuses on the importance of wayfinding in u. In 2013, he was awarded the "Best Student of the Year" in the college of Human Sciences at Texas Tech University. He has published numerous articles in journals and international conferences on environment psychology, evidence based design, and healthcare design.

Visual Impairment and Spatial Cognitive Neuroscience

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1. ABSTRACT

Visual experience is necessary for the normal development of spatial cognition (Pasqualotto & Proulx, 2012). Here we will review how visual experience impacts spatial processing and therefore is a relevant consideration for architectural design. First, congenitally blind participants rely on an egocentric reference frame for spatial cognition tasks, rather than an allocentric reference frame that is favored by late blind and sighted participants (Pasqualotto, Spiller, Jansari, & Proulx, 2013). This suggests that visual experience can influence the neural basis of spatial representations, given the importance of vision for normal multisensory processing (Proulx, Brown, Pasqualotto, & Meijer, 2012). Second, visual experience impacts the development neural regions for multisensory spatial representation (Huang, Chen, Tran, Holstein, & Sereno, 2012). This was revealed when we examined specifically the representation of tactile maps in multisensory areas, such as the putative human ventral intraparietal (VIP) area (Sereno & Huang, 2006). Congenitally blind participants did not have the same representation of the face map as those with visual experience. This finding suggests that visual, rather than tactile, processing dominates activity in this parietal area. Our current work is examining how activity in this area is influenced by transparent barriers. A glass barrier might protect the body from an approaching object, while allowing for full visual perception of the object. Given that this parietal region is involved in defensive movements to protect the head from approaching objects (Stepniewska, Fang, & Kaas, 2005), we are exploring whether the perception of a transparent barrier reduces the activity in this region in response to a looming stimulus. These converging results suggest that the underlying neural and psychological representations of space are influenced by visual experience, or the lack thereof, and design should consider how to best build environments that are congruent with the neural and psychological responses of the inhabitants.

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Michael J. Proulx is Associate Professor in Psychology and director of the Crossmodal Cognition Lab at the University of Bath. His research focuses on unveiling how our senses interact to represent the world, and he has a particular interest in the impact of blindness on cognition. He is a Fellow of the American Psychological Association and was honored as a torchbearer for

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Alexandra A. de Sousa, Ph.D., is an expert in human brain evolution. Her research answers questions such as: What are big brains for? How is the human brain unique and how did it evolve? Dr. de Sousa has held multiple international research positions and has wide-ranging collaborations, based on which she founded the European Network for Brain Evolution Research. Currently she is part of a VW Stiftung-funded investigation at the intersection of neuroscience and architecture, and here and elsewhere aims to enlighten applied research with an evolutionary perspective.

Towards User Personalized Environments: An Artistic Exploration Using an EEG-Based Brain-Computer Interface

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This study in progress consists of virtual-reality-based artistic installation controlled by an EEG headset and evaluates the potential of BCI (brain computer interfaces) devices for use in generative virtual environments, as well as the users' perception of their own influence on these environments. The goal of this study in progress is to explore the design of a 3D computer-simulated virtual environment that directly responds to users' current emotional and cognitive state, and to test to what degree users are aware of their influence on the system. Combining artistic and scientific approaches in this work, we have found that users were able to perceive differences in the model (the virtual environment projected in physical space) caused by the changes in their inner states. Even though users were not able to precisely describe their feelings, they were able to detect changes in their emotional states and to relate those changes to the changes in our model. We evaluate the possible uses of emotional state tracking in virtual and built environments .

1. EXTENDED ABSTRACT

With the development of low-cost brain – computer interface (BCI) devices, a number of authors suggested (Zander et al.,2011) that BCI devices should be considered as a state tracking tool rather than merely a task processing device (e.g. moving a cube on a screen). Studies conducted so far were focusing mostly on technical aspects (such as accuracy, response time and reliability) of BCI devices when used as game input, on practical implications for people with disabilities, or for real time processing tasks. This study focuses on qualitative aspect of BCI devices in tracking users inner states in creating an immersive ambient art installation,.

As a first prototype and testing platform we designed a virtual environment in Unity3D in form of an art installation. This installation incorporates an EEG-based BCI, and it is placed in a dark room with a video projection displaying a flock of birds. Simulation parameters (number of birds, flying speed and motion type, as well as ambient soundscape) either directly corresponded to the user's current state assessed in real-time by an Emotiv Epoc EEG headset (experimental condition), or were randomly generated (as a control condition).

Participants were drafted from the visitors in the exhibition. A total of 13 participants completed the experiment (8 female). No age limit was established, but mainly the participants were within 18 - 50 years old range with different knowledge backgrounds. Participants were simply asked to "explore the system". The experiment consisted of two conditions: experimental condition (controlled by Emotiv EPOC) and control condition (randomly generated input data); it was executed in two stages. In the first stage the participants were exposed to the model and asked to fill in the affect grid prior to and after the session. The second stage of the experiment consisted of an audio-recorded interview and a questionnaire. Questions were oriented towards finding answers about degree of immersion, system responsiveness, degree of users' influence on the system, as well as towards finding overall impression of the system. Despite lack of any detailed explanation of how the system works, post-experimental interview and questionnaire data confirmed our hypothesis that participants are typically aware of the amount of control they do or do not have over the environment, which directly affected their degree of immersion in the environment. This corroborates the potential of designing BCI-supported interactive environments. The overall impression of the system was positive, and participants reported pleasant feelings and stressed the meditative quality of our system.

Insights gained will help to guide the development towards our long-term goal of creating a truly interactive system that not only reads a user's states but creates a feedback loop between the user's state and the perceived environment that allows us to shift the user's emotional state in the direction that the user desires (e.g., more relaxed or more engaged states). To this end, we will research common principles of expanding environment from virtual to physical, built, spaces and investigate which aspects of a physical or virtual environment are most likely to steer the emotional state in the desired direction.

The long-term goal includes research on how to create, reshape, and adapt surrounding environments

(virtual and real) to make them responsive to the users' presence in that space (e.g., movement, thoughts, feelings, and expressions). We hope to implement our findings into built environments in order to create personalized, state driven architecture that will enable users to interact and explore their inner states, individually and collectively

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3. AUTHOR BIOS

Mirjana Prpa is an architect, a virtual reality utopian and a graduate student - researcher at iSpace lab for Virtual Reality at School of Interactive Arts and Technology, Vancouver, Canada. She received a Master Degree in architecture from the University of Novi Sad, Serbia, and has worked mainly on ephemeral designs for performance art projects including projects for theaters and open public spaces. Her current research is in user personalized spaces that are created based on user's emotional states and traits which are resonating with the environment , both virtual and physical.

Svetozar Miucin is a PhD student in the School of Computing Science at Simon Fraser University. Aside from his main research path, which is currently oriented to improving memory behaviour of complex software systems, he is interested in the places where computing science meets areas like interactive arts, neuroscience and social studies.\

Bernhard E.Riecke: As an assistant professor at the School of Interactive Arts & Technology at SFU and associate member of the SFU cognitive Science Program, Riecke is one of the leading experts on self-motion illusion and how it can be implemented and utilized in immersive Virtual Reality to enable more natural embodied spatial perception, cognition, and behavior. This fundamental knowledge is employed to guide the design of novel, more effective human-computer interfaces and interaction paradigms that enable similarly effective processes in computer-mediated environments (such as virtual reality, immersive gaming, and multimedia). Riecke's scholarship is exemplified by more than 70 peer reviewed papers and book chapters, including four best paper awards (ACM & IEEE conferences) and four invited speaker appearances at international conferences and workshops.

On the Visual Experience of Meaning, Dwelling, and Place

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1. ABSTRACT

It is well established that our vision breaks down into two separate pathways of central and peripheral processing (Leibowitz & Post, 1982; Mishkin, M., Ungerleider, L. G., & Macko, K. A., 1983; Livingstone, M. S., & Hubel, D. H., 1988; Norman, J., 2001). Each pathway responds to distinctly different types of information within the world around us; central vision is concerned with meaning, or what an object is, while peripheral vision is concerned with our dwelling or action, within a place or scene, in an environment (Goodale, M. A., & Milner, A. D., 1992; Larson, A. M., & Loschky, L. C., 2009; Leibowitz & Post, 1982). What is less known is how our visual experience of meaning, dwelling, and place is processed through these two pathways within the context of an emotional reaction to architecture (Heidegger, M., 1971; Norberg-Schulz, C., 1976).

In regards to emotions, neuroscientist Antonio Damasio describes two types of fundamental emotional reactions as primary and secondary emotions (2005). He defines primary emotions within the tone of action, while his definition of secondary emotions refers to the processing of semantic, or the meaning of, information present in the world. Given Damasio's definitions, there exists an overlap in the visual processing pathways and the two types of emotional reactions mentioned. Here, central vision processes "what" an object is in the context of our secondary emotions of meaning, like the objects painted in the caves of Cantabria, Spain, while our peripheral vision processes the primary emotional "actions" we perceive when dwelling in the scene of our environment, much like Monet's Impression, Sunrise.

As Louis Kahn's setting sun provides celestial meaning to the dwelling of place within the Salk Institute's plaza, our contribution for the presentation at ANFA is to illuminate a logical distinction between naturally dwelling within architecture through peripheral vision and examining the meaning of architecture through central vision. This is a distinction that divides the experience of place from the analysis of built form.



Figure 1. Altamira Bison, Cantabria, Spain by Ramessos

<http://commons.wikimedia.org/wiki/File:AltamiraBison.jpg>



Figure 2. Monet's Impression, Sunrise by Paris 16

http://commons.wikimedia.org/wiki/File:Monet_-_Impression,_Sunrise.jpg

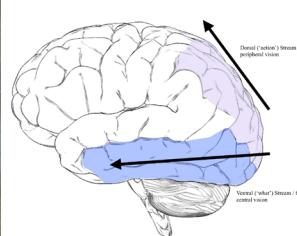


Figure 3. Dorsal versus Ventral Stream by Selket (modified by author)

http://commons.wikimedia.org/wiki/File:Lobes_of_the_brain_NL.svg



Figure 4. Salk Institute Sunset by Tom Shess (modified by author)

<http://www.webestates.biz/wp-content/uploads/2014/01/tom-shess-pillar-post-salk-institute-solstice-sandiego-34823.jpg>

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3. AUTHOR BIOS

Kevin Rooney is the director of innovations at Dimensional Innovations and principal investigator for the Architectural Perceptions Lab at Kansas State. His work encompasses a diversity of scale and design disciplines, from engineering works like the facade for Cooper Union by Morphosis, the Taubman Museum of Art by Randall Stout, and 40 Bond by Herzog and de Meuron, to designing wearable technologies in response to the human experience of the internet-of-everything. He is currently a Ph.D. candidate studying neurocognitive design at the College of Architecture Planning and Design in conjunction with the department of Psychological Sciences and the department of Philosophy at Kansas State University with a professional degree in Architecture from the University of Arkansas. His work is focused on understanding how designed environments are cognitively processed through the visual perception stream and how those perceptions form our physiological responses into certain types of emotional experiences. He is the co-founder of the Architectural Perceptions Lab at Kansas State along with his Major Professor Bob Condia in the study of physiological responses to architecture. He also works closely with the Visual Cognition Lab run by committee member, Dr. Lester Loschky, to understand visual perception and attention as related to environmental conditions.

Bob Condia is an architect and design partner with Condia+Ornelas Architects, an award winning practice cited for intimately scaled and palpable experiences. A professor of architecture at Kansas State, he teaches architecture as an art form with due considerations to: beauty; coaching expertise; structural determination; the ancient works of man; a building's terrestrial and celestial alignments; phenomenology of perception; poetics of space; and the perception of constructed space from neuroscience. He has been a design studio critic for 30 years in both architecture and interior design. In 2008, he received the Kansas State's Commerce Bank Distinguished Teaching Award. His publications range from monographs on progressive architects theoretical articles on the experience of space (focusing on Louis Kahn and Alvar Aalto); to a catalogue of his own surrealist illustrations; and discussions of creativity and expertise. Of particular interest to this abstract are his advanced seminars in perception that combines architectural theory, analytical philosophy and the neuroscience of aesthetic experience. Rare for an architect, he is certified in human subjects and won a university grant to equip a graduate lab with feedback gear, used in a study of emotional response to architectural imagery; "Architecture and Mood: physiological response to images of houses." Prof. Condia earned his Master in Architecture and Building Design at Columbia University 1983, and a Bachelor of Architecture at California Polytechnic State University, 1980.

Lester Loschky is an Associate Professor of Psychological Sciences at Kansas State University and heads the Visual Cognition Laboratory there. He does research and teaches primarily in the areas of Perception and Cognition, which intersect in the area of Visual Cognition. One of the major themes in his research over the last 20 years has been the perception of real-world scenes across the visual field, from central to peripheral vision. This research has generally focused on several key inter-related issues: the relationship between eye movements and attention, how peripheral vision guides attention, how perceptual quality varies from central vision to peripheral vision, and how much information from peripheral vision a viewer can process at any given moment in time during a single eye fixation. His work with Kevin Rooney and Bob Condia is at the confluence of several of the above issues with the experience of architectural environments.

Spirit of Place, Spirit of Discovery: Special Program to Celebrate the Centenary of Jonas Salk's Birth

PETER SALK, M.D.; JOHNATHAN D. SALK, M.D.; JOHN PAUL EBERHARD

1. ABSTRACTS

OVERVIEW AND INTRODUCTIONS

PETER L. SALK, M.D.

Jonas Salk would have been 100 years old on October 28 of this year. He lived a life devoted to bettering the human condition, through his work on developing the first effective influenza and polio vaccines, his founding of the Salk Institute, his research into the treatment of cancer and autoimmune disease, his efforts to develop a vaccine against HIV/AIDS, and his ceaseless questioning of what humanity needs to do to bring out the best in ourselves as individuals, as a society and as a species. This special session in honor of Jonas Salk's centenary will consider his contributions in the field of architecture, including the stimulus he provided which led to the formation of ANFA, and the special relationship that existed between scientist and architect that resulted in the design of the Salk Institute. It will also consider the particular features of the Salk Institute's design which shape the experience people have of the site, the neural mechanisms underlying profound and transformative aesthetic experiences, and the "Anatomy of Reality" (the title of Jonas Salk's last book) that may underlie the human experience of grand architecture.

PERSONAL REFLECTIONS ON JONAS SALK AND LOUIS KAHN

JONATHAN D. SALK, M.D.

The Salk Institute was conceived of, founded and built when Dr. Salk, the youngest of Jonas Salk's three sons, was in his late childhood and early teens. In this presentation, he offers his personal recollections of that period of time with a particular emphasis on the design of the buildings and the extraordinary creative relationship between Jonas Salk and Louis Kahn.

ON THE ORIGINS OF ANFA: JONAS SALK, THE AIA AND INSPIRATIONAL ARCHITECTURE

JOHN PAUL EBERHARD, FAIA

Jonas Salk in a meeting with the Executive Committee of the American Institute of Architects Foundation (which included Norman Koonce and Syl Damianos) told of his experience at Assisi. Because he had been so stimulated by the architectural setting of Assisi he suggested someone in the architectural profession explore how and why the brain responds to attributes of the designed environment. Norman and Syl recruited me to play that role (in 1995).

2. AUTHOR BIOS

Peter L. Salk, M.D., the eldest son of Dr. Jonas Salk, graduated Phi Beta Kappa from Harvard University in 1965 and Alpha Omega Alpha from Johns Hopkins University School of Medicine in 1969. Following two years of house staff training in internal medicine at the University Hospitals of Cleveland, he worked in his father's laboratory at the Salk Institute from 1972-1984 conducting research on immunotherapy of cancer and autoimmune disease, and strategies for vaccine production. He worked again with his father from 1991-1995 on a project to develop an inactivated vaccine for HIV infection, and subsequently worked on the introduction of AIDS treatment programs in Africa and Asia. He is currently President of the Jonas Salk Legacy Foundation, where he is devoting attention to educating the public regarding his father's life and work during the centenary year of his birth in 2014-2015 and to extending and applying his father's vision to help address humanity's present challenges and opportunities. Dr. Salk is a member of the ANFA Advisory Council.

Jonathan D. Salk, M.D. is a psychiatrist in private practice in Los Angeles, CA and Assistant Clinical Professor of Psychiatry at the UCLA/David Geffen School of Medicine. He completed his undergraduate work at Harvard and Stanford Universities with a degree in Anthropology. He received his MD from the University of Southern California and did residency training in Psychiatry at UCLA, followed by a 2-year fellowship in Child and Adolescent Psychiatry. His current interests are in integrating biological, psychotherapeutic, neuropsychological and family approaches in the treatment of psychiatric disorders. In addition, he has expertise in the treatment of trauma and with focus on the developmental consequences of early childhood experience. In 1981, he co-authored with his father World Population and Human Values: A new reality and is currently working on a revised edition. He lives in West Los Angeles with his wife Elizabeth Shepherd. They have two sons, aged 23 and 20.

John Paul Eberhard, FAIA, the founding president of ANFA, earned his BS in Architectural Design from University of Illinois and MS in Industrial Management from MIT. His career highlights include serving as Director for the Institute for Applied Technology;

Dean of Architecture and Environmental Design at SUNY Buffalo; President of AIA Research Corporation; and Head of the Department of Architecture at Carnegie Mellon. Eberhard's expertise and passion for the intersection of architecture and neuroscience are demonstrated through his work as a Consultant on Research Planning for the AIA, the research he conducted as a Latrobe Fellow, as well as, his continued guidance and dedication to ANFA.

Allotopes: Place, Moment & Thought (Explorations in Neuro-Architectures)

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AlloTopes is a series of 6 black and white drawings with an accompanied sound piece listened through a pair of headphones. The work is generated as a specific frozen moment chosen from a dynamical system by six friends (three women and three men). One at a time each person was asked to wear a wireless EEG headset, which samples the electrical action potential of his or her brain waves. Their mental modulations are analyzed using real time DSP and turned into a real-time visual geometrical landscape and soundscape that they become immersed in. During the continuously transforming experience, the user is asked to select a moment, in which they feel particularly compelled by; something, which they personally resonate with and are invited to freeze that moment. Data, image, signal and geometry of the chosen moment are then saved and through a series of processes used to produce a drawing, which is unique and specific to those person's mental proportions. Lastly, a soundscape is composed using this mental moment data, focusing on translating the aural proportions into temporal and harmonic cues. The two are meant to experience together, hearing the drawing and seeing the sound, one special moment, within a world, within each one of us.

1. ALLOTOPES

1.1. INTRODUCTION

How might one diagram the patterns found in a stream of collected data related to a certain experience? How would these patterns compare to the experience itself? Might they help us understand how we feel, what our favorite color is, or the things that we don't prefer despite how we may be convinced otherwise? How might these developments affect current fields of praxis and theory? Might new fields merge or ideas that were once prevalent become relevant once again? How might these concepts materialize, generalize and perhaps most importantly, specialize? These are not new ideas, rather they are ideas that beg to be continually imagined, reconstituted and reconfigured. Allotopes and the ideas that led to its realization have their roots in these questions and point towards a relationship with architecture and spatial thinking. These drawings do not follow a scientific systematic process, though they are produced by a methodical approach. They do not objectively define an emotion or feeling, though there may be a particular understanding to which the drawings allude. Technical processes are utilized without alienating our sensibility; the rule based system subject to the rational nature of the intuitive, neither enslaved by the other. Sequences and structures grow from the micro to the macro, determining a compositional arrangement, a notational drawing, scoring one specific moment within a world, within each one of us, celebrating the local universal.

1.2. OTHER-PLACES

Allotopes are a series of six black and white drawings with an accompanying soundscape. The intention is to experience these two modalities together, hearing the drawings and seeing the sounds; the music of the mind. A "Tope" is a place, a specific and spatial moment chosen from a dynamical system unique to one person while connecting to the others, the "Allo". Each drawing is unique and specific to each person and their experience. The work experimented with the selection of a moment from a continually evolving dynamic system. A frozen moment by using a balance between ones conscious taste, proportions of bio-data and the patterns found throughout the other's chosen moments. Sensibility — Specificity (Sense - Sample - Select - Scan - Synthesize)

1. The visual and aural translation of bio-data
2. Interacting with a self-generating system
3. Selecting a frozen moment from a dynamic system
4. Personal spatial preferences and proportions
5. Scanning for preferential patterns
6. Specification through the particular

1.3. PROCESS

One at a time, six friends (three men and three women) were asked to sit in front of a large screen and a pair

of speakers while wearing a wireless EEG headset that samples the electrical activity occurring in the brain. The content presented was a visual and aural composition that used the raw data from the EEG and translated through variable spatial parameters, and into a virtual scene of geometries, colors, textures, pitches and intensities. This provided a window into a world where one was witnessing their personal data as it was occurring. Immersed in their own continuously transforming experience, each friend was asked to select, freeze, and save a moment they found particularly compelling a moment in the visual and aural space that they personally resonated with. Emphasis was placed on the decision by allowing the dynamic system to be frozen at any time giving the freedom to inspect and analyze the process, yet limiting the final selection to only one moment. The data associated with this moment was collected, saved, filtered and scanned, noting the proportions and patterns. The results were compared across all sets and a group-set was produced that fed-back into the translation process, tuning each set to the common bond and celebrating the differential unity. This process finalized with the patterns and proportions translated to geometry, and the final drawings emerged. Lastly, a soundscape was composed using the resolved data, focused on translating the proportions into temporal and harmonic cues. As each drawing exists in space, its corresponding sound is scored through time. One after another, each person's selection flows in and out as the group-set grounds the piece with its modulating flow and rhythm. (Listen at: soundcloud.com/socinematic/allotopes-blindspot)

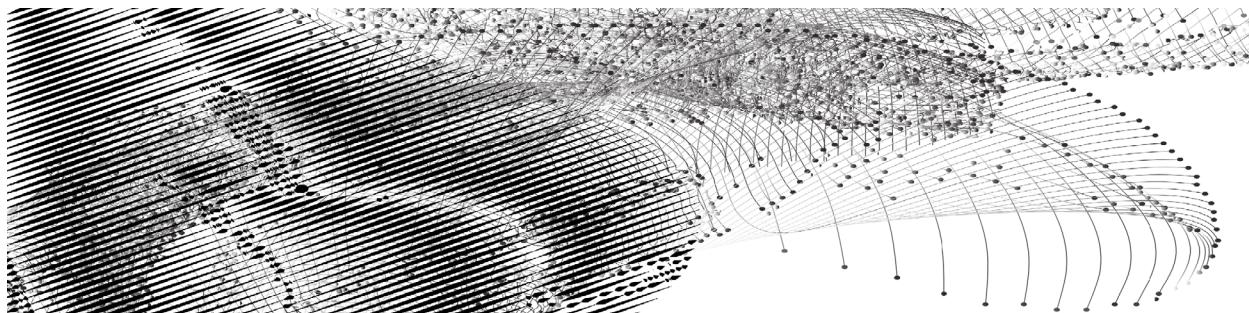


Figure 1. Allotopes Composition Study

ACKNOWLEDGMENTS

Marcos Novak: MAT, UCSB

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Dr. Neil Leach: USC Architecture

Alan Macy: BIOPAC

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Allotopes Website: www.alternity.info/works/allotopes/

3. AUTHOR BIO

F. Myles Sciutto is an architect interested in the dynamics between architecture, sound, sense, sensibility and the dialogue between architecture and the body. He received his Masters of Architecture from SCI-Arc where he received the Best Thesis Honor studying with Jean-Michel Crettaz, Michael Rotondi and Benjamin Bratton. He is currently a PhD student at UCSB studying with Marcos Novak and holds a Lecturer position at USC School of Architecture teaching studios that focus on the role of interactive systems and sound within Architecture. As a teacher and a maker, his work encourages the development of behavior and feedback within the composition of spatial environments and reactive mechanisms between the body, sound and space. He has taught and critiqued at SCI-Arc, USC, Columbia, Art Institute and Art Center and lives in downtown Los Angeles.

Speaking Space: Developing a Cognitive Language for Architects

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1. ABSTRACT

GOALS

1. Describe, for neuroscientists and architects, an evolving approach to influencing architectural training through an understanding of neuroscience.
2. Describe the enhancement of traditional architectural design can be modified and enhanced by integrating neuroscience.
3. Clarify the common underpinning of art, architecture and neuroscience as it relates to architectural design and experience.

SUMMARY

Graduate architecture students in a course titled Beauty & Brains learn about architecture and neuroscience in theoretical and practical terms, fostering significant changes in attitude, analytical assumptions, design process and philosophy. They learn and rehearse a design process parallel to, and in contrast to, traditional design methodology. Architecture and neuroscience together open the door to an alternative way of looking at architectural experience. It is a rich source for understanding and one that appeals to the interests and appetite of graduate level architecture students. The course weaves together neuroscience, environmental psychology, theories of art and theories of architecture. An integrated view develops from an understanding how the senses operate in humans, how perception organizes sensory information, how cognitive process connects perception to meaning, and how action, from an architectural viewpoint, is triggered. "Artistic Tension" is defined cognitively. The notion of "comfortable environments" is explored. In these areas, there is connection with the keynote speaker, Juhani Pallasmaa. A related project, the Design of a House for a Blind Composer, will be given a brief introduction. The design precluded use of visual cues and relied instead on other senses for architectural effectiveness. A side-by-side comparison between traditional (form-driven) and neuroscience-oriented (experience-driven) architectural design processes will be presented.

COURSE COMPONENTS

- » An introduction to neuroscience and cognitive process as they relate to the experience of architectural space and form
- » An introduction to cognitive theory derived from an evolutionary perspective
- » Investigation of primary aesthetic issues, also from an evolutionary perspective
- » A theoretical approach to incorporating neuroscience into architectural thinking, in abstract, practical and historical terms
- » Development of a language of design addressing cognitive and affective elements of responsive design solutions

Examples of significant buildings will be provided, citing them as examples of cognitively responsive design, along with student work. Academic

2. AUTHOR BIO

ACADEMIC

The Catholic University of America, Adjunct Associate Professor. Teaching, since 1977, studio courses from the two-semester freshman course through Thesis, as Visiting Critic, Studio Master and Thesis Chair, as well as creator of required non-studio courses. The latest course is Beauty & Brains, an advanced theory graduate level elective. This course grew out of the development of a freshman architecture program. During research for that course, the author, dissatisfied with the traditional Basic Design curriculum, investigated art theory. The course was profoundly changed after finding powerful insights in the writings of E.H. Gombrich and Rudolph Arnheim, moving from pure design exercises to investigation with the students into

the cognitive basis of architectural experience and architectural design. The author's long interest in science and medicine supported and helped motivate a search for a productive meeting place between architecture, science, art and design process.

PROFESSIONAL

Shinberg.Levinas Architects Founding Principal. Has led the design of approximately two-million square feet of educational environments from birth-age through higher education. A core element of these projects is an ongoing search for ways to organize and shape space to resonate with the needs and goals of each educational program beyond normative program quantifiers. Investigation of qualitative requirements, through words and images has been integrated in initial ideas and development of design ideas. Lessons learned in teaching the perception and cognition of architectural space have been applied through these projects.

Virtual Environments to Assess Facility Design for the Cognitively Impaired

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It is difficult to assess the impact that architectural designs have on individuals with age-related cognitive problems, such as Alzheimer's disease and mild cognitive impairment. We have developed an immersive virtual reality system to assess the behavioral and physiological conditions of subjects while interacting with a realistic virtual environment, assisting clinicians in cognitive evaluation and architectural designers in designing for cognitive difficulties.

1. ABSTRACT

It is difficult to obtain solid evidence of how aspects of a built environment affect the inhabitants of that environment. It is particularly difficult to do so for facilities designed for habitation by or service for individuals with age-related cognitive problems. While designing for the gradual impairment of navigation abilities and route learning widely documented in normal aging (Yamamoto 2012, Moffat 2009, Harris 2012) is challenging, designing for age-related dementias, such as mild cognitive impairment (MCI) and Alzheimer's disease (AD) is even more so. Designing such facilities well and understanding their effects on their inhabitants is becoming increasingly important, as the population ages and more individuals develop dementia, with over 5 million current diagnoses in the USA, and the number increasing inexorably (National Institutes of Aging Website - nia.nih.gov)

Classically, testing the effects of such facilities is done by analyzing aspects of existing architecture and implementing them into a new building, followed by behavioral observation, a system which is both expensive and cumbersome. More recently, virtual reality (VR) environments, such as the StarCAVE at Calit2, have allowed individuals to experience a virtual incarnation of a building in an immersive and interactive way while allowing monitoring of the subjects position and head orientation (Zhang et al., 2011; Macagno et al., 2012). Unfortunately, such systems are geared towards research and development, rather than broad testing of subjects' responses to designs of the built environment in VR. Due to their developmental nature, these systems, while capable of implementing software for such tests, are expensive, difficult to use by untrained individuals, and require specialized technical support.

Based upon these existing technologies we have developed a more cost-effective, immersive VR system for use by clinical researchers at the UC San Diego Center for Neurodegenerative Diseases. This modified mini-WAVE system, is a more portable VR system incorporating an easy-to-use interface, such as a steering wheel and pedal, virtual sound, and integration of sensors for determining the state of subjects in real time. These sensors may include motion capture, eye tracking, and non-invasive physiological sensors (such as EEG, EOG, ECG, etc.), allowing researchers to evaluate the cognitive state of patients with dementia as they interact with the virtual environment. The adaptation and integration of these technologies is vital for the assessment of behaviors within a virtual environment similar to the behaviors such subjects would have with an actual environment, especially allowing maximally natural movements of the subjects' body and unimpeded visual feedback of actions both within the VR environment and with the physical interfaces.

We have also developed experimental paradigms for testing features of the environment, cognitive function of patients navigating the environment, and software for real time evaluation of sensors during the testing. Existing systems have been used to perform experiments in virtual environments (Flynn '03, Cushman '08) and realistic models of actual (or proposed) built environments have been displayed in our existing facilities. These new paradigms, however, are adapted from classic neuroscience experiments, specifically geared towards the evaluation of cognitive processes and integration of monitoring sensors. These paradigms are implemented using a baseline virtual model we have developed, able to be customized to test aspects of spatial memory, orientation skills, navigation, and structural cue recognition. One of the key aspects of this model is its versatility; allowing an experimenter to easily place visual and auditory objects in the virtual environment, set experimental parameters, define basic interactions, while collecting information about the experiment and subject. This allows our system to be used (1) by clinicians working on dementia, looking

for environmental biomarkers related to disease progression, and (2) by architectural designers to better inform the design of assisted care facilities and hospitals.

ACKNOWLEDGMENTS

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3. AUTHOR BIOS

Cory Stevenson is currently a PhD student in the Department of Bioengineering, at UC San Diego, where he previously graduated with a BS in Bioengineering: Biotechnology. His research focuses on the control of human movement in space.

Scott Runyon graduated from the Computer Science Department at UCSD in 2013. He wrote the initial version of the software for the VE-HUNT project.

Jürgen Schulze, Ph.D., is Assistant Research Scientist at Calit2, with expertise in the implementation of software and hardware for 3D Immersive Virtual Environments. His research interests include computer graphics, human-computer interaction, and information visualization.

Gert Cauwenberghs, Ph.D., is a Professor of Bioengineering at UCSD, where he researches brain-machine interfaces, neuromorphic engineering, and adaptive intelligent systems. He is the codirector for the Institute for Neural Computation, a member of the Institute of Engineering in Medicine, and IEEE Fellow.

Michael Rafii, MD, Ph.D., is Director of the Memory Disorders Clinic at UC San Diego Perlman Ambulatory Care Center in La Jolla, and Assistant Professor of Neurosciences at UC San Diego. He is also Associate Medical Director of the NIH-funded Alzheimer's Disease Cooperative Study and Attending Neurologist at the Shiley-Marcos Alzheimer's Disease Research Center. He specializes in cognitive disorders, including dementias, such as Alzheimer's disease. Dr. Rafii also directs the Adult Down Syndrome Clinic. He is Clinical Director of the UCSD Down Syndrome Research and Treatment Center and serves as Principal Investigator on numerous clinical studies.

Eduardo Macagno, Ph.D., is Distinguished Professor of Biological Sciences at UCSD. His field of research is Neuroscience, and his current research interests include the interface between this field and Architecture. He has also been President of ANFA and is currently a member of its Board of Directors.

Emotion in the City: The Power of the Weak in the Construction of Place

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1. ABSTRACT

Globalisation, increased mobility, increased virtual connectivity and consequent reduction of attention to the physical environment, jeopardize our relationship with the places that used to be important to us. As a result, we get lost in the process of adaptation to the built environment, feeling increasingly uprooted, and try its adaptation instead, raising the problem of attachment in the construction of place. This paper seeks to uncover the role of architecture in this affective process.

In the literature about place we can find many models to describe how the physical environment can generate a sense of place and intensify the attachment to a place. However, none of these was 'tested' to gauge the extent of the relationship between the built environment and place attachment, nor the means by which it operates. This paper seeks to fill some of these gaps, asking: How does architecture contribute to the bonding between person and place? What is the model that provides the best explanation of the process by which this bonding occurs?

Assuming that place attachment has an affective base, this paper studies emotion in the experience of space to identify the architectural qualities that contribute most to place attachment. The research combines expertises of Architecture, Phenomenology, Psychology, and Neuroscience, in order to investigate the process associated with perception and encoding of spatial cues that induce place attachment and enhanced use of public space.

The working hypothesis departs from the notion of weak architecture (Vatimo, 1983; Solà-Morales, 1987) as a means to facilitate emotions (and save resources). The analytical model considers architecture, in any form or type, as experience, dealing, therefore, with phenomena. The study of how phenomena appear must therefore be the best way to understand the process by which architecture contributes to place making.

The analysis is based in two case studies conducted in everyday public spaces of Hong Kong and Lisbon. In loco behavioral observations were conducted to assess movement patterns, physical and social interactions with the object. Interviews were performed to assess attention and emotion. This will provide insights into the identification of the spatial cues that operate within and outside consciousness and make emotion and sensuousness necessary to the processes of attention, cognition, and ultimately attachment to a place.

2. AUTHOR BIO

Diogo Teixeira is a doctoral candidate in Architecture at the Technical University of Lisbon (Portugal). His major research interests are event-based design strategies, emotions and public space, namely understanding how architecture influences emotions and may be responsible for creative processes such as learning and modeling our memory associated with a place. He conducted research in the Institut d'Urbanisme de Paris (France) and in the Laboratori d'Urbanisme of the Polytechnical University of Catalonia (Spain).

Teixeira is currently a Senior Lecturer at the University of Saint Joseph (Macao, China), where he teaches design studios, and lectures on urbanism and construction technology.

More info: <http://usj.edu.mo/en/education/faculty-directory#user/2234>.

Electroencephalographic Signatures of Interior Design Appreciation in a CAVE System: A Pilot Study

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The aim of the present work is to provide evidence of how it is possible to correlate neurophysiological parameters with the appreciation of interior designs. For this purpose, we performed electroencephalographic (EEG) recordings within an immersive virtual reality CAVE system during the perception of three kinds of interior designs. Results highlighted that EEG alpha rhythms are correlated with judgments of familiarity and novelty, showing asymmetrical activations of the prefrontal cerebral areas as signs of motivational factors. Such as preliminary findings have to be further investigated to be used as tools for designing architectural environments.

1. EXTENDED ABSTRACT

1.1. INTRODUCTION

Nowadays there is the hope that neuroscientific findings will contribute to improvements in the design and control of intelligent buildings and ultimately help to create artificial environments that satisfy the man's dual demand of easy adjustment (familiarity) and easy arousal (novelty) (Eberhard, 2008; Gombrich, 1984). In order to investigate the brain activity related to the experience of architectural environments, we performed three pilot electroencephalographic (EEG) recordings in an immersive virtual reality CAVE system during the perception of three different kinds of interior design. Specifically, the goal is to examine how the motivational factors, as indexed by EEG asymmetrical activation of left and right hemispheres over the prefrontal cortex, could be associated with the experience of familiar and novel environments. In fact, left- and right-anterior brain regions are part of two separate neural systems underlying motivational aspects (Davidson, 2004; Coan and Allen, 2003).

1.2. METHODS

Three-dimensional environments have been simulated in a virtual reality CAVE system formed by three back-projected active stereo screens and a front-projected screen on the floor surrounding the subject (Sanchez-Vives and Slater, 2005; Cruz-Neira et al., 1993). Three rooms have been designed in real size and tested with different interior design: empty, common and cutting edge furniture, respectively. After the appreciation of each room, the enrolled volunteers expressed three different judgments about familiarity, novelty and comfort. Correlation analysis between these ratings and with EEG index of frontal lobe asymmetry in processing the different stimuli was performed.

1.3. RESULTS

The alpha power of the left frontal lobe resulted positively correlated with judgment of familiarity ($R = 0.81$, $p = 0.01$), whereas the alpha power of the right frontal lobe is negatively correlated with novelty ($R = -0.72$, $p = 0.03$). Moreover, synchronization of both theta and alpha power, computed across both hemispheres, resulted negatively correlated with novelty.

1.4. CONCLUSIONS

The present experiment provides neuroelectrical evidence of the asymmetrical involvement of the prefrontal cortical areas during the appreciation of familiar and novel architectonical stimuli in a CAVE virtual reality system. Although further investigation is needed, these observations may allow to develop quantifiable neural markers for testing how the design process of architectonical environments matches the changing needs of man.

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3. AUTHOR BIOS

Dr. Giovanni Vecchiato achieved his Bachelor and Master degree in Telecommunication Engineering at Federico II University (Naples) in the 2004 and 2007, respectively. He achieved his Ph.D. in Neurophysiology at Sapienza University in 2010. Since then, he is Ph.D. fellow at the Dept of Physiology and Pharmacology of Sapienza. In his research, Dr. Vecchiato is currently investigating cognitive and emotional correlates of the EEG related to the observation of advertisements, emotional, artistic and architectural stimuli. In the 2012, Dr. Vecchiato developed a system for the biometric measurement and analysis of cognitive and emotional variables during the observation of TV commercials and appreciation of artistic exhibitions. He is author of several scientific publications on international peer-reviewed journals, book chapters and a book. Dr. Vecchiato also acts as reviewer and guest associate editor for peer-reviewed journals and as member of several conference program committees. Dr. Vecchiato ideated the experiment, performed the recordings, analyzed the data and wrote the abstract.

Dr. Gaetano Tieri achieved his Bachelor and Master degree in Psychology and Cognitive Psychology at University "G. d'Annunzio" of Chieti in the 2008 and 2010, respectively. He is Ph.D. student in Social and Cognitive Neurosciences at Sapienza University. Dr. Tieri is an expert in modeling and programming of 3d virtual bodies and environments and currently he is investigating the behavioral and neurophysiological responses of human experience through the exposure to the Immersive Virtual Reality. Dr. Tieri designed and programmed the 3d virtual environments.

Dr. Anton Giulio Maglione achieved his Bachelor degree in Clinical Engineer and Master degree in Biomedical Engineer at Sapienza University of Rome in 2008 and 2011. Since 2011 he is Ph.D. Student at the Dept of Anatomy, Histology, Forensic Medicine and Orthopedics at Sapienza. Dr. Maglione is working with the EEG and autonomic variables in several cognitive and emotional tasks. Dr. Maglione performed the EEG recordings and analyzed the data.

Prof. Fabio Babiloni got his degree in electronic engineering from the Sapienza University of Rome with honors in 1986. In the 2000 he received his PhD in Neural Engineering at the University of Technology of Helsinki, Finland. He is currently Professor of Physiology at the Dept of Physiology and Pharmacology at the Sapienza University of Rome. To now, Prof. Fabio Babiloni has published 185 papers on peer-reviewed journals, with a total impact factor of more than 400, H-index of 45. He is in the list of the Top Italian Scientists and his current interests include the use of brain computer interfaces for communication between people and electronic devices and the study of the cortical activities during cognitive tasks in humans. Prof. Babiloni is auditor of research projects for several international agencies and editor of four international scientific journals, such as International Journal of Bioelectromagnetism, IEEE Trans. On Neural Systems and Rehabilitation Engineering, IEEE Trans. On Biomedical Engineering and Computational Intelligence and Neuroscience. Prof. Babiloni ideated the experiment and supervised the data analysis.

The Experience of Rhythm in Architecture, Music and Dance from Practice to Performance to Perception

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1. ABSTRACT

Architecture, Music and Dance are distinct forms of art that have influenced and complemented each other throughout the centuries. The qualities they share are numerous, but the way we experience them lies within the element of rhythm. It is thought that producing or participating in the aesthetic experience may be creative and revelatory, "a means to self-transcendence that can disclose the sacred in the familiar and ordinary." Can understanding and utilizing rhythm expand one's happiness and creativity? There is strong reason to believe that we can use rhythm in Architecture, Music and Dance to encourage innovation, creativity and a better quality of life.

Architecture, Music and Dance share many intrinsic qualities. They reflect what is happening in our culture, challenge our perceptions and inspire our creativity. But, underneath the surface there is a powerful force called rhythm that shapes the way we experience the arts. It begins with earliest stages of training with the endless repetition of barre exercises, musical scales or drawing of architectural lines, then culminates in a final "presentation" or "performance." This is where we see rhythm come to life through a patterned recurrence of specific features. Relationships develop between a dance's series of steps, lines of a musical score or forms of a building's composition giving the arts more subtle, prosaic meaning.

Through neuroscience research, we've learned that the brain also perceives rhythm. In fact, the body receives a wealth of information from the outside world then merges it with its own natural rhythms to produce creative thought, put things in order and send messages to our muscles. Studies show the brain also understands rhythm through the element of expectation.

Rhythm's intrinsic qualities of movement, repetition and pattern are primarily sensed by the eyes and ears (and sometimes touch) and evoke in us an internal pulse and organization producing a deep emotive external response. They are discriminated by the mind while tapping into our natural biological rhythms instilled in us at birth. Rhythm is at the center of our being and our evolution. Rhythm heightens our experiences, brings people together and helps us better understand life.

2. AUTHOR BIO

I have always been interested in modern and contemporary architecture and its relationship to art, music and dance. As a Ph.D Candidate at the Illinois Institute of Technology under the tutelage of Professor Harry Malgrave, I am researching the topic of Rhythm and its relationship to the arts in order to provide a new and more comprehensive understanding of how the arts address social issues, benefit humanity and inspire creative growth. I am a licensed architect and a registered interior designer in the State of Illinois, with a lifelong love for education. For over ten years, I have been co-principal of Olsen | Vranas, an architectural and design practice based in Chicago. Our firm has received commissions that have produced award-winning residential and commercial spaces throughout the U.S. Recently, a home designed and built by Olsen | Vranas in the Gold Coast won a Preservation Excellence award for New Construction from the City of Chicago and was awarded LEED Gold status by the USGBC. My focus is on a rational approach to design with an emphasis on constructability and sustainability. Previous experience includes work with the prestigious firm Murphy/Jahn. My commitment to education is equally strong. For five years, I was Associate Dean at the Harrington Institute of Interior Design. There, my opportunities included the redevelopment of the curriculum, allowing me to teach many classes and begin their foreign studies programs in Europe. I have also pursued studies in art, Modern Greek language and culture, and training in classical ballet and piano. This multi-disciplinary background has confirmed my interest in the underlying element of Rhythm as it is experienced in Architecture, Music and Dance.

Bridging Architecture & Psychology in the Learning Environment

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Environments can affect mood, productivity, or focus, impacting both the individual and the community. This project examined the impact of spatial and other environmental features on emotion and cognition. There were two components to the project: an installation on the CMU campus and a survey of 36 students. The goal for the installation was to create a momentary experience that instilled an awareness of one's self in the space, both physically and mentally. The survey focused on the role of communal spaces and lounges in the learning experience: how the aesthetics of the space have the potential to increase relaxation and productivity and minimize stress and anxiety.

1. ABSTRACT

1.1. INSTALLATION & QUESTIONNAIRE

The installation was an interactive exploration of the relationship between simple spatial and environmental cues and how they may be internalized on an emotional and cognitive level. This was a full sensory experience, from touch to sound to sight, used eclectic materials including tinfoil, bubble, wrap, lights, tissue paper, string, and chicken wire, and manipulated the shape and size/scale to arouse the individual's sense of presence in the space. Visitors completed brief questionnaires which measured their reactions to the installation and assessed the effects that even a temporary and unconventional space can have on emotions and experiences.

1.2. SURVEY & RESEARCH PAPER

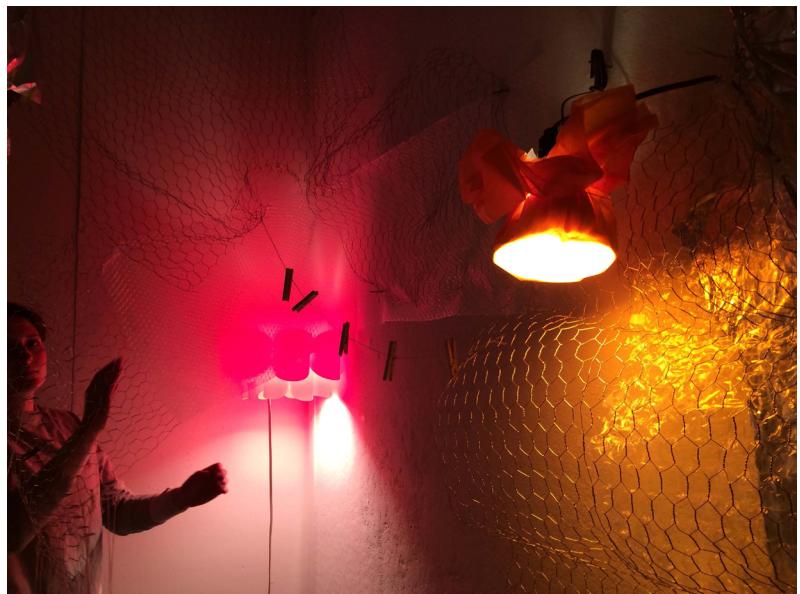
The research paper focused on the role of communal spaces and lounges in education facilities and the impact of their designs on focus, stress, and collaboration. It appeared that "successful" collaborative student spaces at several higher education institutions integrated three domains: learning and teaching, space and environment, and social and community. 36 students on the CMU campus completed the survey, which was adapted from a standard architectural Post-Occupancy survey. The purpose was to learn about their use of and experience in existing student spaces on campus that were intended to be collaborative and relaxing.

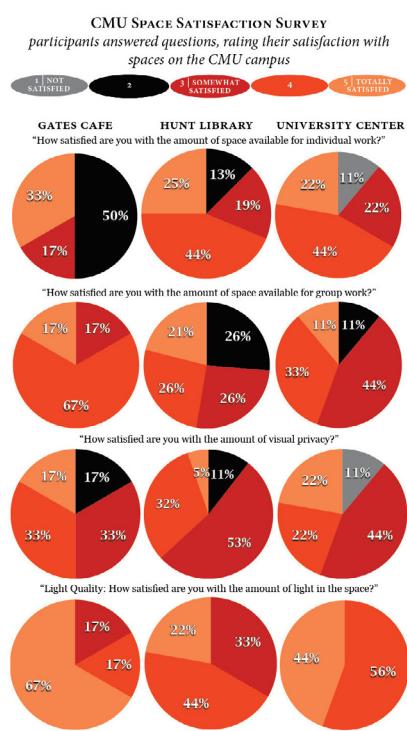
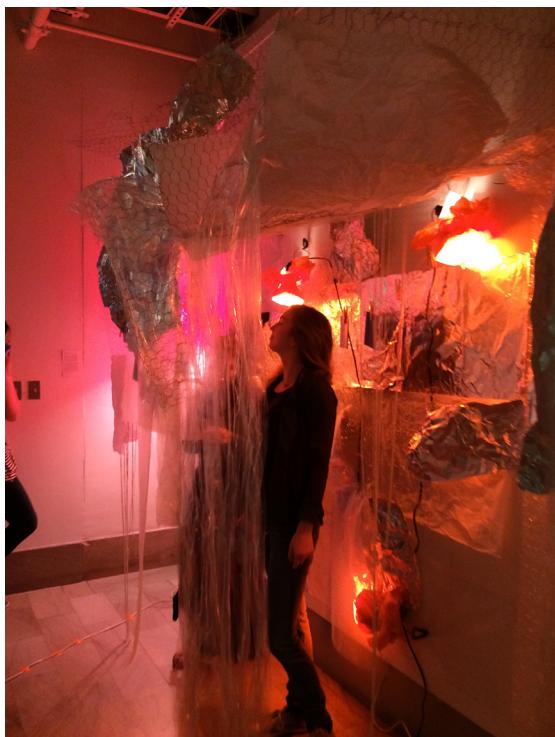
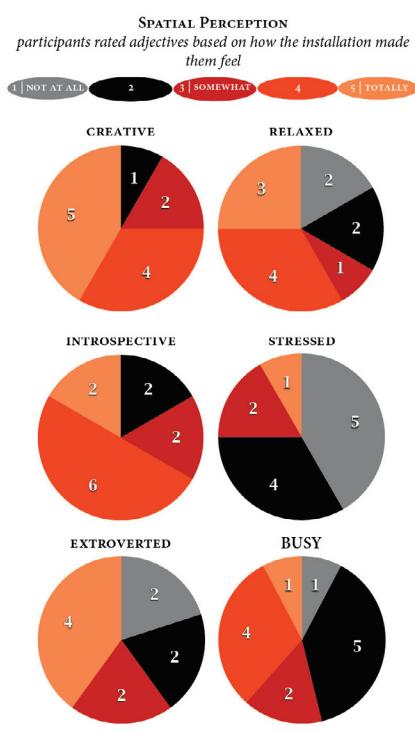
1.3. DISCUSSION

Though the installation and survey were quite different, the findings were surprisingly similar. People often associated the same architectural features with the emotions evoked by the space regardless of the function of the respective space. For instance, many students reported that the lighting, colors, and size of the installation were some of the architectural features that accounted for their feelings of warmth, calmness, and security. These qualities were emotions that other students, both at CMU and elsewhere, wanted to experience in student spaces. The relationship between subjective experience and architecture is important for the implementation of successful and satisfactory design of communal and collaborative spaces in the learning environment.

1.4. IMAGES & FIGURES:

A selection of images of the installation and figures of results from the surveys:





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3. AUTHOR BIO

Eliana Weiner graduated in May of 2014 from Carnegie Mellon University with a Bachelor of Humanities and Arts in Psychology and Architecture. She spent much of her academic career exploring the relationship between the individual and the environment; how the design of a space has a positive or negative impact on how people think, feel, and behave.

The Locksmith of Fascination: Resistance and Cognitive Stimulation in Architectural Space

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1. ABSTRACT

Before the grand entrance of any architectural space there is the moment of tactile connection when all the senses combine and form an impression of the experience to follow. In its simplest form this initial contact can be thought of as a latch or gate being moved, physically. As in discussions of consciousness we often speak of the subliminal awareness, this paper speculates that numerous active sensory moments can be understood to create the various elements of an experience of architecture. The touch of a surface, the thermal delight, a feeling of security. How these cognitions are expressed in changes to neurotransmitters and neurotransmitter receptors may have long term effects on building users. We propose a metric for the study of these potential qualities that may actually link the mechanism of ion channels to the tactile experience of quality in material, light and sound. It can be seen that different building types convey a language, does this language have a quantifiable effect on brain function? The investigation will provide a platform for further investigation of psychological and physical benefits of certain architectural qualities.

2. AUTHOR BIO

Mr. Whittet has been a part of the high performance building field as a contractor, designer, developer and consultant on work across the United States for over three decades. His interest in Neuroscience began when he interacted with the Telluride Neuromorphic Engineering Workshop twenty years ago and formed lasting connections with the members of that research group that continue to this day. He has continued to investigate and be active in the development of high performance sustainable architecture and its relation to human potential.

He has worked in Southwest Colorado and Maine on photovoltaic off grid projects pioneering sustainable net zero systems in remote island and mountain locations. Notable LEED projects include Boston's iconic International Place towers, Las Vegas CityCenter, Boston Society of Architects and the Princeton Plasma Fusion Lab Lyman Spitzer building.

Currently active in the Massachusetts USGBC and Member of the ASHRAE SSPC 189.1, he is also a board member of the ADPSR, Architects, Designers and Planners for Social responsibility.

Passionate about craft, quality of life and culture he writes and blogs about these subjects often and takes every opportunity to explore new ways to see, appreciate and encourage a better world.

An Architecture of Embodied Cognition: Louis Kahn's Salk Institute

SARAH WILLIAMS GOLDHAGEN

1. ABSTRACT

How might findings from cognitive neuroscience be useful to professionals charged with the concrete task of designing buildings for individuals and social groups? Answering this question in principle is easy: the more that architects understand about the operations of human cognition, the better positioned they will be to design buildings and places that enhance or at least do not violate human experiential needs.

Moving from principle to practice is more challenging. To study the brain and human behavior, cognitive neuroscientists conduct circumscribed research to establish precisely articulated, often narrowly calibrated propositions. Yet answers to the large questions that bear obvious relevance to architecture, such as how a given factor in the environment influences human body states, emotions and cognitions come slowly. Two decades into the cognitive revolution, we find countless dots still to connect between laboratory-based research findings on cognition and the making of a good building or urban area.

I propose for this paper that we begin not with the science but with a building. Discussing one that most scientists know—the plaza of the Salk Institute—the presentation will explore how the Salk Institute's architect, Louis Kahn, deliberately manipulates the machinery of human sensory cognition to orchestrate an emotionally powerful experience that effectively communicates the essence of the institute's mission.

The Salk plaza's siting; simple geometric volumes, flat planes and linear paths; compositional differentiation of laboratories and studies; obscuring of the ordinary architectural indicators of human presence and scale—stairs, windows, corridors—orient the viewer's cognitions toward his own solitary experience, deemphasizing membership in a social group. At the same time, the building's rich textures, tactile materials and deliberate construction details prime the viewer to mentally simulate a whole-body, multisensory engagement with the plaza. In this context, Kahn, aware of the human visual and auditory systems' acute orientation to environmental change, makes the plaza's only constants the visual and auditory spectacle of moving water and crashing waves. Together, these design moves subtly manipulate the operations of human cognition to heighten people's conscious awareness of their situatedness in the horizontal infinitude of nature, of the human-made in the biological world.

2. AUTHOR BIO

Sarah Williams Goldhagen, the author of Louis Kahn's Situated Modernism, is The New Republic's architecture critic. She has taught and lectured at universities and colleges around the world, including for ten years at Harvard's Graduate School of Design. Her scholarly essays and architectural criticism has appeared in numerous edited collections and general publications. Currently she is working on a book on the experience of the built environment to be published by Harper/Collins.

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