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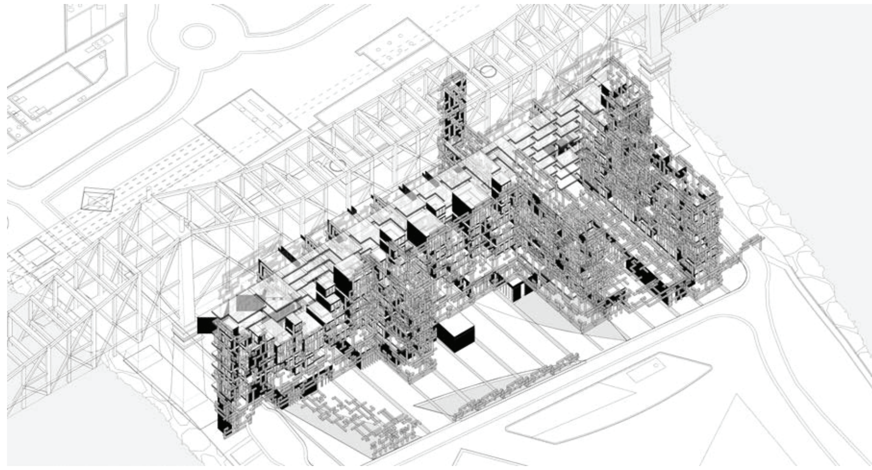
Hotel of Memory: Interpreting Neuroscience to Design in a Memorable Guest Experience

Alvaro Alvarez
Cornell University

I. ABSTRACT

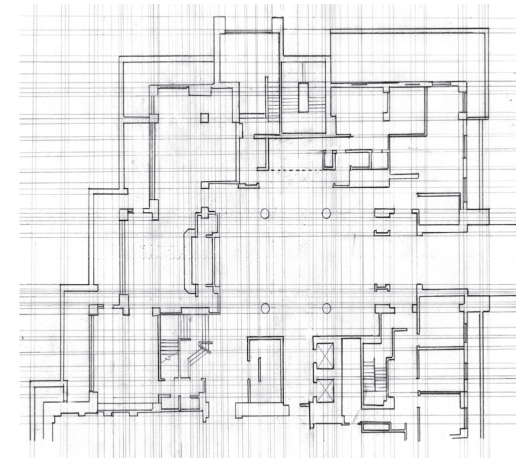
Our hippocampus is extremely important in spatial memory – any time we enter a new place, our brain interprets our environment and takes physical cues to assemble a mental field map. This map remains archived in the deep recesses of our mind and is retrieved when, if ever, we enter the same space again. It makes perfect sense to test this notion in a hospitality setting, where guests are encouraged to remember their lodging experience for years, often with only a single-night stay.

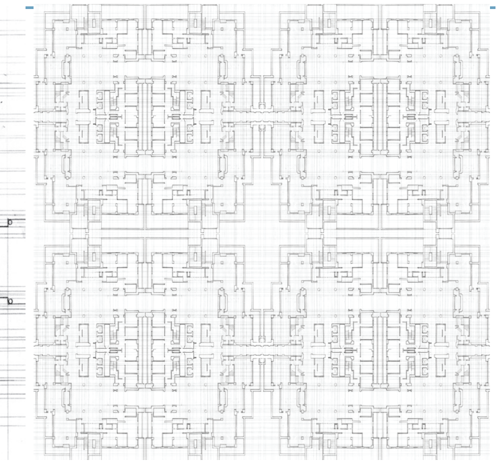

Hotel Proposal Below Queensboro Bridge, New York

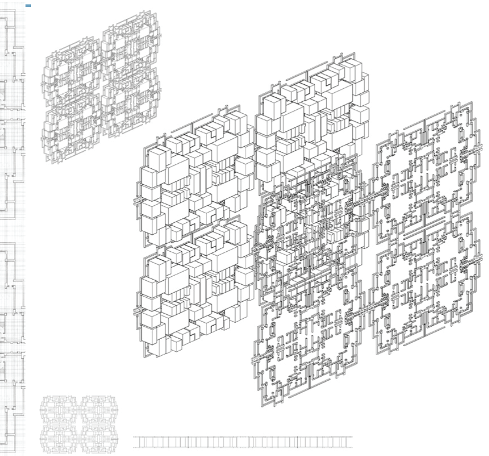
This thesis challenges architecture to learn from spatial memory and navigatory relationships to design with more careful, corporeal considerations. The hotel operates as a testing field for memory since guests often get a limited time to become familiar with their environments, pressuring design to offer an experience that will remain in the user's mind long-term. Through the graphic abstraction of architectural informational present in the Queensboro Bridge in New York and Statler Hotel in Ithaca, this embodied hotel design engages guests with the site through experiential, both physical and mental, cues.

After analyzing the hippocampal research relevant to memory, I concluded that there are five physical cues that can make a space more memorable: Depth, Complexity, Landmark, Symmetry, & Repetition. Architecturally, based on the strong relationship between memory and navigation, I identified a hotel guest's purest sequence of circulation: Entrance, Lobby, Elevator, Hallway, & Guestroom. I used these ten concepts as an index to derive design. To translate neurological information into an architectural language, it is crucial I push the hotel design process through many mediums of representation: photography, hand-drawings, physical models, and 2D & 3D modeling software. The final building proposal is a result of integrating site (Roosevelt Island in New York City) and program (a hotel servicing the new Cornell Tech Campus), with physical concepts meant to enhance the guest's memory.


Hotel Proposal Beer Garden

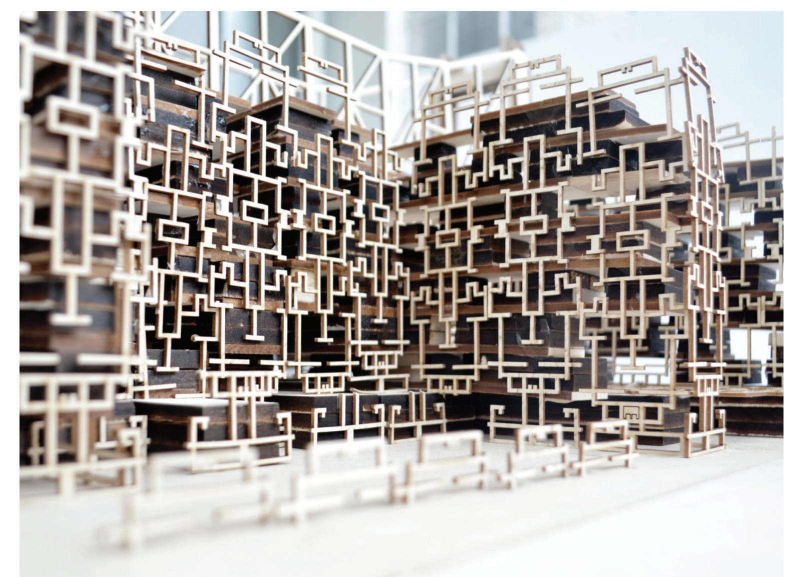

1. Floor Plan of Typical Hotel Reception


2. 2D Re-Interpretaton of Floor Plan


3. 3D Manipulation to Generate Space

The Cornell University faculty and critics welcomed the integration of the two fields. During one of the presentations, however, they questioned why I was so interested in neurological information and asked why I was attempting to be a scientist. I responded that interpreting relevant information is essential to generate meaningful architecture and improve a user's experience. Interpreting the mind and body is as equally important as interpreting landscape, program, or conceptual form – a response they accepted.

Now, as a practicing architect, it is my goal to take neurological information to a built-phase through a real project. Hotel of Memory is a starting point, the work of an individual designer; it is my hope that this thesis shows the enormous potential behind neuroscientist and architect collaboration, and the untold innovative opportunities for spatial experiences.


Physical Model


Hotel Proposal Lobby

2. BIOGRAPHY

Alvaro Alvarez is an architectural designer with the Rockwell Group in New York City, responsible for hospitality, residential, and interior projects. Originally from the border region of San Diego, California and Tijuana, Mexico, he graduated from Cornell University with a Bachelor of Architecture in May 2015.

Please visit AlvaroAAlvarez.com for full project details and bibliography

Neuroscience Informing Design: Impact of Fluorescent CCT on Neurodiverse Populations

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1. EXTENDED ABSTRACT

1.1. Methodology / Procedure

A purposive sampling was used to generate twenty subjects; taking into account gender, age, ethnicity, brain lateralization, as well as the exclusion of color blindness. The participants underwent 1) an anatomical scan and 2) a functional scan, using Functional Magnetic Resonance Imaging fMRI technology, while a random sequence of three types of illustrations from the aforementioned categories were projected by a computer controlled visual presentation system. Each image category included 6 images for a total of 18 images that every participant evaluates. Concomitantly, the participants were asked to respond to each image by fiber optic button devise, rating each image on a seven-point Likert satisfaction scale of 1=very dissatisfied and 7=very satisfied. Behavioral data was analyzed using t-test factor analysis and one-way analysis of variance, while the neural data maps were analyzed using FSL Neuroimaging Software.

1.2. Outcome / Discussion

Findings suggest that contrary to precedents (seeing color activates the ventral occipital and fusiform); the Warm White color temperature (2800K) did not show activation of the occipital cortex. This may indicate disinterest or dissatisfaction with the warm spectrum. Important to note that, under the Cool White spectrum (4100K) the activation of the Superior Temporal Gyrus implicated in critical structure of social interaction; the Middle Frontal Gyrus implicated in semantic and analytical tasks; and the activation of the Angular Gyrus implicated in memory retrieval, areas associated with brain cognitive functions, have been activated. Furthermore, under the daylight color spectrum, the cerebellum—emerging neuroscience indicates that is involved in cognitive brain processes—has been activated. These neural findings, in support of behavioral findings, suggest a higher satisfaction with cool white and daylight full spectrum than with the warm spectrum.

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Emotional Design in Architecture

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I. ABSTRACT

I.1. Background

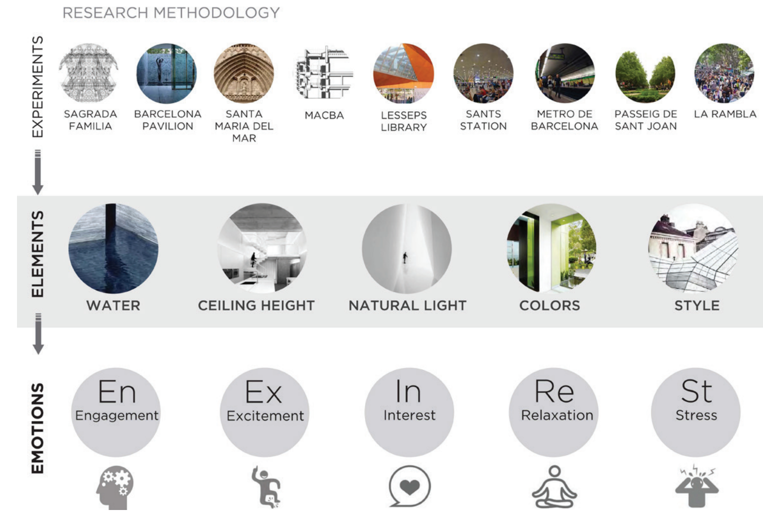
Architecture and Neuroscience were two separate disciplines, until it was found that the brain is constantly adapted to the environments we are living in. Focusing on healthy environments, a well-designed built habitat with principles of neuroscience, reduces patient stay for example, and even plays part in treatment such as retrieving old memory and brain stimuli. **Neuroscientists** study behavior and brain. In addition, they study sensation and perception, how the brain influences decision making, emotion. For example how we interact with our environment and how we navigate through it, how we hear, taste, and even smell things, how we store the information received and how we can recall the same information, how we react to various situations for example fear and how we evaluate the results of our actions. As seen all these are *affected by environmental designs.* This therefore requires **Architects** to use these neuroscience principles to input them in their designs. Learning how our brain works with perception will lead to new developments on behalf of users in design, and more specifically Architecture. Our **Environment** explains the different experiences that we receive; for examples, people in *rural settlements* have certain mindfulness that people in *urban areas do not possess.* It is therefore of paramount importanct for designers to understand the effect various designs have on our emotions. For example, new treats combiend with architecture approaches give individuals a pleasant stay, shortens the healing.

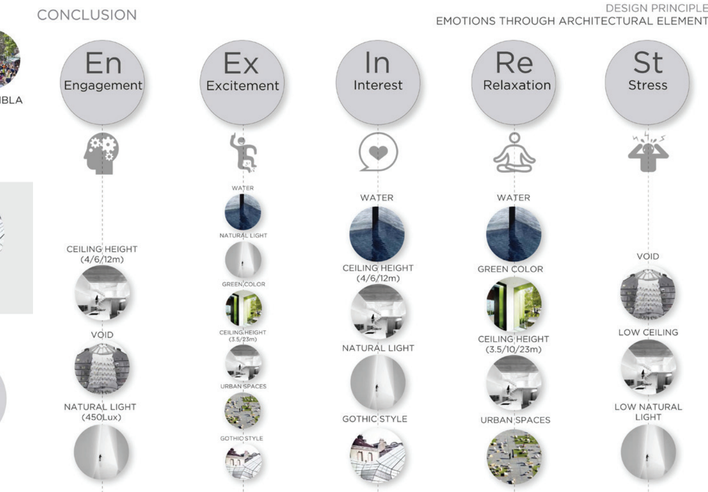
I.2. Methodology / Procedure

Over the past years, several studies have been, done focusing their attention on the **impacts of architecture on emotions**. This research focuses on **experiences** done in **Architectural** and **Urban** settings in the city of **Barcelona**. In this experiment, **two subjects** essentially **brain mapped** by use of portable **EEG** neuro-headset connected to its software on the laptop, which analyzed brainwaves in the **brain**, so that it could detect different degrees of emotions. In addition, this machine has a capability of measuring the **affect of the environment** on emotions. Therefore, it has become more accessible to measure the architectural impacts on emotions. This paper aims at explaining different effects of **Architectural Elements** on special Emotions. It also targets in conclusion to be able to design our emotions, through architectural elements.

The choosing in the methodology used **designs that activate distinctive emotional expressions** that can be felt through changeable **architectural elements**. The various elements trigger certain emotions. The **elements** used include *Water, Ceiling Height, Natural Light, Colors and Styles*. These **design elements** provokes **emotions** of *Engagement, Excitement, Interest, Relaxation and Stress.*

OUTCOME DATA: EMOTIONS IN PERCENTAGE





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3. AUTHOR BIO

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Culture, Neuroscience, and Design

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Fellow, American Psychological Association

I. EXTENDED ABSTRACT

Does our culture influence how we process sensory information and the sorts of spaces where we live our best lives? Neuroscientists have shown that it does and designers can increase user wellbeing by applying what these researchers have learned about culture and place-based experiences.

Studies have linked how the physical environment is experienced to parameters of national culture identified by Hofstede, Hofstede, and Minkov (individualist or collectivist, accepting of power distance or not, masculine or feminine, tolerant of uncertainty or not, long- or short-term orientation, indulgent or restrained) (2010). Scientists have also tied national culture to preferred physical environments. Neuroscience indicates that curvilinear elements are significantly more likely to be preferred by people from more collectivistic cultures, while people from more individualistic ones find angular shapes significantly more attractive than people from collectivistic ones do, for example (Zhang, Feick, and Price, 2006). Designing for preferences is important because when the space we're in aligns with them, our mood is more likely to be positive (Veitch, 2012), which has beneficial implications for problem solving, creativity, socializing with others, and health, for example (Fredrickson and Branigan, 2005; Isen, 2001; Isen et al. 1985; Segerstrom and Sephton, 2010). In addition, neuroscientists, including Park and Huang (2010), have linked neural function and culture: "there is limited evidence that cultural experiences affect brain structure and considerably more evidence that neural function is affected by culture, particularly activations in the ventral visual cortex – areas associated with perceptual processing."

The design of public spaces that are iconic among particular populations will be examined in a case study format to illustrate how place form should recognize and respond to users' national cultures. Structures in Finland, the Netherlands, the United Kingdom, Italy, the United States, Japan, China, and Turkey will be featured. Applying neuroscience research to inform the selection of specific, culturally-appropriate design elements will be the focus of the presentation.

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3. AUTHOR BIO

Sally Augustin, PhD; Principal, Design With Science; Fellow, American Psychological Association

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 integrating neuroscience-based insights to develop recommendations for the design of places, objects, and services that support desired cognitive, emotional, and physical 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, is the editor of Research Design Connections (www.researchdesignconnections.com), where she has written widely on science-based design for a broad audience of people interested in the designed world.

At Work, In View: The Cognitive Science of Working in Spaces with Transparent Boundaries

Sally Augustin, Ph.D.
Principle, Design With Science; Fellow, American Psychological Association

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I. ABSTRACT

Open floor plans and transparent walls are regularly used in corporate offices and at co-working sites to symbolically communicate organizational transparency, encourage interpersonal coordination and communication, transmit natural light throughout a space, and provide views throughout the workplace and outside the building.

Previous research has identified differing cognitive and emotional consequences of working in environments where people can see/hear or be seen by/heard by others. It can be distracting (Veitch, 2012), for example.

However, prospect over the nearby area increases awareness of colleagues' activities and shared, amenity-rich common spaces encourage interactions that have been linked to the development of positive inter-personal bonds and creative/innovative solutions (Allen and Henn, 2007). Biophilicly-designed spaces facilitate focused thinking and creativity; one of their attributes is a view out over the nearby area from a location that seems secure because the person in it is mainly shielded from view (Heerwagen and Gregory, 2008).

Social facilitation is tied to working in view of others (Myers, 1996), as are worker modifications of their behavior in visually open environments (Bernstein, 2014).

This study examined the self-reported performance-related repercussions of working in open spaces and in areas bordered by transparent glass walls, with insights derived leading to a more comprehensive and nuanced understanding of working in view, and often the acoustic range, of others. The co-working site at which data were collected is unique because almost all interior walls are clear glass; the proliferation of transparency allows not only co-workers to connect visually but also for people working at different firms to do so. In addition to spatial analysis conducted by an architecture team, data were gathered via interviews and observation. Observations were done on all three floors of the co-working center. Interviews probed issues raised by the observations.

People working in spaces bordered by transparent glass walls or no walls at all felt more energized than relaxed while working and participants were somewhat more likely to find it distracting to work in transparent-walled or no-wall spaces than in other spaces. Awareness of others and their activities was higher in more open spaces and this awareness did have positive professional ramifications. Visually open environments were perceived to enhance professional performance by people working at young firms competing in challenging markets, the most prevalent sort of organizations renting workspaces at the co-working site where data were collected.

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3. AUTHOR BIOS

Sally Augustin, PhD; Principal, Design With Science; Fellow, American Psychological Association
Sally Augustin, PhD, is a practicing environmental psychologist with extensive experience integrating insights derived from environmental neuroscience, other social/physical sciences, and project specific research to develop places, objects, and services that support desired experiences.

Melissa Marsh, Assoc. AIA; Chief Executive Officer, PLASTARC
Leveraging a background in the social sciences with a Master of Architecture at MIT, Melissa built cross-disciplinary consulting practices within a number of leading architectural firms. Interested in further exploring the intersection of design and human factors research, Melissa started her own interdisciplinary consultancy firm, PLASTARC, where she leads a diverse team, from sociologists to data visualizers, dedicated to shifting the metrics associated with space from square feet and inches to occupant satisfaction and performance.

Kristin Mueller, Design Analyst, PLASTARC
Since the completion of a Master's program at Yale in 2009, Kristin has been involved in both the academic and professional realms of architectural practice. She has worked in both the US and Europe in a range of office sizes and cultures, from those with global reach and several hundred employees, to localcentric ones with less than ten.

Sasha Ragland, Environmental Psychology Research Specialist, PLASTARC
While pursuing psychology as an undergraduate student Sasha realized a desire to engage her interests in design and art. Sasha has a great deal of research experience.

Cassie Hackel, Sociospatial Analyst, PLASTARC
Cassie is a sociospatial analyst at PLASTARC and a Master's of Urban Planning candidate at the University of Michigan. Cassie's current work includes analysis and advisory on workplace strategy, change management, industry trends, and the intersection between design and human factors. Cassie holds a degree in Urban Studies from Vassar College.

Architects without Buildings: Philip Thiel and the systematizing impulse in modern spatial study

Ian Baldwin
DUAL, LLC and Rhode Island School of Design

1. EXTENDED ABSTRACT

Architects speak constantly of "space." Yet we lack a single effective, objective method to describe spatial configuration. Words lack visual immediacy and precision. Architectural drawings enable the abstraction and organization of space, but ignore human visual experience. Images create a semblance of experience, but only from the subjective gaze of the camera, and the comprehensive physical detail they capture makes it hard to isolate purely spatial qualities.

This poster examines attempts to visually quantify space outside of the design process. Its focus is Philip Thiel, an architect and academic active in the second half of the 20th century. While the frameworks for spatial documentation developed by Thiel and others drew interest and attention in their time, none were widely adopted by neuroscientists or designers.

Interdisciplinary collaboration between the neuroscience and design fields requires a set of agreed-upon understandings about the built environment. These early attempts at visual codification are a compelling case study in the potentials and pitfalls of quantifying spatial perception.

"Space" is a recent addition to architectural discourse. In 1863, Gottfried Semper wrote that enclosure of space, not material, was the fundamental quality of architecture. 30 years later, two other German theorists articulated the modern interpretation of space that would hold sway to the present. Adolf Hildebrand saw an "internally animated" continuum of solids and voids where the outer bounds of each object defined external space as much as the object itself. August Schmarsow argued that spatial understanding was empathetic, a mental projection derived from embodied experience. For Schmarsow, humans' innate sense of space preceded the actual built space, making architecture the outcome of "spatial imagination."

The idea of space as an embodied, experiential construct paired with, but separate from, built form was central to modern architecture. It also revealed new ways of understanding cities. In 19th-century Vienna, Camillo Sitte pointed out that the irregular enclosures of the medieval city made for richer urban experience than the new boulevards and grand buildings of the Ringstrasse. In the 1950s, Steen Eiler Rasmussen separated buildings' "cavities" from the "space" of the city. Rasmussen did not view buildings as an expression of "style" or as objects. He presented them as inseparable from urban context, and observed that we do not experience buildings as though looking at them in a picture, but rather through a range of incomplete sensory impressions including texture, color, light, and sound.

In the aftermath of World War II, urban planning largely ignored these ideas in favor of isolated object-buildings on cleared sites. Gordon Cullen's "Townscape," first published in the late 1940s, reclaimed the use of variety, sequence, and passage as an urban-design technique and corrective to indifferent Modernism. Cullen's compelling analysis of old towns, often arranged into "serial vision" sequences simulating movement through an area, formed an operative theory of the urban picturesque. Cullen's sketch vignettes visualized not only spatial arrangements but the impression-forming miscellany Rasmussen had written about, such as street lamps, pavement textures, and signage.

MIT professor Kevin Lynch published The Image of the City in in 1960. It became well known for its classification of urban components, which are still widely used in design education today: Edges, Paths, Nodes, Landmarks and Districts. For Lynch, the "imageability" of these components was only secondarily spatial. Nodes, for examples, had to be distinct places first, host an intensity of use second, with "coherent spatial form" (by which he meant simply enclosed, well-defined areas) the finishing touch.

The Image of the City was a watershed. It abandoned the coherent fabric of the European city for the relative chaos of Los Angeles, Jersey City, and Boston. It considered the role of traffic and high-speed movement through cities enabled by new Federally-funded highways. It adopted social-science research techniques, using interviews with residents of the three cities to create mental-map overlays of "major" and "minor" urban elements. The opinions of these residents about their cities formed a quasi-empirical data set (what we would today call crowdsourcing) that Lynch drew on to strengthen his arguments.

Lynch collaborated with MIT professor Gyorgy Kepes on the Perceptual Form of the City project, which began in 1953 and culminated in The Image of the City. In that role, Lynch exchanged letters with James J. Gibson, author of The Perception of the Visual World, and summaries of Gibson's concepts (including the visual field/visual world dichotomy) were were included the project's research papers. Though Gibson's work was never directly cited (probably for political rather than academic reasons), The Image of the City stimulated interest in environmental psychology among designers, and by the early 1970s its foray into cognitive mapping could be appreciated by the behavioral science community.

In 1952, a naval architect turned architecture student, Philip Thiel, completed his Bachelor's thesis at MIT. It proposed a series of urban landscape interventions to visually unify the pedestrian experience in a central part of Boston, not unlike the Freedom Trail, which debuted around the same time. Thiel returned to MIT in 1956 a researcher for Lynch. He traced over image sequences in an attempt to edit and clarify how the hierarchy of visual content changed as one moved through urban space.

After taking a position at Berkeley, Thiel continued his research with a study of precedents in sequential- and movement-notation systems, citing the work of Gibson, Sergei Eisenstein's cinematographic diagrams, and Rudolph Laban's "labanotation" choreography. In the next two years, Thiel produced a conceptual framework positing an "Anatomy of Space" comprised of space, surface, and volume, followed by a case study of a four-block area of San Francisco, where he experimented with notational diagrams based on plan, axonometric and perspective views. Soon after, he drew up a prototype system relating different views and spatial conditions to a diagram set using a central crosshair to mark the center of vision.

Thiel would develop this system through a 15-month stay in Japan, and published the results in a series of journal articles in 1961 and 62. The system became more sophisticated, more flexible, and much more esoteric. The bullseye graphic was joined by a vertical track indicating movement, as well as numbers indicating height and positioning, and references to opaque categories and types of space beyond the original three-part anatomy. Though the system was improved over the four articles Thiel published, it remained impossible to read without close attention to explanations and photographs.

Thiel continued his work on space notation through his decades teaching at The University of Washington. It took until the publication of Thiel's magnum opus, in 1997, to collect his research and experimentation on spatial representation in one volume (where it is spread over about 100 pages). This diverse collection of approaches is wide-ranging and creative, though it also seems an elegy for the original promise of a simple, systematic and objective method for documenting the experience of the built world.

Such a system would be especially useful today. The rapid development of computing power has made software that creates virtual 3-D environments on screens widely available. We still await a full conceptual framework to explore the utility of graphic representation to spatial experience.

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3. AUTHOR BIOS

Ian Baldwin (BA, NYU; MArch, U. Penn.) is a Principal and Cofounder of DUAL, a design and architecture practice in Providence, RI. He has written extensively on the built environment as an Editorial Board member of ArchitectureBoston and a Contributing Editor of Places, and presented his research on urban design at Association of Collegiate Schools of Architecture conferences and the U.S. Naval War College. He has taught architectural history/theory, design, drawing, and urbanism at such schools as RISD, Brown, Northeastern and NYU.

Curiosity as a Design Tool

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1. EXTENDED ABSTRACT

1.1. Research Goals

Curiosity is a basic element of our cognition[1] and a powerful drive influencing human exploration. Our research proposes to harness design heuristics for the purpose of amplifying curiosity in the general population with the ultimate goal of developing designs promoting curiosity to improve human cognitive and general wellbeing. Studies have highlighted that people are better at learning information they are more curious towards, as well as learning incidental information while in curious states.[2] This research program is aimed at potentiating cognitive improvement in users via architectural designs informed by neuroscience. Specifically, our study will evaluate methods of employing curiosity to open a cognitive reception window, laying the groundwork for its use towards enhancing cognition.

1.2. Methodology

A methodology for designing with curiosity in mind should lead to further research as to the possible benefits of curiosity evoking environments. The implied potential in an architectural context is the development of Evidence Based Design methods to improve spaces such as learning facilities. The study aims to provide an easily replicable approach for future research that can yield empirical results from which to extract implications for design. In order to evaluate the ability of design elements to arouse curiosity we will use behavioural paradigms, as well as eye tracking (ET) and wireless electroencephalography (EEG) to directly correlate the visual focus and neuronal activity of a subject.

1.3. Interim Results

We measured the Response Time (RT) to a series of simple binary decisions regarding the shape characteristics of letters in the center of a screen, whilst visual distractors (shapes and images of objects) appeared in the peripheral vision. RT for each letter presented was recorded and associated to the specific accompanying distractor (if one appeared). The extent to which a subject has decided to allocate visual attention to the distractor at the cost of success in the task is represented by RT. On this premise, distractors were expected to produce different response times.

Our preliminary results show differences in average response times, which suggest that some distractors are more curiosity evoking than others and that we can isolate this phenomenon in order to evaluate the eyemovements and neural activity associated with heightened curiosity. A further analysis of RT will inform the nature of future sets of distractors in order to test the designability of curiosity evoking visuals.

1.4. Future Steps

Identifying the hallmarks of curiosity through ET and EEG: Eye movements have been shown to indicate epistemic curiosity states.[3] Our next step is to employ ET to confirm that response time variations associated with heightened curiosity correlate with saccades from task to distractors. Additionally, we will use EEG with the "most curious" and the "least curious" distractors in order to identify specific components/patterns of brain activity hallmarking curiosity in the brain.

1.1. Project Impact

Outcomes from our study will facilitate the development of curiosity metrics and their application in the design of built environments, creating neuroscientifically informed architecture. Such an approach can be adopted with immense benefits for society by improving learning in schools, memory and cognitive enhancement in retirement communities, and rehabilitation facilities.

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3. AUTHOR BIO

Professor Moshe Bar, Ph.D. is a Director of the Gonda Multidisciplinary Brain Research Center and the head of the Cognitive Neuroscience Lab at BarIlan University, Israel where he returned after 13 years at Harvard University. He is also an associate professor in Neuroscience and Psychiatry at Massachusetts General Hospital and Harvard Medical School. Prof. Bar is an internationally recognized cognitive neuroscientist, whose novel research has made major contributions to our understanding of perception, cognition and issues in psychiatry. His work explores topics spanning from the flow of information in the cortex during visual recognition to the importance of mental simulations for planning and foresight in the brain, and from the effect of form on aesthetic preferences to a clinical theory on mood and depression. Prof. Bar uses neuroimaging (fMRI, MEG), psychophysical and computational methods in his research.

Itai Palti is an architect and researcher focusing on designing with the human experience in mind. Practicing internationally, he has also worked alongside the late worldrenowned architect Jan Kaplicky at Future Systems. He is a fellow at The Centre for Urban Design and Mental Health, has edited its inaugural journal, and also contributed to a number of international publications such as The Guardian. Itai is an adjunct faculty member at the Bezalel Academy of Arts and Design and a visiting critic at other academic institutions. His work on the concept of Conscious Cities has helped it emerge as a new field of research to improve our built environment.

NeuroAesthetics initiative at John Hopkins Brain Science Institute

Julio Bermudez, Ph.D. (Facilitator)
Director, Sacred Space & Cultural Studies, Catholic University of America, Washington, D.C., USA

Invited Panel: Anjan Chatterjee, Ph.D.[1], Susan Magsamen[2], Ed Connor, Ph.D.[3]
[1] Elliott Professor, Chair of Neurology, Pennsylvania Hospital, Philadelphia, Pennsylvania, USA
2 Senior Advisor, Science of Learning Institute & Brain Science Institute, John Hopkins University, Baltimore, Maryland, USA
[3] Director, Krieger Mind/Brain Institute, John Hopkins University, Baltimore, Maryland, USA

I. EXTENDED ABSTRACT

Susan Magsamen, Johns Hopkins University
An Introduction: The Neuro Aesthetics Initiative at the Johns Hopkins Brain Science Institute
Over the last five years, the Brain Science Institute at Johns Hopkins University has conducted a series of basic research programs in touch, sight, music, and creativity, including a Science of the Arts Symposium aimed at an interdisciplinary research to practice outcome. This work has culminated in the development of a program in neuro aesthetics that brings together international leaders in science and practice to create real world solutions informed by neuroscience and implemented in health, wellness, education and other areas of our lives.

Anjan Chatterjee, The University of Pennsylvania
On Building a Neuroscience of Architecture: A View from Neuroaesthetics
The neuroscience of architecture, as a field of inquiry, is early in its development. I will ruminate on opportunities and challenges for this nascent field by comparing it to recent theoretical and empirical developments in neuroaesthetics.

Julio Bermudez, The Catholic University of America
Contemplative Neuroaesthetics
Contemplative neuroscience is developing a growing body of knowledge with little attention to aesthetics. Yet, meditative experiences generated by aesthetic objects and spaces have been the hallmarks of many spiritual and artistic traditions. Neuroaesthetics may cast light on this matter by considering the insights of non-modern aesthetics vis-à-vis recent neuroscience studies of sacred/contemplative architecture, embodied phenomenology, and aesthetic experiences.

Ed Connor, Johns Hopkins University
Quantitative Neuroaesthetics
Making neuroaesthetics into a real science will require quantifying aesthetic properties as well as psychological and neural responses to those properties. I will show how this has been done for sculptural aesthetics and how it could be done for architectural aesthetics.

2. AUTHOR BIO

Susan Magsamen is an active member of the brain sciences research community. She currently serves as a Senior Advisor to the Science of Learning Institute and the Brain Science Institute at Johns Hopkins University and executive director of the BSI Neuro Aesthetics Initiative, and Chair of the Center for Innovation and Leadership in Special Education at the Kennedy Krieger Institute. Susan is also an associate editor for the Science/Nature Science of Learning Journal and senior vice president of the science of learning at Houghton Mifflin Harcourt.

Anjan Chatterjee is the Elliott Professor and Chair of Neurology at Pennsylvania Hospital. He is a member of the Center for Cognitive Neuroscience, and the Center for Neuroscience and Society at the University of Pennsylvania. His clinical practice focuses on patients with cognitive disorders. His research addresses questions about spatial cognition and language, attention, neuroethics, and neuroaesthetics. He wrote The Aesthetic Brain: How we evolved to desire beauty and enjoy art and co-edited: Neuroethics in Practice: Mind, medicine, and society, and The Roots of Cognitive Neuroscience: behavioral neurology and neuropsychology. He is or has been on editorial boards of several neurology, neuroscience, aesthetics and ethics journals. He was awarded the 2002 Norman Geschwind Prize in Behavioral and Cognitive Neurology by the American Academy of Neurology and the 2016 Rudolph Arnheim Prize for contributions to Psychology and the Arts by the American Psychological Association. He is a founding member of the Board of Governors of the Neuroethics Society, a past President of the International Association of Empirical Aesthetics, and a past President of the Behavioral and Cognitive Neurology Society. He serves on the Boards of Haverford College, the Associated Services for the Blind and Visually Impaired, and the College of Physicians of Philadelphia.

Julio Bermudez directs the Sacred Space and Cultural Studies graduate program at the Catholic University of America School of Architecture and Planning. He holds a Master of Architecture and a Ph.D. in Education degrees from the University of Minnesota. His expertise covers architectural phenomenology and the relationship between architecture, culture and spirituality. Bermudez has widely lectured, led symposia, and published in these areas. Current research projects include a fMRI study of architecturally induced contemplative states and the analysis of a survey on profound experiences of place. He is the current president of the Architecture, Culture and Spirituality Forum, a 400+ member international organization that he co-founded in 2007.

Ed Connor obtained his Ph.D. in Neuroscience from Johns Hopkins in 1989. After postdoctoral studies at CalTech and Washington University, he joined the Hopkins Neuroscience Department in 1996. He has served as Director of the Krieger Mind/Brain Institute since 2007. Dr. Connor's research focuses on neural mechanisms underlying object vision. His work has shown how object structure is represented by populations of neurons in higher-level visual regions of the brain. In studies funded by the Hopkins Brain Science Institute, his laboratory has investigated the neural basis of shape aesthetics

Exploring visual and affective qualities of equivalent colors under architectural-scale, full-field exposure conditions

Ute C. Besenecker, Ph.D.
School of Architecture, Renseelaer Polytechnic Institute, Troy, NY

Ted Krueger, Ph.D. [1], Zachary Pearson [1], Alicia Walf, Ph.D. [2], John D. Bullough, Ph.D.[3]
[1] School of Architecture, Rensselaer Polytechnic Institute, Troy, NY
[2] Cognitive Science Department, Rensselaer Polytechnic Institute, Troy, NY
[3] Lighting Research Center, Rensselaer Polytechnic Institute, Troy, NY

I. EXTENDED ABSTRACT

I.1. Background

Color used in architectural settings impacts our perception of form, space, and ambiance (Laganier and van der Pol 2011). The increased availability of light-emitting diodes (LEDs) eases the implementation of luminous color into the built environment. This is evident in urban light and color festivals (Besenecker 2015), as well as architectural projects (Bahamón and Alvarez 2010, CoopHimmelblau 2012).

LED lighting technology introduces the necessity and opportunity to mix and match luminous colors in various ways. Using color matching models (chromaticity), nearly-identical-appearing colors (so-called metamers) can be created that have different spectral compositions depending upon the specific technologies used to create them (Fairchild 2013, Boyce 2003). We set out to explore how individuals may respond to metameric colors in a spatial environment that are produced using different technologies.

Current research in visual perception demonstrates that, when viewed with the full field-of-view, the hue, saturation and brightness of these colors do not necessarily match (Besenecker and Bullough 2016, Gerlach 2003, Horiguchi et al. 2013). In addition, health related sciences suggest that different spectra can have distinct physiological, neurological and psychological effects, this is especially true for spectral compositions with varying melanopsin stimulation (Lockley et al. 2006, Lucas et al. 2014, Vandewalle et al. 2010). We used mixed research methods to conduct architectural-scale studies to explore possible differences in visual, affective and physiological qualities for nearly equivalent stimuli, matched very closely for chromaticity and light level (Besenecker and Krueger 2015).

I.2. Methodology / Procedure

Two different color series were tested, amber and cyan. For each, there were seven different ways to produce near-metameric color conditions: 1) color filtered tungsten, 2) distinct narrowband LED, 3) RGB source LED, 4) 7-color source LED, 5) video projector, 6) colored paint illuminated by white tungsten, and 7) colored paint illuminated by white LED. The conditions illuminated semicircular 'tubicles' (14' height x 9' diameter) that were located in a 50' x 60' x 32' black box studio space (see Figure 1). A qualitative study was performed first (Study 1), with 17 participants who were free to comment on the conditions close-up (immersed) and from afar in comparison to a reference. Based on the responses we received, we conducted a quantitative follow-up study (Study 2) with 12 participants that used a fixed viewing location. All subjects also participated in sessions where heart rate and blood pressure were measured. About half of each of the participant groups had professional experience working with light and/or color.

I.3. Outcome / Discussion

Results from both Study 1 and 2 suggested that there were reliable differences between the seven near metameric conditions for the perceived visual perceptions of brightness and saturation as well as the affective qualities of emotional and spatial qualities. Furthermore, we were interested in the possible relationships between visual, affective and physiological measures. We assessed whether there were statistically significant correlations between the dependent variables of visual (brightness, saturation), affective (emotional, spatial quality) and physiological (heart rate, blood pressure) measures in Study 1 and 2. Figure 1 depicts these significant correlations ($p<0.05$).

In addition, as we noticed that variations between individuals' responses were substantial, we have started to more closely examine the influences of factors such as, age, sex/gender, and color experience. Future work will continue to examine these relationships and extend this work by assessing consistency with using different colors and spatial set-ups.

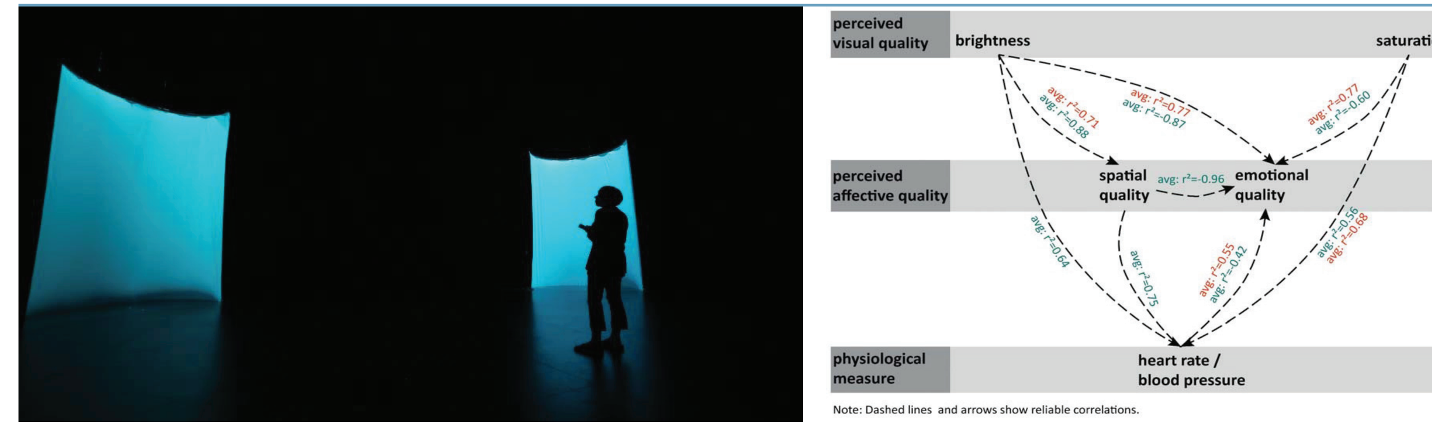

Figure 1. Left: Experimental set-up for Study 1 (cyan session) showing reference condition 1 (left) and test condition 4 (right).
Right: Diagram illustrating statistically significant correlations between visual and affective qualities as suggested by the results from Studies 1-2. Amber or cyan values correspond to the comparison of seven nearly-metameric conditions, amber or cyan respectively.

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5. AUTHOR BIOS

Ute Besenecker is a PhD candidate in Architectural Sciences at the School of Architecture (SoA) and the Center for Cognition, Communication and Culture (CCC) of Rensselaer Polytechnic Institute (RPI). In addition to working on her dissertation (The impact of spectrum on the experience of equivalent coloR in architecture), she currently assists her advisor, Prof. Krueger, with research and teaching assignments at SoA.

Prior to her doctoral work, she received a master's degree in lighting from RPI's Lighting Research Center (LRC) with a research focus on light spectrum and scene brightness perception (advisors: Prof. Figueiro and Dr. Bullough). During her time at the LRC she also worked as research assistant in the outdoor lighting program.

Mrs. Besenecker has presented her research at national and international lighting conferences and her articles have been published in peer reviewed journals. She also holds graduate architectural degrees from the University of Hanover in Germany as well as Columbia University in New York City. Prior to starting her studies at RPI, she worked at several architectural and lighting design firms in Europe and New York City, amongst them Rafael Vinoly

Architects PC, and Leni Schwendinger Light Projects Ltd (now part of ARUP Lighting).

From principles to locality: Bridging the gap from neuroscience to architecture

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University of Porto

I. ABSTRACT

A project - both conceptual as process - grounds, bounds, and frames the design process as such, representing our best present knowledge within a given framework, not an absolute knowledge as it is typically distributed in a system of agents in a community.

How to strengthen the bonds between architects and neuroscientists? I must first stress that architecture and the neurosciences have always shared the domain of animal/ human agency. This shared domain should be sufficient to suggest cross research, regardless of their different cultures, their diverse methodological principles and practices, and diverse technical and technological constraints.

Science moves from particulars to general principles, while architects operate on a local context – "place building" – and within a large spectrum of social, cultural political constraints. This gap is not always consciously internalized by the arts and the humanities. Architects and neuroscientists must find a common operative ground – animal/ human agency – which could encourage mutual contributions.

From "natural" inception, we are gradually constrained by culturally driven commonalities. Ingrained neural activity can be observed on both the agents' behaviour and on their built environment. From this standpoint, architecture and neurosciences have interweaving histories, even if this is not always evident. Architecture and neurosciences should continue strengthening these threads. Analytical research should reveal the hidden or yet unseen bonds between animal/ human animal and their environment. Architecture needs to focus on both the agents' behaviour and on their contingent environment. As a culture-bound practice, it must operate consistently by verifying its principles, and find the path from principles to locality. Architecture and design must gain a fuller insight of the local rules, principles and constraints – e.g. traditions, arts, rituals, whatsoever relevant. To this purpose, architecture and design must use also big data, modelling, information flow and communication. Thus both ethics and aesthetics engage on a rhetoric dialogue - persuasive from ethical, logical and emotionally empathic grounds - that emerges as "as-if-theories" or "folk-theoretic frameworks" which an agent feels correlating - internal/ external, agent/ environment - either as pleasure or pain. When designing for pleasure we try - that's what architects do - attain a foundational desire for survival.

From my personal experience resilient design and designing for resilience conjointly appeal for a methodological approach concerning agency. Thus embracing the architect's embeddedness on communities' projects within which he operates, and observing its agency level as a maieutic architectural practice and its practitioners as catalysts through the design process. The environment, including other agents, and as integral of this process, sets properly the fundamental local constraints. Context-dependent vs. context-free design, as my school of thought - some at Porto School of my generation, e.g. - rightly claims. This theoretical framework gave rise to my architectural studio practice as well as my research and teaching guidelines.

To illustrate it, the images included in this presentation relate work carried out by my architectural studio over a long period of activity and under the project's conceptual framework of the design process I want to share with all of you.

Grounded on my architectural works – although not exclusively – and within the theoretical work in progress - both as architect practitioner/teacher - my Research Program is a follow up of the Phd Research Project, and nowadays intended as particularly focused on strengthening ties with neuroscience's researchers in order to make explicit the linkages that suggest the indiscernible assumption I've taken, and particularly keen to present and discuss links - theoretical and practical - which fit the argument's goal to consolidate these relations.

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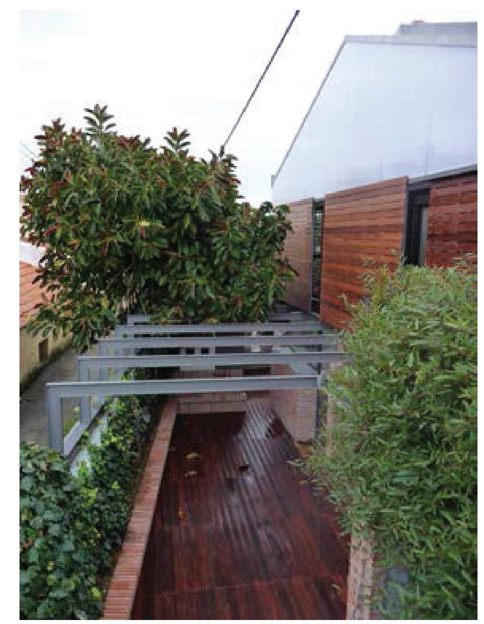
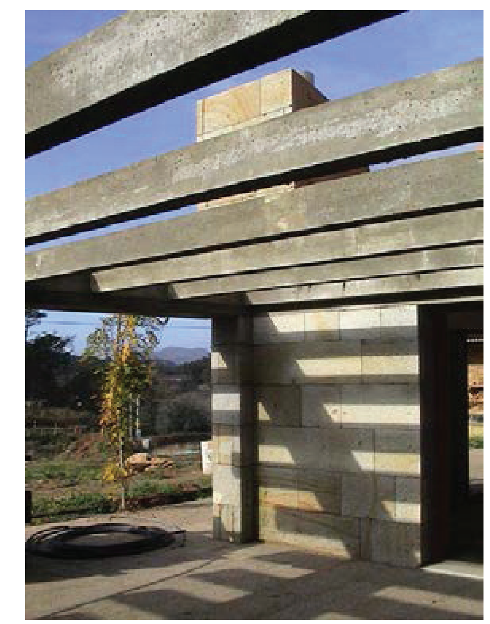
3. AUTHOR BIO

[Born 1950, Porto]; Architect [ESBAP Escola Superior de Belas Artes do Porto /FAUP, 1975]; MD Philosophy, FLUP Faculdade de Letras/University of Porto Faculty of Arts [Ideas, Words, Things and Possible Worlds. Interior architecture according to Noam Chomsky] 2009; Metadisciplinary Phd Dissertation in Architecture and Philosophy [Architecture-Philosophy]: Contribution to the Research on the Complexity of the Project. Operational Models on the Domain of Architecture, Heritage, Museum] at UPorto 2015; Architect since 1975 and partner on architectural studios:[Pedro Ramalho, 1973-76] developing SAAL Process (recently displayed at Canadian Center for Architecture) and António Menéres [co-author of the Portuguese Regional Architecture Survey [1955-1961] and Popular Architecture in Portugal [1961] from 1976-85; Professor at FLUP [Archaeology, Art History, Museology; Department of Sciences and Techniques of Heritage]; Member of MLAG [Mind, Language & Action Group] Institute of Philosophy/U. Researcher at the Institute of Philosophy at the University of Porto. Founding member of MLAG and current coordinator of research Project Autofocus [af]p. Professional activity as both architect and teacher after 1975 shaped research interests: Architecture and Philosophy, animal and vernacular architecture; analysis of agency in design processes and systems, the ontoepistemological framework and metaphysics of agents in the real world.





The Real Meaning of Architecture: Or How to Make Architecture Mean Something

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I. ABSTRACT

Architects ask, 'How does Architecture mean something?' Recent developments in neuroscience and brain imagining bring insight to this classical question. Our proposition is that architecture is understood in an instant, much as we realize a 'first impression,' through the medium of an atmosphere, by way of embodiment, in the manner of affordances.

Architecture is like a *first impression*. The etymology of 'impression' is, "the first and immediate effect of an experience or perception upon the mind," and, "an image in the mind caused by something external."[1] A first impression, being more than a mere impression, is a psychological schema. A phenomenon of composite signals emitted by a new stimulus that is imagined virtually immediately.[2] Such snap-judgments evolved as a survival skill in an eat-or-be-eaten world, however, first impressions are not solely an animalistic survival aptitude. Culturally and socially we are proficient to judge others through archetypes, stereotypes, consciously, or otherwise.[4] Studies in first impressions reveal that in a tenth of a second, humans make characteristic assumptions of a stranger's face.[3] To see a building is similar to perceiving human faces and the connotation of façade. In a study by Chalup et al., facial recognition software was first enlisted to detect human faces, then, the same software was overlaid onto building façades.[4] Facial perception is formed in the brain as empathy or embodied simulation, which not only connects people to other people, but also with objects. The brain pre-reflectively scans a room like a face, with similar accuracy in speed, judgment, empathy and nuance. Our knowledge of space, a product of brain biology, is understood immediately, pre- reflectively, the product of two million of years of evolution.

Atmosphere[5] – more palpable than coordinate space – is commonly understood as a romantic, candlelit dinner. Yet, like an altered state of cognition (ASC), atmosphere is an elusive yet profound consequence of architecture. To convince scientists and architects of it's weight requires tools more precise than language. It requires Arnold Ludwig and EEG studies of the brain. Dr. Ludwig's explains ASC's as deviations of normal, patterned, human cognition, like the mind shift of viewing a movie, listening to music, sexual arousal during foreplay, or architecture, where involved motor impulse and cognitive properties are catalyzed by extraordinary internal and external stimuli; environmental, chemical, emotional, among others. [6] [7] Their consequences include deviations in perception, dissolution of internal and external boundary, altered measures of time, and elastic understanding of consciousness. The science of ASC's is condensed to the oscillations of brainwaves; layered in response to degrees of relaxation and stimuli reception. Four primary waves exist, Beta, Alpha, Theta and Delta, each with measured range in frequency and amplitude.[8] Lowest tiered are delta waves, active in perception and bodily projection (empathy). These waves are monitored through EEG mapping, precisely recording amplitude and frequency of electricity in the brain. Potential for this mental mapping was demonstrated via Gallese and Freedberg by observing suppressed mu rhythms in response to viewing authentic artworks and digitally reproduced counterparts.[9] Mental activity increased significantly more in response to viewing authentic works, opposed to the reproductions. This suggests that humans don't simply spectate creative acts, and are instead biologically tuned to detect human gesture and intent. This is the outcome of evolutionary development to communicate and cooperate with one another pre-linguistically. If true for 2-dimensional artworks, the realm of architectural works, embedded with a complexity of motives and intentions, then such psychological consequences seems certain. Without discrediting atmosphere's poetic champions, we recognize the potential of modern instruments (EEG and fMRI), and developments in psychology endow us with the potential, to measure, at least in part, the consequences of atmospheres.

As atmosphere gives aesthetic medium to space, embodied metaphors give it value. "Embodied" infers embodied simulation10 whereas "Metaphor" originates from the Greek metapherein - 'to transfer,'[11] indicating the transfer of ideas from one item to another, whether animate or inanimate. The most fundamental of embodied metaphors are harmonies of kinetics. The Greeks implanted the body, as geometry, into art and buildings intending an aesthetic order. These lessons were recorded by the Roman architect Vitruvius,[12] and revived in the Renaissance with a renewed interest in the human body and the revealed divinity of harmonics. Equally, current neuroscience insists that symmetry and proportion are hardwired into pre-reflective judgments of beauty and action. In "Neuroaesthetics: A Review," Cinzia, Gallese, and Di Dio[13] give such a testimony. One can refer specifically Di Dio et al's study of Greek statues,[14] some original and others graphically altered in proportion. The subjects could tell the difference without recognition. As architecture frames aesthetic participation through empathy, geometry and proportion affords us a presence of the body and is seen with higher gravitas as when resonating with harmonics. Geometry in architecture is musical, with rhythm and consonance being the metaphorical equivalent of proportion and perfect geometry. Architecture, in compliment to embodied simulation, is comprehended as a body, the orderly projection of ourselves. The body is acknowledged and embodied in its simplest metaphor as pure geometric projection.

Embodied metaphors are in architecture through the agency of mirror mechanisms as affordances. Standing between scientists and architects, philosopher Mark Johnson, by way of mirror mechanisms, advises that in addition to our need for habitation is our need for meaning. "In other words, although we are animals evolved for fitness, we are just as much animals with a deep desire for

meaning as part of our attempts to grow and flourish."[15] Meaning in architecture arises in two ways: First as a felt qualitative unity that sets up a world (i.e., aesthetic experience); Second, as a building's specific affordances offer the possibility of meaningful engagements relative to its contexts.[16] Johnson's application of Gibson's 'affordances' gives critical specificity to how meanings in architecture are made. Affordances – the actions our body can create with objects and situations – are only meaningful in relation to their context. For instance, room not only affords us the ability to house our personal objects, but to have meaningful encounters with/in them. The affordances of a room also extend to social and cultural functions.[17] Since embodied simulation (empathy) is responsible for the social understanding among humans, we are naturally able to intuit the mood of the room for different scenarios, such as personal study or a romantic dinner. The room also affords personal and past experiences. Memory and spatiality are inseparably linked. While navigation is a multi-modal task requiring memory, spatial representation is necessary to recall specific memories.[18] A simple room is a fraction of that which Juhani Pallasmaa asserts architecture may accomplish. Neuroscience provides a foundation for architects to create potential places of meaning.

To confirm our several notions we need to discover how faces and architecture are similar in the brain. For architects atmosphere is thick with mood, but how do we measure it. That we embody architecture is well understood, the aesthetic implications of such simulation is an open research on how architecture can be a stimulus. Relatedly, the meaning of architecture is in what it affords us, yet can a design theory be one result of this clear thinking? We seek intimate partnership between architect and scientist, harkening back to an age when both were one, with the same obligation as servants of society.

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[7] The gentle alteration of the mind is not exclusive to the built environments. Due in large measure to our evolutionary development, rooted in survival tactics on the savannas of Africa. To scan our environs, receiving information through our complete set of senses in order to ensure the continuity and provision of our lives. The 'wholeness' of atmosphere refers to the reflective and pre-reflective nature of presence [the event]; a cooperation of our psychology and physiology its result. The "seduction" of atmosphere lies in its mysterious—hypnotic—presence, drawing its participant back to precise, profound, moments in time and space (production of image/memory). Zumthor reduces the wholeness of Atmosphere to nine components, each with sensual consequence and mental contemplation. For architects, 'atmosphere' is perhaps poetic jargon to describe the seduction of space, and its ability to transport its participant to two places; the physical space of the present, and the mental—imagined—space of the past.

[8] Four primary waves exist, Beta, Alpha, Theta and Delta, each with measured range in frequency and amplitude. Beta waves, primary in cognitive function, mobilize our immediate understanding of the external world, facilitating comprehension of time, space, thought organization and logic. Alpha waves, bridge consciousness and unconsciousness and are responsible for the production of image, intuition, and the event of creativity. Theta waves are present in the formation of symbolism and spiritual matters.

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Accelerating Human Imagination

Invited Speaker: Sheldon Brown
Director, Arthur C. Clarke Center for Human Imagination
Director, Center for Hybrid Multicore Productivity Research
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1. ABSTRACT

Our imagination is the underpinning our cultural development. Yet, what is "imagination"? Is there a singular basis of imagination that develops into a number of different phenomena, or do we use the word imagination to group together a number of aspects of behavior and cognition into a common category? If we can better understand imagination, we might be able to find ways of directly engaging it in order to accelerate its operation. What use might we put this accelerated imagination to? These questions are being asked by the Arthur C. Clarke Center for Human Imagination. I'll describe how we are pursuing the understanding of imagination, how we are accelerating it, and how we are thinking about the best ways of aiming an enhanced human imagination. In particular, I will focus on how we are looking to augment human imagination through a variety of computational techniques ranging from genetic algorithms to neural network processes, and how this methodology provokes insight into the ways in which new ideas come into existence.

2. SPEAKER BIO

Sheldon Brown combines computer science research with vanguard cultural production. He is the John D. and Catherine T. MacArthur Foundation Endowed Chair of Digital Media and Learning at UCSD, and is the Director of the Arthur C. Clarke Center for Human Imagination where he is a Professor of Visual Arts and a co-founder of the California Institute of Telecommunications and Information Technologies (Calit2) and he is also the UCSD Site Director of the NSF supported Industry-University Collaborative Research Center for Hybrid Multicore Productivity Research (CHMPR).

His interactive artworks have been exhibited at: The Museum of Contemporary Art in Shanghai, The Exploratorium in San Francisco, Ars Electronica in Linz Austria, The Kitchen in NYC, Zacheta Gallery in Warsaw, Centro Nacional in Mexico City, Oi Futuro in Rio de Janeiro, Museum of Contemporary Art San Diego, and others. He has also been featured at leading edge techno-culture conferences such as Supercomputing, SIGGRAPH, TedX, GDC. He has been commissioned for public artworks in Seattle, San Francisco, San Diego and Mexico City, and has received grants from the NSF, AT&T New Experiments in Art and Technology, the NEA, IBM, Intel, Sun Microsystems, SEGA SAMMY, Sony, Vicon and others.

The Urban Grid, the Hippocampus, Savannahs and Real Property

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I. ABSTRACT

This paper provides a framework for the understanding and application of biophilic design. It begins by briefly explaining the concept of biophilia as an inherent inclination to affiliate with nature (the nonhuman environment) essential to human health, fitness and wellbeing. The paper describes how the prevailing paradigm of design of the modern built environment has encouraged environmental degradation and separation from nature. Biophilic design is the attempt to incorporate understandings of biophilia into the built environment. The paper describes the principles and practices of biophilic design. Five basic principles are identified essential to the successful application of biophilic design. The practice of biophilic design involves the application of 3 basic categories of direct and indirect experience of nature, and the experience of space and place, and some 24 associated attributes, which are briefly described. The paper concludes with the consideration of the ecological and ethical imperative of biophilic design as a remedial response to the breach of modern society from the natural world.

I. What is Biophilia and Biophilic Design?

II. The Principles and Benefits of Biophilic Design

III. The Application of Biophilic Design

IV. The Ecological and Ethical Imperative

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3. AUTHOR BIOS

Stephen R. Kellert, PhD, Tweedy Ordway Professor Emeritus at Yale University, School of Forestry and Environmental Studies
Dr. Kellert helped develop both the theory of biophilia and its application in the built environment, biophilic design. He co-edited with Professor E.O. Wilson the first scientific examination of the theory of biophilia in 1993, "The Biophilia Hypothesis" (Island Press 1993). Dr. Kellert also published the first books on biophilic design – "Building for Life" (Island Press 2005) and "Biophilic Design" (John Wiley 2008), and the only film on the subject, "Biophilic Design: the Architecture of Life" (2011).

Elizabeth Freeman Calabrese, AIA, LEED AP, NCARB, Calabrese Architects, Inc.
Elizabeth has been the principal architect for Calabrese Architects for over 20 years. Her projects are located throughout the US and Kenya and focus on creating built environments that connect people to nature and each other to promote human and environmental health and well-being.

Elizabeth recently published an on-line monograph with Stephen Kellert, "The Practice of Biophilic Design" (www.biophilic-design.com).

Brains Crave Natural Environments

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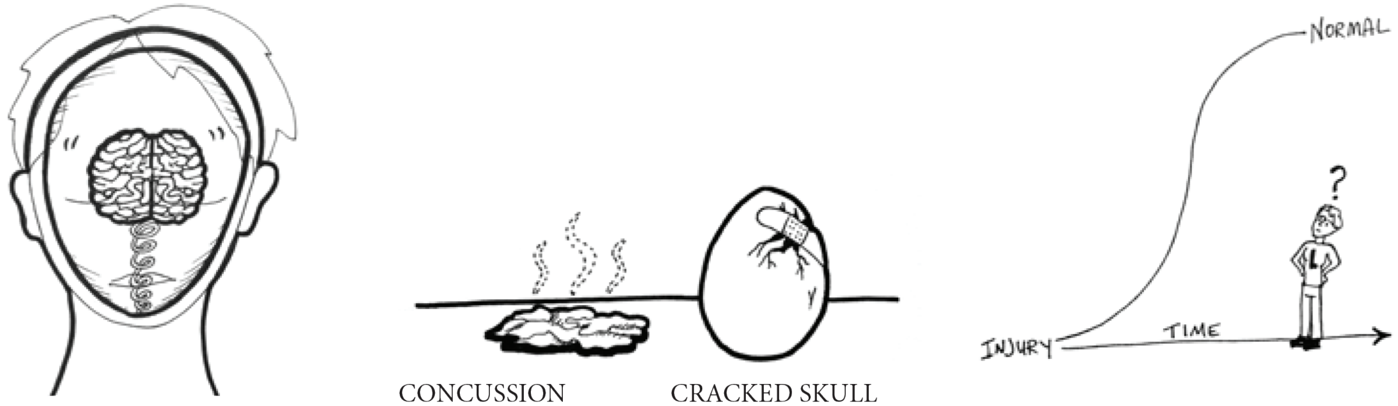

Illustrations by Leah Simmons

1. EXTENDED ABSTRACT

Digital tools and toys have become quickly integrated into our professional and personal lives. What is this doing to the "human being"? (Gadamer, 12).We must examine how the digital environment affects our physical, mental and emotional health and welfare.

Our understanding of brain injuries and positive recovery could help define healthy use of future digital environments. Neurocognitive tests and ocular movement document the normal brain and recovery path for brain injuries (Samadani). A concussed person is advised to minimize stimuli. Excessive use of digital screens exacerbate symptoms and prolong brain healing. Concussion specialist Dr. Valentine recommended artistic tasks, such as drawing, to his patient, Leah Simmons, who suffered over six months from a concussion she received while playing roller derby. Simmons found drawing challenging, but did not aggravate symptoms. The task became a predominant role in her recovery.

Even with minimal use of digital reality, we are forced to adapt as technology is streamlined, and ergonomics requires a broader definition. Inventions such as glasses with computer screen lenses could solve the physical harm our bodies suffer while looking down at a phone or tablet. However, our brains might not easily assimilate to a world with constant 3D environments, which is where technology is moving, especially in architecture.

3D or digital environments, such as 3D movies, computer modeling, tablet or phone use, can trigger nausea and dizziness for some people. Motion Sickness is a common term, however, the sickness we feel from digital environments is not. Cybersickness, Simulator Sickness, Visually Induced Motion Sickness, etc., are some terms to describe it.

"Cyriel Diels from Coventry University's Centre for Mobility and Transport, England explained that cybersickness is a basic dilemma that has sort of been swept under the rug in the technology sector. 'It's a natural response to an unnatural environment,' he said" (Tech Times).

The unnatural environments of the 21st century are affecting our health beyond our comprehension (Gadamer). Technology is here to stay, and we need to think beyond limiting computer and television time because our brains crave natural environments.

2. ACKNOWLEDGEMENTS

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"Recovery Map"
Illustrations By Leah Simmons

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4. AUTHOR BIO

Sandra Callies: Graduating from the University of Minnesota with a Master of Architecture in 2015, Sandra is working towards becoming a licensed architect. Originally from the Great Plains of South Dakota, she is interested in architecture that ascribes to its landscape. As desire for dexterity is seemly fading, Sandra loves craftsmanship and encourages everyone to find a craft they enjoy doing. Art is a therapeutic effort anyone can benefit from. Her artistic interests are in watercolors, stained glass, sewing, and singing.

Sandra's past five years of skating with women's roller derby (WFTDA) has caused two concussions, and her recovery has been a battle while depending on digital resources. With architectural theory in mind, Sandra hopes to speculate how the digital environment affects us.

Cognitive perspective ameliorates way finding in a complex shopping building having some architectural flaws

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This study aims at empirically analysing pedestrian movements to investigate architectural flaws with the assistance of some robust cognitive principles associated with an individual's brain in order to facilitate wayfinding of a stranger/tourist in a complex shopping building. A complex building having one main entrance and six secondary entrances were taken as the centre of observation. A total of 42 subjects were closely observed without their knowledge. This was essentially a blind randomised study, and the data collectors were themselves unaware of the objectives of the task. Data was collected during weekdays when maximum crowd was expected. The experimenter selected the subjects who only roamed around the building with no immediate goal of purchasing anything. One subject was followed for a maximum of ten minutes, and if he/she got out before that then the time was noted. Entry gate was taken as the independent variable, while exit gate, total time taken, total distance covered and number of pauses were taken as dependent variables. Pearson correlation was calculated between variables. Result showed that there was least entry from gate number 6 which was due to poor building design. People found it difficult to identify the location, because of smaller dimensions of the gate and since the larger portion was covered with the wall. Another finding was that people covered large distance to take an exit from gate 6, and reason was that their head bearing led to longest corridor as entry opened in that corridor. Application of cognitive principles can facilitate wayfinding such as provision of a survey view of shopping complex at each entry point can improve orientation of person.

Keywords: Cognitive principles, Wayfinding, Architectural flaw.

I. ABSTRACT

I.I. Background

Wayfinding in a complex building requires a lot of cognitive abilities like learning , memory, decision making etc. Other way to identify routes and make trail from entry gate to exit gate is to either follow a map or rely on the given instructions. People in an unfamiliar environment often requires assistance. Moreover, cognitive science offers help to ease wayfinding in an unfamiliar building (Peters, 2012). This can be provided by visuo-spatial system (Münzer, & Stahl, 2007) that assist the navigator's ability to locate himself; identify route to destination; and accumulate spatial information for the space. Considering all this points, cognitive principle guide navigator for successful wayfinding. In this study, we aim to apply cognitive principle to provide a solution for a architectural point of view(complex shopping building). Once building is constructed, spaces around the building and surroundings can either assist or disorient the navigator which contribute to architectural flaw.

I.I. Methodology / Procedure

Participants: This was essentially a blind randomised study, and the data collectors were themselves unaware of the objectives of the task. Forty two subjects were closely observed without their knowledge.

Apparatus: A complex building having one main entrance and six secondary entrances were taken as the centre of observation. Exit can be made with those entrances, also. Data was collected during weekdays when maximum crowd was expected. Experimenter had pedometer and GPS enabled system which could measure variables like steps taken, distance covered etc. Experiment did not count the subjects who took entry and exit from the same gate.

Procedure: The experimenter selected the subjects who only roamed around the building with no immediate goal of purchasing anything. One subject was followed for a maximum of ten minutes, and if he/she got out before that then the time was noted.

Analysis: Pearson correlation was applied on the obtained variables in the 'R' software. Entry gate was taken as the independent variable, while exit gate, total time taken, total distance covered, and number of pauses were taken as dependent variables.

I.3. Outcome / Discussion

Correlation analysis revealed strong relationship for 'average distance covered' and 'average time taken', r=.358,p=.004, and 'average time taken' and 'total number of pauses', r=.351, p=.005 as shown in Fig.1. Similarly scatter plots were drawn to identify patterns between this variables (Fig.2 and Fig.3).

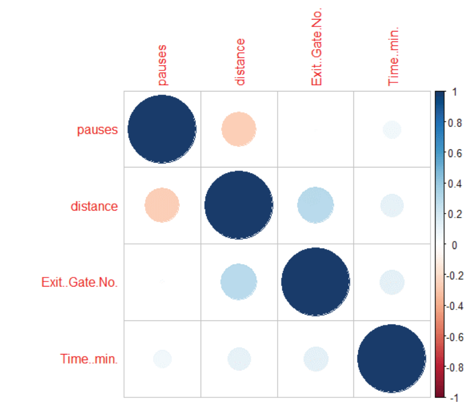

Fig.1 Correlation result between different variables

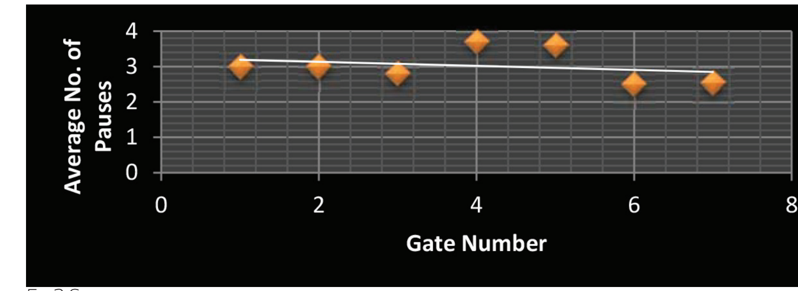

Fig.2 Scatter plot for gate number and average number of pauses.

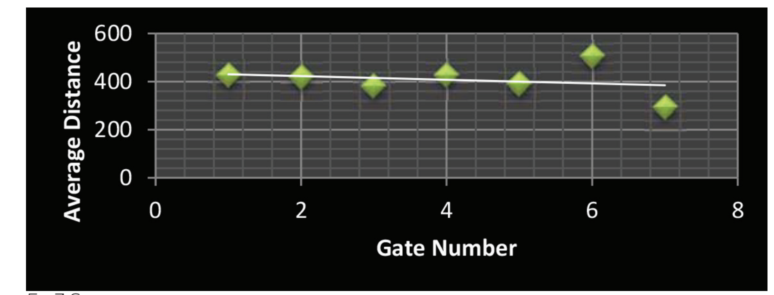

Fig.3 Scatter plot for gate number and average covered distance.

Result showed that there was least entry from gate number 6 which was due to poor building design. People found it difficult to identify the location, because of smaller dimensions of the gate and since the larger portion was covered with the wall. Application of cognitive principles implicated that it would be better to install signboards to indicate the entry gate (Passini, 1984). Another finding was that people covered large distance to take an exit from gate 6, and reason was that their head bearing led to longest corridor as entry opened in that corridor. Reflection can be applied for people to calculate the distance from exit or another kind of exploration which would reduce the probability of getting lost. In addition to this, provision of a survey view of shopping complex at each entry point can facilitate wayfinding (Bovy & Stern, 2012;Thorndyke & Hayes-Roth,1982). Future scope of this study can be identified in the form of application such as understanding the applied cognitive principles can improve performance besides just constructing a mental map. Also, in the low intensity conflict scenarios, where at the time of any kind of disaster inside the building, applying cognitive principles would make the mission a successful operation with minimum casualties under virtual reality training.

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Architecture and Recovery: Understanding the role of domestic residential spaces in assisting and enhancing stroke recovery

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1. ABSTRACT

One person every 10 minutes suffers from stroke in Australia. Occurring without warning stroke involves blood vessels within the brain becoming blocked causing significant death of brain tissue. As a result patients that have suffered from stroke are often left with significant disability and their relationship to the built environment becomes radically altered. This project recognises that patients recovering from stroke need to be stimulated, enriched, and challenged by their spatial environment and that there is an absence of current research into how architecture and design-related fields can better contribute to this, outside of traditional institutional health settings. This paper brings together a team of neuroscientists, architects, landscape architects and designers in order to better understand the role of architecture and the built environment in assisting and facilitating stroke recovery. There is already an emerging field of architectural research into the positive relationship between architecture and neuroscience (Cohen, 2000; Ednie Brown, 2012; Robinson, 2015), but this has, to date, not directly addressed the potential of design to play a leading role in recovery. General themes that have emerged from research within the field of neuroscience have demonstrated that view (Ulrich, 1984), the proximity to a garden (Cooper Marcus, 1995), access to light, colour (Holzman, 2010) and also organisational layout (Ulrich, 2004; Ellison, 2004) can all have a significant and tangible impact on patient recovery times, pain reduction and general well-being. This research has, for the most part, however, focused on design within an institutional context, and rarely, if at all, considered the broader role of domestic or everyday residential or urban environments on health care and recovery.

The current paper addresses this important role of domestic residential, landscape and urban environments in enhancing patient recovery after the acute and sub-acute periods. The research will bring together key themes from the existing studies in the field of neuroscience, to better understand the role that architecture can play as an active, rather than passive component of recovery. Currently, nearly all of the recovery process for survivors of stroke occurs within the residential environment. This, however, is problematic as these environments have been designed around able-bodied individuals with a completely different need set compared to stroke survivors. The vast amount of research that has been undertaken in this field has focussed on the architecture of institutional environments, and this project will explore how aspects of care and recovery can be extended to urban environments outside of a hospital setting, or the immediate residential environment. This is critical because only a small proportion of the recovery period from a stroke can take place within an institutional environment, and the broader social and cultural aspects of recovery have not been addressed in the current scholarship.

Using a design research methodology, supported by empirical and theoretical knowledge of sub-acute stroke recovery, the project will identify existing urban and social environments where criteria essential to stroke recovery can be enhanced and stimulated, and provide a coherent strategy for implementation. Expanding the domain of research to include non-institutional environments, and the broader social space of the city has the potential to dramatically reshape the current knowledge in this field. Drawing from a detailed spatial analysis of the cultural and social conditions of existing residential recovery environments, and accessing a broad-range of statistical data, the paper will summarise the key criteria for residential spaces of recovery, before framing the brief for a cross-disciplinary design research project which aims to actively engage architecture, technology and neuroscience to enhance the recovery process. Central to this multi-disciplinary approach is the role of integrated technology in the development of "smart" houses, which track activity and behaviour as a way of monitoring recovery and well-being.

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Enriched Environments
Enhancing Psychiatric Care Facilities for Transitional Youth

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I. EXTENDED ABSTRACT

The number of transitional youth affected by mental illness is growing at an alarming rate. This group, between ages fifteen and twenty-five, often undergo personal, interpersonal, and social trauma that result in chronic stress and anxiety. Tragically, transitional youth often fall through the cracks of the mental health care system. We argue that this is due in large part to a conceptual gap between the architecture of existing facilities and the methods of treatment. In this paper, we will discuss a reformulation of psychiatric facilities for transitional youth through an examination of 'enriched environments'. In the context of our discussion, an enriched environment is understood as an architecture that nurtures both the physiological and the psychological aspects of being — creating a neurological union of body and mind.

This understanding of enriched environments will be presented through a case study developed as a part of a professional M.Arch thesis. Beginning with a synopsis of current literature concerned with healing and neuro-architecture, we will discuss how research in the neurosciences can inform the design of psychiatric facilities for transitional youth. This discussion will be presented through a speculative architectural project. Recognizing that the causes for psychiatric disorders are the result of complex relationships between environmental, psychological, and physiological factors — making the condition of each patient essentially unique — an understanding of how the brain functions and reacts to given stimuli within the built environment is taken as a starting point for design. The project is not understood as a general proposition to 'cure' mental illness, but a specific exploration of how architecture could play an important — even crucial — role in the treatment and recovery of transitional youth.

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3. AUTHOR BIO

Lara Chow is a graduate student in the PhD program at the Azrieli School of Architecture at Carleton University. Lara's ongoing research focuses on how humans experience architectural space and the effect on both physical and psychological well-being — specifically within mental healthcare facilities. Her masters thesis Enriched Environment: A Psychiatric Facility for Transitional Youth translated emerging biological and neurological research into a design intended to promote both physical and psychological well-being. The research thesis was awarded the Azrieli Scholars Award and also featured under Current Notable Work on the Academy of Neuroscience for Architecture (ANFA) website.

IMAGES FROM PROPOSED PROJECT

Underground and windowless spaces: a neuroscience approach

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1. EXTENDED ABSTRACT

The proliferation of Mega-Cities, especially in Asia, has an effect on the available space. Because of lack of space, an increasing number of workers spend a significant portion of their time in window-less environments (WLE). In addition, underground spaces (UGS) have been promoted as viable solution for places that space is at premium. However, there has yet to be a unified, systematic and holistic examination of the interaction of human psychology and health with WLE/UGS spaces and this may affect the public's acceptance to the idea of potentially working underground in future.

Here, we present the key elements of, probably the only currently running, inter-disciplinary, sys-tematic research program aiming to examine the relationship between the design, environmental and architectural characteristics of WLE/UGS with critical aspects of human behaviour and well-being. Specifically, we examine how (i) working in WLE/UGS influences (positively or negatively) human psychology, cognition, performance and well-being (ii) critical aspects of human health are affected by such environments (such as circadian rhythms, including core body temperature) and (iii) general attitudes and lay beliefs towards working at UGS. The research outcomes will eventually be combined and summarised by employing a Risk Analysis approach, to translate the results to practitioners. In addition, assessment tools, recommendations, solutions, case studies and standards will be developed and disseminated to assist the industry, policy makers, researchers and the public to reach well-informed decisions.

The main aim of this presentation is to introduce the research program and invite interested stakeholders for a possible global research effort to better understand the effects of working at WLE/UGS on the population. To that end, we invite ANFA members to actively contribute to this extraordinary research effort.

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A/ Prof George Christopoulos holds a Ph.D. (Cambridge) in Decision and Social Neuroscience. He is currently Assistant Professor at Nanyang Business School, NTU and his current research examines the relationship between the built environment and human decision making, psycho-physiological responses and brain function. Lab webpage: https://sites.google.com/site/labdeon/home.

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Eun Hee Lee holds a PhD in Social Cognition from University of Cambridge. Her thesis explored the effect of social power on perception of the physical variables, looking at distance, slope and weight estimates. Currently she is a postdoc researcher at Nanyang Technological University in Singapore, researching social aspects of working in the built environment.

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*** Presenter**

Applied Neuroscience for Architects (an architect's primer)

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I. ABSTRACT

Architecture is an applied science, so for architects design begins where science ends. This is as true of neuroscience as it is for strengths of materials, heating and air conditioning systems, sustainable practices, lighting, acoustics, geometry, etc. What can the biology of the brain teach us about designing architectural space? Much. Sorting from the many consequences that neuroscience has for the practice of architecture, I suggest three substantial claims from science for an architect's primer: 1) Immediate engagement with architecture is pre-reflective and meaningful; 2) The experience of architecture is kinesthetic and emotive; hence perceived through enactments with ones own body; 3) The duality of vision, from the structure of the eye, supports a polar yet interlaced experience of architectural space into object meaning and atmosphere.

Architecture is pre-reflective, meaning the whole body\brain receives sensory stimuli to which it responds emotively, before intellectual processes reflect. In simple analogy, confronted by a speeding taxi as you step off the curb, your senses and adrenalin take over and you react defensively stepping backwards. Afterwards, cognition kicks in and you examine your feelings (Oh my, I was nearly killed – fear, anxiety, accelerated heart rate, etc.). Emotion (meaning motion and internal chemistry) is first. It is involuntary. At least since the Greeks, architects have recognized similar involuntary sensory responses to built spaces as fundamental to the profession: an expertise Peter Zumthor compares to a first impression.[1] Such corporeal knowing or snap judgments are evolved from survival on the African savanna. Like a first impression, a room is its own kind knowledge and judgment, informed by experiences, personal and cultural bias that operates below consciousness as emotion before emerging, cognitively like a feeling. One reads a place with the full power of Pallasmaa's seven senses,[2] memories and life's experiences. A corner stone of intuition for architects, for scientist this is now being revealed by brain imagining experimentation.

Experiencing architecture is emotive and kinesthetic, a hypothesis unfolding from the discovery of mirror mechanisms in the brain, understood as embodied simulation. This hypothesis is similar to an architect's sense of empathy, but much deeper. Where empathy implies an tangential understanding of the other's emotion – sheading a tear for another's lost, seeing anger or evil in a face – what embodied simulation suggests is that we actually perceive through enactments with ones own body. This is a broad and complex topic, but our profound and precise ability to mime is a good demonstration. If for example you want to show your son how to fillet a fish, you say watch me (not I will explain and see how you do). More significant for architect's is that this embodiment of actions and intentions is not only true for animate creatures, but also inanimate objects like sculpture (Michelangelo's Slaves), paintings (Vermeer, Kandinsky, Jackson Pollack, etc.), the tension of Bernini's Baldacchino's twisted columns, even haphazard things touching one another (a pinecone or fallen limb on the deck). Art Historian, Prof. Freedberg and Neuroscientist, Vittorio Gallese summarize in an argument revising art history, that all esthetic reaction to art is not necessarily cognitive. Alternatively they propose, "that a crucial element of esthetic response consists of the activation of embodied mechanisms encompassing the simulation of actions, emotions and corporeal sensation, and that these mechanisms are universal.

This basic level of reaction to images is essential to understanding the effectiveness both of everyday images and of works of art. Historical, cultural and other contextual factors do not preclude the importance of considering the neural processes that arise in the empathetic understanding of visual artworks." [3] Allied studies show that people know the differences between images of the sliced canvases of Lucio Fontana when compared to graphic representations. Our body understands the art works by reenacting the slicing actions on the canvas with our own hand. Likewise, subjects can sense, can discern, the original classical statues from proportionally manipulated alternatives.[4] The brain is made for motion, as the science of mirror mechanisms reveals. Many basic implications for the architect are well conceived in the writings of architect Harry Mallgrave[5] and neuroscientist. Michael Arbib.[6] Embodied simulation is feeling oneself into a space with its component affordances, whole to parts, as the architect will say.

Architecture is said to be a visual art. Insofar as this is true, then the visual experience of architecture divides into two types based on the physiology of the eye.[7] (fig.1) The first is central vision (foveal), a visual field the size of your fist at arms length. Here one can read, write, discern fine detail, discover meaning in objects, relate to craft, and our focused intellectual awareness of architecture. The remainder of our visual field is peripheral vision, with a loss of detail recognition as vision moves out, from its center. Peripheral vision is good for movement and gist of a scene, for locating yourself in space, balance, and the ambient processing of architecture as atmosphere.[8] From objects to scenes, it is how our attention is allocated and deployed within this system, which gives meaning to space. Meaningful for architects, is how emotional images are dealt with differently in foveal and

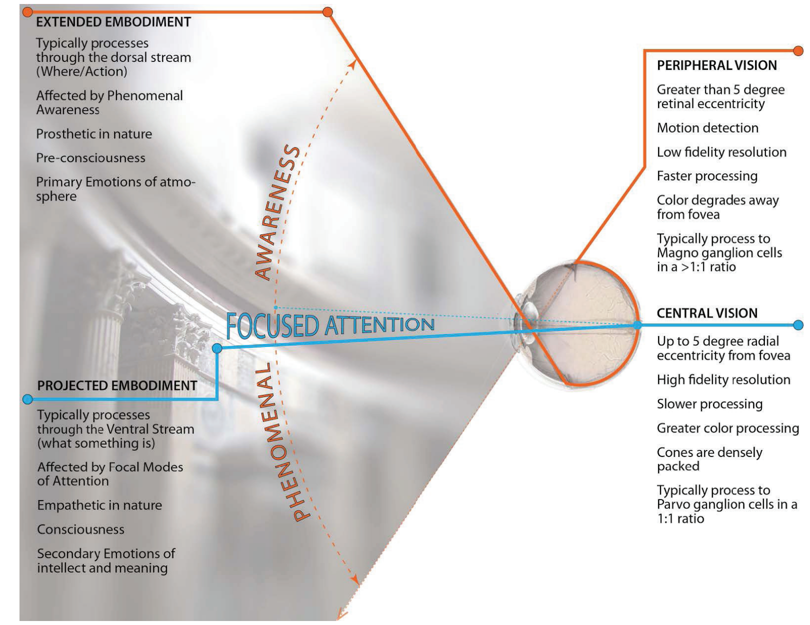

Figure 1 is a schematic of our contentions for architecture and the eye. I realize that these are vast generalizations in the complex biology of the eye \ brain. For instance the ventral and dorsal streams overlap and share in the parahippocampal area, however, dividing into two emotive and cognitive realms, between central and peripheral vision gives insight into our common experience. However, the eye as medium of artistic exchange carries with it means that architects will do well to understand. (Diagram courtesy of Kevin Rooney)

peripheral vision. Studies indicate that central vision is required to discern emotional content. Indeed, our attention is draw to emotional content – involuntarily[9] – versus neutrally charged images or situations within a functional visual range close to the 5° of visual angle of central vision.[10] A broad range of reporting demonstrates our recognition of emotive content, in contrast to neutrally charged images, while in our peripheral field of view: for instance, one's attention on the Baldacchino within the perspective of St. Peter's Basilica. Peripheral vision contains many false alarms, yet supports vague but meaningful impressions.

Architects will appreciate this as context. This capturing of emotional gist is imprecise, yet dually present. What I am proposing is a biological basis of mood from atmosphere in architectural space.

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3. AUTHOR BIO

Bob Condia, AIA is the design partner with *Condia+Ornelas Architects*. A professor of architecture at Kansas State, (1989 – present) he teaches architecture as an art form, with serious considerations to: design process; structure; the ancient works of man; and a thick perception of space. His publications range from architects' monographs; articles on the experience of space; papers on creativity in design; and a catalogue of his surrealist illustrations. Since 2012 he has taught graduate seminars combining architectural theory, analytical philosophy and the neuroscience of aesthetic experience. He is IRB certified.. Prof. Condia earned a Master of Science in Architecture and Building Design at Columbia University 1983, and a Bachelor of Architecture at California Polytechnic State University, 1980.

Education at the intersection of Architecture & Neuroscience

Facilitator: Gilbert D. Cooke, FAIA
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Invited Panelists: Tom Fisher [1], Eduardo Macagno, Ph.D. [2], Marvin Malecha [3], Bob Condia [4], Meredith Banasiak [5], Grace C. Lee [6]
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[3] FAIA, DPACSA President and Cheif Academic Officer, NewSchool of Architecture + Design, San Diego, California, USA
[4] Professor, Kansas State University, Manhattan, Kansas, USA
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I. ABSTRACT

Architectural education is by nature an amalgam of multiple disciplines, all deemed necessary to prepare students for practice. Many once necessary components have already been replaced; an evolutionary necessity in virtually all majors. How do does one segue yet another area of very appropriate study into an increasingly crowded curriculum? Does the panel see this as a separate track, a part of other courses, a hybrid of both, or any other method of delivery?

2. AUTHOR BIO

Tom Fisher is a Professor in the School of Architecture and Dean of the College of Design at the University of Minnesota. A graduate of Cornell University in architecture and Case Western Reserve University in intellectual history, he was recognized in 2005 as the fifth most published writer about architecture in the United States. He has written 9 books, over 50 book chapters or introductions, and over 400 articles in professional journals and major publications. Named a top-25 design educator four times by Design Intelligence, he has lectured at 36 universities and over 150 professional and public meetings in the U.S.

He has written extensively about architectural design, practice, and ethics. His books include In the Scheme of Things, Alternative Thinking on the Practice of Architecture (Minnesota), Architectural Design and Ethics, Tools for Survival (The Architectural Press), Ethics for Architects, 50 Dilemmas of Professional Practice (Princeton Architectural Press), two monographs on the work of architect David Salmela (Minnesota), a book on the work of Lake Flato (Rockport), and a book on system design entitled Designing to Avoid Disaster, The Nature of Fracture-Critical Design (Routledge). His newest book, Some Possible Futures, Design Thinking our Way to a More Resilient World (Minnesota) will come out in Spring 2016.

His current research involves looking at the implications of the "Third Industrial Revolution" on architecture and cities in the 21st century. He is principle investigator on several related grants in the Metropolitan Design Center at the College of Design at the University of Minnesota.

Prof. Eduardo R. Macagno, Ph.D., is a neuroscientist at UC San Diego, where he was recruited as the Founding Dean of the Division of Biological Sciences in 2001. His laboratory investigates how neurons innervate their correct targets in the developing nervous system. Another current research project, at the interface of Architecture and Neuroscience, employs Virtual Reality environments to study the interaction of normal and neurologically impaired subjects with the built environment. Macagno was President of the Academy of Neuroscience for Architecture in 2010-12. Macagno teaches courses on "Dementia Science and Society," "Diversity, Equity and Inclusion in the Biomedical Sciences" at UCSD and on "Brains and Buildings" with Gil Cooke at the New School for Architecture and Design.

Marvin J. Malecha, FAIA, is the President at NewSchool of Architecture & Design in San Diego, California. He was elected as First President/President Elect (2008-2009) of the American Institute of Architects and in 2009 served as the professional association's National President. President Malecha also received the Topaz Medallion for Excellence in Architectural Education from AIA in 2003 and was recognized as a Distinguished Professor by the Association of Collegiate Schools of Architecture (ACSA) in 2002.

Bob Condia, AIA is the design partner with *Condia+Ornelas Architects*. A professor of architecture at Kansas State, (1989 – present) he teaches architecture as an art form, with serious considerations to: design process; structure; the ancient works of man; and a thick perception of space. His publications range from architects' monographs; articles on the experience of space; papers on creativity in design; and a catalogue of his surrealist illustrations. Since 2012 he has taught graduate seminars combining architectural theory, analytical philosophy and the neuroscience of aesthetic experience. He is IRB certified.. Prof. Condia earned a Master of Science in Architecture and Building Design at Columbia University 1983, and a Bachelor of Architecture at California Polytechnic State University, 1980.

Meredith Banasiak, M.Arch., EDAC, Assoc. AIA cultivates multi-disciplinary research, knowledge sharing, and application to promote human health and wellbeing through the designed environment. Her research and teaching supports the transformational shift in design practices towards an evidence-based culture. In 2012, she launched Humans and Buildings Laboratory (HabLab), an interdisciplinary research group committed to studying interactions between people and environments using performance-based, emotional, and physiological measures. As a faculty member in architecture and environmental design programs, she has developed lecture, studio and seminar courses incorporating neuroscience for architecture concepts and research. As a design researcher, she is responsible for establishing evidence-based design processes and exploring innovative research practices for healthcare design.

Grace C. Lee, LEED AP BD+C, is currently a M.Arch candidate at NewSchool of Architecture + Design with an expected graduation date of June 2017. She will be starting her thesis project in October, which will focus on integrating neuroscience and architecture. Prior to starting the masters program, she worked for Fox Nahem Associates in New York City and obtained an B.S. Interior Design from Virginia Polytechnic Institute and State University.

Using Neuroscience and Experiential Anatomy in Architectural Design: Recent findings regarding organic and rational drawing

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I. ABSTRACT

This research demonstrates that architects and other designers can use experiential understanding of the brain deliberately to influence the characteristics of their drawings and design products. The human brain has three levels: the brainstem and cerebellum control involuntary activities such as respiration and organ function; the limbic (mammalian) system processes emotions and memories; and the neocortex plans and performs higher cognitive functions. Architectural sociologists Galen Cranz and Leonardo Chiesi, building on insights from medical researcher Jader Tolja and founder of Body-Mind Centering Bonnie Bainbridge Cohen, have tested the idea that the brainstem and limbic system can be activated through experiential anatomy to stimulate a distinct type of creativity in drawing and design (Cranz and Chiesi, 2014). Drawings produced after stimulating the neocortex with simple arithmetic, and those produced after stimulating subcortical parts of the brain (the brainstem and limbic system via the kidney) evidenced theoretically predicted differences in drawing qualities. Small, straight, two-dimensional drawings morphed into large, curvilinear, three-dimensional drawings of the same objects. The earlier study with a sample of 200 in seven trials used drawings of handles and lamps, but architects wanted to know if the differences would hold at the building and urban scales. Accordingly, following the same research design, this replication study compares and contrasts sets of drawings of buildings and urban squares produced by 30 subjects in two trials.

The drawings are coded by independent researchers (Rushton and Rosen) for line quality (curved or straight), size (smaller or larger image), and three-dimensionality (shading, perspective), and number of depictions of nature (birds, trees, flowers, sun, water). The same differences are observed at the architectural scale as at the product scale.

"Experiential anatomy," somatics, and neuroscience have direct implications for teaching architectural design, and for promoting creativity in general. Further, this research on the power of accessing organs through somatic experience gives new meaning to the term "organic" architectur. If consciousness can influence design, the design of an object, room, or place may also affect users' consciousness. This is probably assumed by designers, and neurological evidence is a welcome confirmation. Finally, this research suggests that creating with the subcortical brain may facilitate relational or ecological thinking by instigating deepened relationships between practitioners, their bodies, and their surroundings. Using all levels of consciousness in drawing and design offers new potential to forge ecologically sustainable connections between humans, nature, and our future built environments.

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Dr. Galen Cranz, Professor of Architecture at UC Berkeley, is a sociologist, designer, and certified teacher of the Alexander Technique (a system of body-mind postural education). She studies the social-cultural components of environmental design, including how the body meets the environment, a new subject she has called Body Conscious Design. She provided a critique of the practice of chair sitting from a somatic point of view in The Chair: Rethinking Culture, Body and Design. She also studies post-occupancy effects of designs on users, the role of urban parks, and taste as a communication process in design.

Chelsea Rushton holds an MFA in Visual Art and 500-hour level certification as a yoga teacher. She is the designer and instructor of Art of the Soul: Creative Process as Spiritual Practice, a special topics combined lecture, seminar, and studio course offered at the University of Calgary. Her creative research focuses on the intersections of art, ritual, and spirituality, and the potential of art practice to document and facilitate personal and collective growth and evolution. Her meditative practices hold as a primary goal the experience and alignment of the physical and energetic aspects of the self.

Emily Rosen is an MS candidate in Architecture: Body Conscious Design at UC Berkeley. She holds a BA in Art and Design from Bennington College and has worked as an artist in the mediums of video performance and installation. She is a student of the Alexander Technique, and her academic research focuses on physiological and socio-cultural relationships to the built environment, gestural interfaces, and body-awareness practices.

De Humani Corporis Fabrica – Fabricating and Measuring Emotions through Architecture

Maria Da Piedade Ferreira, Ph.D., Andreas Kretzer
Maria da Piedade Ferrira: Architect, M.S. Architecture, Ph.D. Architecture
Andreas Kretzer: Architect, Production Designer

I. ABSTRACT

This paper describes an experiment that took place at the Digitale Werkzeuge at the Fachbereich Architektur of the TU Kaiserlsautern during the Winter Semester of 2013/2014. The subjects of the experiment were students of Architecture who attended the elective course "De Humani Corporis Fabrica – Fabricating Emotions through Architecture" in which the experiment took part. The title of the experiment, "De Humani Corporis Fabrica: Fabricating emotions through Architecture" is a reference to the first anatomy treatise with the same name (from Latin to English, "On the Constitution of the Human Body"), in which Andreas Vesalius presents dissections of human bodies in order to explain its inner workings. The title was suitable for the experiment also because the original Latin word for fabrica can have the multiple meaning of "fabrication, constitution,or construction" and the elective course had the goal to teach students of architecture to design and construct architectural settings with digital tools of design and fabrication. The overall purpose of the experiment was to evaluate the emotion reaction of subjects who would design, fabricate, assemble, and perform in architectural settings, taking in consideration the direct effect that the design elements in such settings would produce specific physical and emotional effects on the subjects, or as the subtitle suggests, "fabricating emotions through architecture. The ultimate goal of the experiment was the evaluation of emotional reaction to changes in the sensory perception when a user is performing the same actions in settings that have the same design but significantly different dimensions. The goal of the course was to increase students' awareness of the direct effect that variation in the values of basic design parameters, such as scale and dimensions, produces on the human body, while conditioning movement. Psychophysiological changes in the body's sensory perception during the performances were evaluated through the combined use of biometric technology, a Presence Questionnaire and a SAM chart. The course was attended by 4 students who participated as subjects in the Experiment. The course was offered during the Winter Semester of 2013/2014 and the experiment took place on the last day of the course, on February 14th. The Experiment had the technical support of the DFKI - Deutsches Forschungszentrum für Künstliche Intelligenz, which provided the machinery necessary to collect the biometric data during the Experiment. The experimental results support the main research Hypothesis H1 - a user's emotional response to design objects as "compelled or not compelled", "positive or negative", "aroused or not aroused" and "dominant or dominated" can be evaluated through objective measurements of emotion. The results colected through the Presence Questionnaire and the SAM charts show that the majority of subjects experienced a high level of "Presence", "Pleasure" and "Arousal". Most subjects describe their emotional response to the performance with the objects as "positive". Most subjects reported to be very involved in the experiment, found the performance sensually very engaging, were very involved by visual aspects and involved by haptic and auditory aspects, while remaining aware of events around and the surrounding space. This suggests that subjects were focused on the most important aspect of the experiment which had to do with the movement of the body while performing with the objects, the kinaesthetic sense. It also suggests that they were involved by the sense of vision and hearing. This confirms a high-level of engagement and suggests that the experience was immersive, although other results show that subjects were somewhat distracted by the suit, mask, and e- health platform. Therefore, results support Hypothesis H2, which suggests that the feeling of "presence" and emotional activation can be intentionally induced through the performance with analogical models, in this case, architectural settings. Results also show that most subjects were involved in experiment and lost track of time during the performance. This suggests that the feeling of "presence" and arousal situations can be intentionally induced in real-space, but further research is necessary to understand which specific design elements are responsable for this. All subjects rated the experiment as a very good learning experience and found that performance art techniques enhanced their creativity and capacity to design. Therefore, results also support hypothesis H3 which suggests that the somatic techniques of "performance art" and "emotional design" are an effective strategy to develop corporeal awareness and stimulate the creativity of students and designers. The amount of participants in the experiment was only four which according to the quantitative research tradition could not be understood and treated as quantitative material. Although a qualitative research approach would be possible to use in such a context and eventually providing interesting results, the same methods used in the experiment can be applied to a larger experimental context. Also, the used approach can be understood as part of the educational content of the course and as training of research methods which incorporate innovative methodologies in the teaching of design and sensitize the students to the emotional impact of design objects in the human body. The results can be seen, for that reason as suggestive, as this experiment was a pilot for future experiments which will involve more subjects and means.The experiment described in this paper shows that PQ, SAM, and biometric technology can be used to objectively discriminate arousal responses. Results confirm that it was useful to include biometric machinery in the experiment, to observe how user emotions are triggered while experiencing design objects, as the participants in the experiment, in this case students of architecture, could see in the computer screen the live feedback of the physical experience of performing in the design settings. The aim in the experiment was to observe peak and limit reactions that would provide for a wide scale of physiological measures. In future experiments, it is planned to integrate the use of EEG and to add to the experimental setting eye-tracking sensing technology to record the position of the user and where s/he is looking at.

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3. AUTHOR BIOS

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Dr. Maria da Piedade Ferreira is an Architect, Master of Sciences in Architecture PhD in the same field. Working as a Lecturer Fachbereich Architektur TU Kaiserslautern since 2012, M.P. Ferreira has been developing research on the topic of Performance Art as a learning tool for Architects. Her work has been dedicated to the artistic exploration of the holistic relationship between Body, Movement and Space. Her work pursuits the understanding of user's empathic connection with Architecture as a source of well being. As a lecturer of Architecture, her work has included experiments with students which introduced notions of neuroscience, the somatictraining of performance art and emotion measurement methodologies.

Andreas Kretzer

Andreas Kretzer is an architect (TU) and production designer (HFF) with an assistant professorship for Digital Tools at the Faculty of Architecture at TU Kaiserslautern since 2011 and a guest professorship for architectural design and film at the Faculty of Architecture at TU Munich in 2016/2017. With a primary focus on architectural representation in both traditional and digital media, he is exploring perception and immersion in architectural environments.

How Educational Environments Impact Learning

John Dale, FAIA, Claire Gallagher, Ph.D., Margaret Tarampi, Ph.D., David Zandvliet, Ph.D.
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Have you tried to convince a client that daylight is beneficial to a classroom experience or that students acquire skills more effectively in a space with more flexible furniture? With huge expenditures at stake and constantly fluctuating spending policies, how do we make the right decisions about designing environments that positively impact learning and student performance? In this session, expert panelists define the challenges, opportunities, and potential beneficial impacts of research in neuroscience and educational design.

I. ABSTRACT

Traditionally, educators have focused primarily on pedagogy and technique while designers have focused on the shaping of space and the two spheres of influence remain relatively disconnected. Recent academic and industrial research and the growing field of neuroscience, focusing on brain response and development through environmental stimulus, are breaking through this traditional barrier. As the influence and impact of learning environments on student well-being and performance is increasingly understood, more meaningful interaction between designers and educators is becoming a necessity. It is increasingly evident that without a synergy between the design of the space and the pedagogy employed within it, the user groups – both teachers and students, teach and learn in spite of, rather than supported by the space they are in.

This panel discussion addresses the challenge of environmental research in sorting through the many contributing factors to student performance –including economic, social and cultural, in order to isolate the specific impacts of the physical environment.

Panelists include leading researchers in education, neuroscience and the design industry who will discuss their current, cutting edge research projects and point to future impacts on educational design as neuroscience uncovers the direct impact of environmental stimulus on the brain.

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Dr. Claire B. Gallagher, Associate AIA, holds professional degrees in architecture and education, has taught both design studio and pre-service teacher education, and is currently a Professor of Education at Georgian Court University. She is the Vice Chair of the American Institute of Architects Committee on Architecture for Education.

Dr. Margaret Tarampi is a neuroscientist and architect who has been in professional practice in both fields. She is currently a Research Associate at the Center for Spatial Studies at the University of California Santa Barbara.

Dr. David Zandvliet is the Director of the Institute for Environmental Learning, a Faculty Teaching Fellow for the Faculty of Environment, and an Associate Professor in the Faculty of Education at Simon Fraser University in Burnaby, British Columbia. He is also the Chair of the Learning Environments Special Interest Group of the American Educational Research Association.

Neuro-architecture & Workplace Design
How space can affect performance and well-being

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I. ABSTRACT

Companies have been suffering great changes over the last decades. Especially due to the changes that technology brought, workers have to do more than just simple and mechanical tasks. Moreover, companies' strategies are not based on graphics and numbers only, but in a more holistic approach. Intangible assets like knowledge, creativity, problem solution and brand are becoming much more important. All such factors made the demand for new workplaces design increase.

On the other hand, neuro-architecture is a field that studies how the built space influences the brain. However, the challenge is to combine corporate contemporary needs with neuro-architecture. To apply neuro-architecture in a workspace is not a simple task. Architects need to consider not only the company's culture, but also what people will be doing in each space designed. A space for working on a routine task should be different from a space for brainstorming that is different from a space for meditating or learning.

The gap that this research intends to fill is that many of the studies related to neuro-business in general or neuro-architecture were never linked to workspace design, although their great potential in this field. Neuro-marketing and neuro-leadership, for instance, can be very helpful in understanding how the workspace can affect the brain. Concepts like SCARF (status, certainty, autonomy, relatedness and fairness) can also have an architectural implication. Therefore, companies will be able to associate neuro-business and neuro-architecture strategies with workspace design and have a whole mix of tools to improve group as well as individual performance.

Some of the questions raised are: What is the relation between workspace and well-being? How can biophilia affect performance? How can workspace influence the amygdala? Is the space able to activate the limbic system and, therefore, affect memory, creativity and emotions? How can workspace stimulate concentration and learning? Can workspace design improve sociability and collaboration? This work does not intend necessarily to answer all these questions, but to investigate, inspire and maybe suggest a few answers.

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3. AUTHOR'S BIO

Master of Arts in Architecture and Design at Middlesex University, London, UK. Graduated in Architecture and Urban Planning at USP (Universidade de São Paulo) in Brazil. Lecturer in neuroarchitecture and neuroplasticity since 2014, with publications about neuro-architecture, smart cities and construction industry.Working as a consultant in the biggest think tank in South America.

Neural-Architecture: Incorporating clinical expertise in brain-based design principles

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I. ABSTRACT

In order to accommodate the wide range of responses from common and expected to extraordinary and unpredictable, careful on-site observations and measures should be taken in real scenarios. Individuals with a neurological, psychological or psychiatric condition (along with comorbidities) can and often do experience the world through a different lens. Brain-based design principles must therefore reflect the complexity of the human condition in health and in illness. In order to advance our understanding of how architectural form may better serve human function, we must consider not only the neuroscientific data from 'average normal' subjects, but also the findings from clinical patients. A large body of clinical research reveals the neural interactions that underlie the human experience of design. Each person's response to the built environment may change over the course of their life, a day, and even a second as their mental state or medical status may be influenced by external stimuli. Neuroplastic changes may also alter the perception or impact of design with exposure to specific environmental features. Further, we must consider how the complexity of the human condition, including co-occurring (comorbid) diseases, disorders and dysfunctions, may alter the response to design, particularly as the global populous ages, and chronic disorders become increasingly prevalent.

I.1. Methods

Neural design principles were derived from clinical experience, literature reviews and discussions with physicians, surgeons, scientists, nurses, specialists, therapists and at several neurology, neurosurgery and rehabilitation facilities in the US, UK, Canada and China. The needs of a patient with a neurological, psychiatric or psychological condition can be difficult to articulate and understand. Changing mental, emotional and physical health status complicate their perspective on their environmental conditions. In order to incorporate this complexity, it is essential that on-site observations, focus groups and meetings bring together clinicians, patients, architects and designers to identify elements that may increase design efficacy, enhance patient outcomes while increasing operational efficiency. The typical on-site walkthrough does not reveal these complex needs. Instead, observation of patients, providers and users must be undertaken to help designers understand how the built environment may be experienced.

I.2. Process

Accessible design begins to address the needs of this unique population, but are often limited to mobility issues (ramps and rails) under ADA laws. To meet the needs of a broad spectrum of neural patients in healthcare settings and in our communities, clinically informed design principles must serve those who appear unaffected to those with severe or life-threatening conditions. The complexity of the built environment must address a wide range of mental, behavioral, cognitive and physical issues including schizophrenia, post-traumatic stress, mood, neurocognitive, neurodevelopmental, neuroinflammatory, or neurodegenerative, or neuromuscular and associated medical conditions.

A review of neural science reveals the complex network systems that must be considered (Kandel et al. 2013). Yet, a pragmatic approach may be applied based upon our current understanding of neural systems, interactions and clinical practice. The physics of form (input stimuli) have been shown to yield measurable changes in sensation, thoughts and actions. These relationships, may move our thinking from a generic or standardized programming approach to a multi-user and multi-functional approach. Design that serves the clinical limits or extremes of neural patients, their caregivers and their providers is more likely to meet most people's needs. It may even go beyond the narrow minima required of people performing generic tasks, and provide a space for delight.

I.3. Application

Our approach began by reviewing the wide range of neurological, neurosurgical, psychiatric and psychological conditions that may be encountered at a clinical neuroscience facility. Guidelines focused on how design might best support many comorbid medical, physiological, cognitive, sensory, perceptual, behavioral, and mobility conditions. Movement ability can be extremely wide-ranging from able-bodied, to full dependence in a power wheelchair, and some have pain, muscle spasms or fatigue with movement. Visual and acoustic privacy used a sophisticated approach to balance clarity, intelligibility with confidentiality. Consideration was given to limited perception of surfaces, color and contrast; visual distractions, changes in thresholds and surfaces can increase fall risk in this population. Existing guidelines for lighting, based upon the average function of young adults are inadequate. Instead, lighting strategies should offer multiple adjustable zones for different visual abilities, task, and circadian needs. Altered perception or cognition may yield difficulty understanding signage or wayfinding leading to frustration and undue stress. The space needed for providers to safely examine patients with limited mobility was also considered.

I.4. Conclusion

Neural design principles may be applied within and beyond healthcare settings to meet the needs of the world's aging populous and the increasing prevalence of neurological disorders. Together, these changing demographics demand that we must design for more than the fit and healthy alone. In collaboration with global clinical partners, we therefore are launching a clinical network to inform neural design principles relevant to industrial, interior, architectural and urban settings.

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3. AUTHOR BIO

Eve Edelstein's neurophysiological research and clinical practice applied novel intracellular, in-vivo, and clinical electrophysiologic techniques to diagnostic assessment of auditory and vestibular disorders of central and peripheral origin in adults and children (National Hospital for Neurology & Neurosurgery, Harvard/MIT Hearing Science Lab, Boston; NASA medical command; etc.). As Fellow of the American Academy of Architecture, is Director of the Human Experience, and the BioAcoustic Neuro Group of the Gadget Lab at Perkins + Will, and is faculty at the NewSchool of Architecture & Design in San Diego, Edelstein leads the Design Health CoLab, participates with the Center for Healthy Environments and the AIA Design + Health Research Consortium. With ANFA and NSAD, Eve developed the Neuroscience for Architecture curriculum, and with the University of California, San Diego created novel virtual visual and sonic simulations that synchronously measure the consequence of design on EEG and human outcomes. With degrees in neuroscience (Ph.D. Institute for Neurology, University College London), Anthropology (UC Berkeley) and Architecture (NewSchool of Architecture & Design), Eve now translates clinical and neuroscientific research into brain-based principles for design in all building types and scales, from rooms to regions, and including workplace, healthcare, educational, science and technology facilities.

Solitary Confinement: Mental Health, Neuroscience, and the Physical Environment

Facilitators: Melissa Farling, Fred H. Gage, Ph.D.
Melissa Farling, FAIA, Vice President, Managing Principal, HDR Architecture
Fred H. Gage, Ph.D., Adler Professor in the Laboratory of Genetics, The Salk Institute

Invited Panelists: Richard Wener, Ph.D.[1], Terry Kupers, M.D., M.S.P.[2], John A. MacAllister[3], Jay Farbstein, Ph.D., FAIA[4], Elizabeth Falcon, Psy.D.[5]
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1. ABSTRACT

It is estimated more than 2 million arrests in the US involve people with serious mental illnesses. Our prisons and jails have become our default mental institutions. No official count exists, however the Vera Institute for Justice estimates between 80,000-100,000 inmates are housed in solitary confinment (also known as isolation or restricted housing) at any given time in the United States. There is abundant evidence prolonged solitary confinement can be mentally and psychologically traumatic. This session focuses on the issues and theories associated with the physical design of solitary confinement and its psychological and behavioral impacts with the goal of outlining neurobiological research model for isolation.

This session will begin with presentations by architects, psychiatrists, and psychologists framing the content to be discussed in a panel moderated by a neuroscientist and an architect.

2. AUTHOR BIO

Melissa Farling, FAIA – Vice President | Managing Principal HDR Architecture; Advisory Council ANFA
Melissa is an architect and managing principal of HDR in Phoenix. She has a long track record of leadership in the profession and has focused much of her career on research into the impacts of architecture on people, believing this knowledge is essential to enable the creation of sustainable and appropriate environments. She was co-chair for the National AIA's Academy of Justice for Architecture (AAJ) Research Committee for ten years, now serving as a member of the AAJ Leadership Group and liaison to the Research Committee. Over the past decade, she has co-led two neuroscience and architecture workshops (correctional facility and courthouse design). Melissa was one of the principal investigators on a National Institute of Corrections funded study to examine impacts of views of nature on stress in a jail intake area. This study received the inaugural Certificate of Research Excellence from the Environmental Design Research Association – with the only special commendation. Her experience has focused on justice facilities and public projects. She has contributed to many publications and gives frequent presentations on evidence-based design applications,

Melissa is a registered architect in Arizona and holds a Bachelor's degree in Architecture from the University of North Carolina at Charlotte and Bachelor of Architecture and Master of Architecture from the University of Arizona

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

Richard Wener, PhD - Professor of Environmental Psychology; Director, Sustainable Urban Environments / Department of Technology, Culture & Society, Tandon School of Engineering of New York University
Richard Wener is Professor of Environmental Psychology and head of the Sustainable Urban Environments program in the Department of Technology, Culture and Society at the Tandon School of Engineering of New York University. He received his Ph.D. in psychology from the University of Illinois-Chicago, and is a fellow and past president of Division 34 of the American Psychological Association. The Environmental Design Research Association gave him its award for distinguished service to the field of environment and behavior in 1995 and its Career Award in 2013. He has published extensively on Post Occupancy Evaluation of the built environment including correctional settings and sustainable design. Professor Wener's research on the behavioral impacts of correctional settings began in 1975 with evaluations of the new federal Metropolitan Correctional Centers. He has since conducted assessments and other studies in dozens of jails and prisons, culminating his 2012 book "The Environmental Psychology of Prisons and Jails: Creating Humane Environments in Secure Settings," from Cambridge University Press. He presented the Distinguished Scholar lecture at ICAP 15 – the conference of the International Correction and Prisons Association, in Colorado Springs, October, 2013.

Terry A. Kupers, MD, MSP – Institute Professor, The Wright Institute
Terry A. Kupers, M.D., M.S.P. is Institute Professor at The Wright Institute and Distinguished Life Fellow of the American Psychiatric Association. He provides expert testimony in class action litigation regarding the psychological effects of prison conditions including isolated confinement in supermaximum security units, the quality of correctional mental health care, and the effects of sexual abuse in correctional settings. He is author of Prison Madness: The Mental Health Crisis Behind Bars and What We Must Do About It (1999) and co-editor of Prison Masculinities (2002). He is a Contributing Editor of Correctional Mental Health Report. He received the 2005 Exemplary Psychiatrist Award from the National Alliance on Mental Illness (NAMI).

John A. MacAllister – Director of Justice Consulting / Principal, Behavioral Health, HDR Architecture
John is a specialist with over 20 years of experience in the development of custodial facilities with a focus on treatment-oriented environments. He has planned, programmed and designed a significant number of the most advanced detention, treatment and secure mental health facilities in the United States and internationally.

John's people-centric approach guides his work, "I believe that human behavior is shaped by the environments in which we live and work and that the built environment is vitally important in the operations and success of custodial and secured treatment facilities." He is dedicated to enhancing environments where people are deprived of their rights to freedom in the public milieu.

Deeply committed to the industry, John frequently presents at industry conferences and has been cited in numerous professional journals and justice and healthcare publications. His extensive list of award-winning work encompasses over forty (40) adult and juvenile custodial projects and secure mental health facilities throughout the United States and around the world.

Fred H. Gage, Ph.D.
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Fred H. Gage, a Professor in the Laboratory of Genetics, joined The Salk Institute in 1995. He received his Ph.D. in 1976 from The Johns Hopkins University. Dr. Gage's work concentrates on the adult central nervous system and unexpected plasticity and adaptability to environmental stimulation that remains throughout the life of all mammals. He has won numerous prizes and awards for his work, including the IPSEN Prize for Neuroplasticity, the Charles A. Dana Award, Metropolitan Life Research Award and the Keio Medical Science Prize. He serves on many health-related boards and was President of the Society for Neuroscience and of the International Society for Stem Cell Research. He is a Fellow of the American Association for the Advancement of Science, a Member of the National Academy of Sciences and the Institute of Medicine, a Member of the American Academy of Arts and Sciences, a foreign Member of EMBO and a Fellow of the American Philosophical Society.

Elizabeth Falcon, PsyD - National Director of Behavioral Health Services for Correctional Medical Group Companies, Inc.
Elizabeth Falcon, Psy.D., is a Forensic and Correctional Psychologist specializing in correctional mental health and behavioral healthcare in jails. She has over 15 years of correctional mental health and behavioral healthcare experience in both the clinical and administrative sectors, and has developed, implemented and managed jail mental health programs in over 24 states totaling over 200 facilities. With her numerous years of correctional mental health experience in the industry, Dr. Falcon's career has been characterized as one of commitment and dedication to helping the nation's incarcerated population. Dr. Falcon specializes in an array of correctional mental health areas including: Suicidology, Suicide Prevention Policy and Program Development, Evidence Based Programming for Severely Mentally-Ill inmates, Segregated Inmates, Competency Restoration, Sexually Violent Predators, Substance Abuse, Inpatient/Outpatient, and Community Reintegration Programs.

Can the design of space alter stress responses?

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I. EXTENDED ABSTRACT

I.1. *Background*

Ever since Roger Ulrich showed that the view from patient bedrooms to nature in hospital buildings could shorten hospitalization and reduce the use of painkillers (Ulrich 1984), the tantalizing idea that human physiology can be influenced through the perception of the environment has existed. However, as Ulrich's study is about the view and not architectural space, we set out to investigate whether the design of a space itself could have a physiological impact as well. We theorized that one way this might come about was through the stress system, as stress basically is a recruitment of resources by the organism for a fight-or-flight behavior, and we hypothesized that an open space potentially offering a possibility for escape would result in a less pronounced stress response than would a closed space.

I.2. *Methodology / Procedure*

We measured the immune regulatory stress hormone cortisol, released by the Hypothalamic-pituitary-adrenal axis (HPA-axis). A virtual reality version of the Trier Social Stress Test (Kirschbaum et al., 1993; Jönsson et al. 2010), in which a test person has to perform certain tasks in front of a committee, was used as a stressor. Because it was a virtual reality version of the test, it allowed for a systematical variation of the test rooms, ensuring that openness versus enclosure was the only variable.
The level of cortisol was significantly lower in the open space than in the enclosed one (Fich et al. 2014). Interestingly, the most pronounced effect occurred after the stress test, and the time needed for the test persons to return to baseline was approximately twice as long for the enclosed room compared to the open one.

I.3. *Outcome / Discussion*

The immediate relevance of these results lies within the working environment where stress is a growing problem worldwide, and within hospital design because of the close relationship between stress and the immune system (Segerstrom and Miller, 2004). As the part of the brain – the hippocampus - that is first attacked by Alzheimer's dementia is a crucial part of the feed-back system of the HPA-axis, it is also possible that these results could be relevant for the design of accommodation for Alzheimer patients. Cortisol itself has a profound influence on a number of cognitive functions such as learning and memory. At the moment, our group is engaged in a four year research program that aims at investigating whether space through the stress mechanisms might have the same effect on physical stress in the form of pain as it had on psychosocial stress, try out other spatial configurations, develop cheaper and more flexible methods and investigate how or if the physiological stress response correlates with the subjective aesthetic experience.

In a broader perspective, the non-conscious mechanism controlling the release of stress hormones seems to be the quintessence of what Antonio Damasio has termed "emotions", defined as "complex, largely automated programs of actions concocted by evolution", in which the actions are as much directed at the body including the brain, as they are at behavior (Damasio 2010, p.109). Harry Francis Mallgrave has drawn attention to the potential of this theory in relation to architecture (Mallgrave 2013, pp. 90-117) and has underlined the need for research addressing this: "The importance of our emotional well-being cannot be overestimated by architects, if only for the reason that designers are principally engaged in constructing the habitats in which we live. Little research has thus been done on how the variables of the built environment affect our emotional life, but it might very well be demonstrated in the near future" (Mallgrave 2010, pp. 190-191).

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3. AUTHOR BIOS

Lars Brorson Fich (presenter) graduated as an architect in 1984, and has worked as a practicing architect until 2008, from 1998 – 2008 as a partner. During this period, he designed well over 100 built projects, ranging from a museum to residential, commercial and hospital projects. In 2008, he changed his carrier and is now teaching and doing research at Aalborg University, Denmark. His Ph.D. focused on whether the perception of architecture potentially can influence the immune system through the stress mechanisms. He is now leading a four year research project on how the design of space can influence the effects of stress on e.g. cognition.

Anne Helene Garde is a professor MSO. Her main research interest is within the psychosocial working environment, working hours and psychophysiology.

Åse Hansen is a professor in psychosocial medicine. Her research interest is how the body reacts to stress and she has specialized in the use of physiological measurement in stress research.

Peter Jönsson is an associate professor in psychology. He has specialized in stress research using virtual models and has led the development of the virtual version of the Trier Social Stress Test.

Laura Petrini is associate professor in neuropsychology and head of the Center of Cognitive neuroscience at Aalborg University, Denmark. Her main research interest is pain studies.

Mattias Wallergaard is associate professor in Electro-technical engineering at Lund University, Sweden. His research interests are interaction design and virtual reality.

Mind, Brain, and the Art of Architecture

Facilitators: Tom Fisher, Thomas Albright, Ph.D.
Tom Fisher: Professor, School of Architecture, Dean, College of Design, University of Minnesota, Minneapolis, Minnesota, USA
Thomas Albright, Ph.D.: Director, Vision Center Laboratory, Salk Institute, La Jolla, California, USA

Invited Panelists: Steven Holl, Eric Kandel, Ph.D.
Steven Holl: Principal, Steven Holl Architects, New York, New York, USA
Eric Kandel, Ph.D.: Director, Kavli Institute for Brain Science, Columbia University, New York, New York, USA

I. AUTHOR BIOS

Tom Fisher

Thomas Fisher is a Professor in the School of Architecture and Dean of the College of Design at the University of Minnesota. A graduate of Cornell University in architecture and Case Western Reserve University in intellectual history, he was recognized in 2005 as the fifth most published writer about architecture in the United States. He has written 9 books, over 50 book chapters or introductions, and over 400 articles in professional journals and major publications. Named a top-25 design educator four times by Design Intelligence, he has lectured at 36 universities and over 150 professional and public meetings in the U.S.

He has written extensively about architectural design, practice, and ethics. His books include In the Scheme of Things, Alternative Thinking on the Practice of Architecture (Minnesota), Architectural Design and Ethics, Tools for Survival (The Architectural Press), Ethics for Architects, 50 Dilemmas of Professional Practice (Princeton Architectural Press), two monographs on the work of architect David Salmela (Minnesota), a book on the work of Lake Flato (Rockport), and a book on system design entitled Designing to Avoid Disaster, The Nature of Fracture-Critical Design (Routledge). His newest book, Some Possible Futures, Design Thinking our Way to a More Resilient World (Minnesota) will come out in Spring 2016.
His current research involves looking at the implications of the "Third Industrial Revolution" on architecture and cities in the 21st century. He is principle investigator on several related grants in the Metropolitan Design Center at the College of Design at the University of Minnesota.

Thomas D. Albright, Ph.D.

Dr. Albright is a leader in the study of the neural bases of visual perception, visual memory and visually-guided behavior. Trained in experimental psychology and neuroscience, Albright has focused on neuronal structures and events that are responsible for visual object recognition. Albright has served on the faculty of the Salk Institute since 1987. He is currently director of the Salk's Center for the Neurobiology of Vision and was honored to receive the generous Conrad T. Prebys Chair in Vision Research. In addition to his work at the Salk, Albright also serves as an adjunct Professor of Psychology and Neurosciences at UCSD, a fellow of the American Academy of Arts and Sciences, a fellow of the American Association for the Advancement of Science, and a member of the National Academy of Sciences. He is a past President of ANFA.

Steven Holl

Steven Holl was born in 1947 in Bremerton, Washington. He graduated from the University of Washington and pursued architecture studies in Rome in 1970. In 1976, he joined the Architectural Association in London and established STEVEN HOLL ARCHITECTS in New York City. As founder and principal of Steven Holl Architects, Steven Holl is the designer of all projects ongoing in the office. Considered one of America's most important architects, he is recognized for his ability to blend space and light with great contextual sensitivity and to utilize the unique qualities of each project to create a concept-driven design.

Steven Holl has been recognized with architecture's most prestigious awards and prizes. He has received the 2014 Praemium Imperiale International Arts Award for Architecture, the 2012 AIA Gold Medal, the RIBA 2010 Jencks Award, and the first ever Arts Award of the BBVA Foundation Frontiers of Knowledge Awards (2009). Mr. Holl is a tenured Professor at Columbia University's Graduate School of Architecture and Planning. He has also taught at the University of Washington, the Pratt Institute, and the University of Pennsylvania. Steven has lectured and exhibited widely and has published numerous texts.

Eric Kandel, Ph.D.

By probing the synaptic connections between nerve cells in the humble sea slug, Eric Kandel has uncovered some of the basic molecular mechanisms underlying learning and memory in animals ranging from snails to flies to mice and even in humans. His groundbreaking studies have demonstrated the fundamental ways that nerve cells alter their response to chemical signals to produce coordinated changes in behavior. This work is central to understanding not only normal memory but also dementia and other mental illnesses that affect memory.

Kandel's research has shown that learning produces changes in behavior by modifying the strength of connections between nerve cells, rather than by altering the brain's basic circuitry. He went on to determine the biochemical changes that accompany memory formation, showing that short-term memory involves a functional modulation of the synapses while long-term memory requires the activation of genes and the synthesis of proteins to grow new synaptic connections. For this work, the Austrian-born Kandel was awarded the 2000 Nobel Prize in Physiology or Medicine.

As a college student at Harvard, Kandel majored in history and literature, but he was drawn to psychoanalysis after befriending a native Austrian student whose parents were prominent psychoanalysts in Sigmund Freud's circle. Kandel went to medical school at New York University with the goal of studying psychiatry and becoming a psychoanalyst himself. But thinking that he should know more about how the brain works, he took a neurophysiology course that shifted his interest toward research into the biology of memory.

More recently, Kandel has expanded his studies of simple learning and memory in Aplysia to include more complex forms of memory storage in genetically modified mice. These studies have focused on explicit memory (the conscious recall of information about places and objects), revealing the importance of a balance of activation and inhibition in memory storage so that animals as well as humans do not store information in their memories that is not important to recall.

Empathic response in office space. The notion of embodied simulation in corporate interiors

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I. ABSTRACT

The subject of the presentation is the relationship between office space and its users. The empathic response to architectural settings will be addressed within the frame of the neuroscientific notion of embodied simulation and its implications for office design.

The presentation is theoretical and incorporates research from architecture and cognitive neuroscience. The field of research is limited to office environments for two basic reasons: first, the number of physical variables is limited, especially with regard to the interior scenery; second, its performative nature entails description and measurement.

The presentation frames the notion of embodied simulation within office interiors, and concludes that interiors and their users inseparably tied, as embodied simulation defines users' basic relationship with space. Neuroscientific evidence is introduced, according to which the experience of architecture is based on a complex relationship between the body, its sensorimotor system, and architectural space.

The experience of office interiors is addressed discussing properties of the visual vs. the sesnorimotor mechanisms at play during embodied simulation. It is concluded that the space around the body within our workplace is defined by the motor potentialities and confinements of our body — meaning also that perception requires action simulation — and that it is perceptually measured not only visually but through a more complex model which involves the potential actions of the worker occurring within it. These simulated potential actions thus define a motor space, since it is mapped in terms of action potentialities.

Such a perspective in cognitive neuroscience describes a new model — opposite to the computational view positing perception, cognition and action as separate domains — according to which the same motor circuits that control the motor behavior of individuals sitting at their desk also map the space around them, and the objects at hand in that very same space with their shape, size, orientation and distance from the perceiver, thus defining and shaping in motor terms their representational content.

Further implications within the users' experience of office space are discussed.

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Alessandro Gattara, MArch, PhD, has practiced in New York and in Italy. He pursued his doctoral degree in architecture at the University of Parma with Vittorio Gallese, with whom he contributed to the book Mind in Architecture. He is the italian translator of Harry Mallgrave's Architecture and Embodiment.

Vittorio Gallese, MD, PhD, is a Professor of Physiology at the Department of Neuroscience at the University of Parma, Italy and Professor in Experimental Aesthetics at the University of London, UK. His research interests focus on the cognitive role of the sensorimotor system and on an embodied account of social cognition. Among his most important contributions to the field is his identification, together with his colleagues at Parma, of mirror neurons and the elaboration of a theoretical model of social cognition — embodied simulation theory.

Geometry of Visual Experience in Large Spaces
2013-2014 Hay Grant Awardee

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1. ABSTRACT

The space that you experience around yourself always has some structure, even when you are surrounded by darkness or dense fog. The otherwise "empty" space has its up and down, left and right, back and front. And when parts of the environment are visible, the structure of experience becomes more complex, articulated by what you can or cannot see from different locations. Visibility varies across locations because of the occlusion and because human vision is highly selective: sensitive to some optical patterns and blind to others. One way to describe the complex structure of spatial experience is to divide space to solid regions where different experiences are possible. This approach would allow the designer to draw maps of potential experiences for any built environment. The maps would help to predict where certain parts of the environment are perceived concurrently, and also to anticipate sequences of experiences by individuals taking different paths through the environment. I describe first steps towards constructing such a predictive model.

2. EXTENDED ABSTRACT

In the 1970s, the influential theorist of art and film Rudolf Arnheim used some core ideas of Gestalt psychology to investigate what he called "the dynamics of architectural form"[1]. He pointed out that "in perceptual experience, the spaces surrounding buildings ... cannot be considered empty. Instead these spaces are pervaded by visual forces generated by the architectural structures and determined ... by the size and the shape of their generators" (p. 30). Arnheim used a drawing by the architect Paolo Portoghesi (Figure 1) to illustrate the "perceptual fields" created by objects. The concentric circles in the drawing represent "a field of visual forces" that "expands from the center and propagates its wave front as far into the surrounding environment as its strength permits" (emphasis by SG). A metaphor inspired by physics, this view anticipated that visual experiences could be represented as a map or a continuous field.

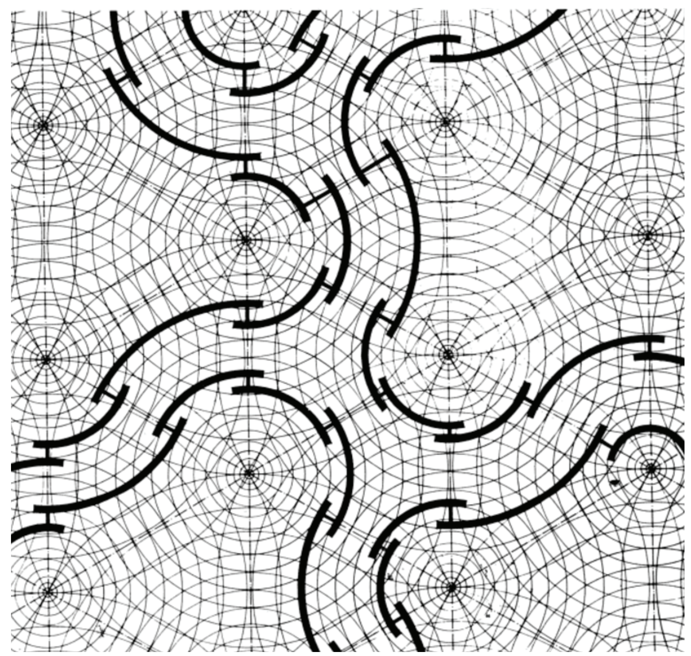

Figure 1: The plan view of a hypothetical "perceptual field" generated by an arrangement of curved walls. The drawing is by Paolo Portoghesi, reproduced from Arnheim [1].

Recipients of the inaugural Harold Hay Research Grant from the Academy of Neuroscience for Architecture, Gepshtein, McDowell & Lynn [2] launched a program of research germane to these ideas. But instead of the metaphorical "strength" of "visual forces," a readily measurable quantity was employed: a metric of pattern visibility adopted from visual psychophysics and systems neuroscience. This metric takes into account the basic fact that the amount of perceptible detail in an optical pattern depends on the distance from the pattern, called the "viewing distance."

Visibility of optical patterns had been studied previously in tightly controlled laboratory conditions. A number of models of pattern visibility were advanced and tested, of which the model of Donald H. Kelly [3, 4] is the most comprehensive. In the laboratory studies, human observers typically report their perception of patterns presented on flat screens at fixed viewing distances in small dark rooms. Gepshtein et al. [2] called this format the "cinematic mode" of perception. For this project, the model of Kelly was generalized so the researchers could derive maps of experience in large built environments, across a wide range of viewing distances. Gepshtein et al. called the latter format the "immersive mode" of perception. The goal was to establish a proof of concept for the generalized model, by testing it in the immersive mode at the UCLA Architectural Robotic Laboratory [5].

Using two industrial robots that carried a projector and a large screen (Figure 2), visibility of periodic optical patterns was measured on the scale of architectural design. Large images propelled through space were used to map the solid regions in which specific visual features could or could not be seen.

Figure 2: The apparatus used by Gepshtein, McDowell & Lynn. Large industrial robots, carrying a projector and a screen, were deployed to map solid regions of visibility for static and dynamic visual patterns on the scale of architectural design [2, 5].

For the proof of concept, the model was first validated in several paradoxical cases. In one case, visibility of patterns predictably diminished as they approached the observer. In another case, visibility dropped abruptly because of a slight change of the viewing distance, again as predicted by the model. The latter effect was enhanced when the pattern was moving, which is important when the environment contains moving parts or digital media, or when static pattern are seen in the periphery from a moving vehicle. In sum, the generalized model successfully predicted dynamics of perception in the immersive mode.

Having such a model embedded in the software for computer-aided design, the architect would be able to derive the aforementioned maps of potential experience for specific built environments. The maps would describe the most likely possibilities (or norms) of experience, rather than predict the actual experience, similar to how "competence" is generally different from "performance." To predict the actual experience, the model should also include a metric of pattern salience, and thus account for the likely shifts of attention by the observer moving through the environment.

Further details of this study, and a list of colloquia and publications inspired by this work, are being gathered in [5]. This project triggered a series of events that led to the establishment of the Center for Spatial Perception and Concrete Experience (SPaCE) at the University of Southern California [6].

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[6] http://wbispace.usc.edu/

3. AUTHOR BIOS

Sergei Gepshtein, Ph.D. is a scientist at the Salk Institute for Biological Studies, trained in neurobiology, psychology, and vision science. Before joining the Salk Institute, where he directs Collaboratory for Adaptive Sensory Technologies, Sergei investigated stereoscopic vision and interaction of vision and haptic sense at the University of California, Berkeley, and then studied computational principles of perceptual organization and pattern visibility 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 humans imagine future and use vision to plan and execute extended, multistep actions. Sergei increasingly collaborates with designers and filmmakers, helping to develop new methods of perceptual continuity in immersive environments: physical, virtual, and mixed.

The perception of symmetry in architecture: an eye movement study

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1. Extended Abstract

1.1. Background

Based on Salingaros theory of architecture, symmetry is a simple yet powerful tool for creating a visual order and a stable balance, and as a result, it reduces the time needed for visual perception of a space (Salingaros, 2006). In many psychological experiments, it has been proved that symmetry is detected more quickly in patterns or visual compositions concluding it, in comparison to ones that do not contain any kind of symmetry (Locher and Nodine, 1989). There are strong evidences that symmetry affects eye movements. Experiments have shown that people discern symmetry or asymmetry " in a single brief fixation". It is believed that it can be detected quickly within about 0.05 second over all regions of the retina (Eberhard, 2008; Koostra et al., 2008; Locher and Nodine, 1989). About the axis of the symmetry, there is a general agreement that "Eye fixations are usually concentrated along the axis of symmetry or the symmetrical center of the patterns" (Kootstra et al., 2008).

That symmetry has a high perceptual value was first discovered by ancient artists. It could be seen in symmetric patterns found many times in ancient architectures and arts even in objects like Persian rugs (Tyler, 2000; Locher and Nodine, 1989). These arts suggest that symmetry and repetition were among the earliest properties of an art which gives them high value. It could have different reasons. First, it could be due to the existence and repetition of symmetry in nature around us. Second, it is possible that because of the circular symmetric structure of human visual system, when viewing mirror symmetric patterns such as the ones in Persian rugs, the resonance occurs and makes them appealing (Tyler, 2003). In ancient houses of Iran, we could see these recurrences of symmetrical patterns. Those houses are still magnificent in the eyes of people, while nowadays we could see that people are not satisfied with their homes. So in this study, we focus on symmetry and the way it is understood.

1.2. Methodology / Procedure

To find out the visual patterns of attention when viewing symmetrical interior of houses, we used eye tracking method. Five photos of ancient houses of Kashan city which include symmetry, have been selected. Each photo was being showed for 10 seconds on video projector to ten university students who were selected by cluster sampling method (5 left handed and 5 right-handed ones) in IUST. The Pupil Eye-Tracker- Dev with 0.6 degree accuracy is used in this experiment.

1.3. Outcome / Discussion

Based on the results, two patterns of eye movements are recognized in visual confrontation with symmetry in buildings. The participants who were right-handed ones, were focusing on the left half of the photos with one or three fixation points on the axis of the symmetry. Also it should bear in mind that these photos have local symmetries too. So we could see that in right half of the photos which has local symmetry, the fixations are more concentrated on the axis of the local symmetry. The experiment shows that left-handed participants were looking at the axis of symmetry and the points around it on its both sides. In other words, the concentration of fixation points is located in the middle of the image around the main axis of the symmetry (Figure 1). A cartoon comparison of these two patterns is shown in figure 2. In second phase of the experiment, we repeated the process by 5 asymmetrical photos from the same houses. The number of fixations and the length of saccades were slightly higher than symmetrical photos.

Figure 1: One of the photos viewed by left handed (a) and right-handed (b) students; dots represent fixation locations of the eye and the lines represent saccades

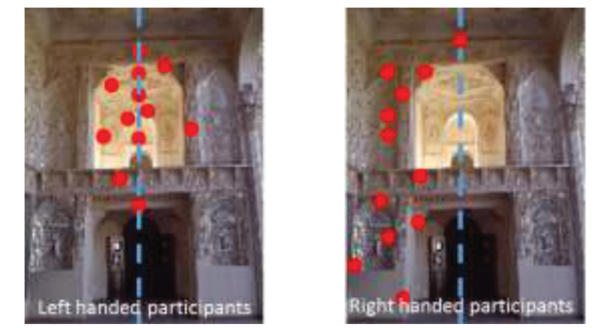

Figure 2: A cartoon comparison of two achieving patterns; the blue line shows the axis of the symmetry, and the red circles are a graphical presentation of eye fixations

1.3. Conclusion

Human beings perception is highly sensitive to symmetry. Symmetry is detected and discerned rapidly in symmetrical scenes. Over all, the patterns for symmetrical scenes demonstrate the perceptual value of the axis of symmetry. For right-handed students, it acts as the separator of two halves of the scene and carries their attention towards the left half of it while for left handed ones it is like an anchoring line which eye movements are in a back and forth movements between the axis and the other parts.

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3. Author Bio

Sharareh Ghanbari Azarneir, is a research assistant in Iran University of Science and Technology where she has obtained her master degree in architecture. Her M.Sc. thesis mainly involves the Interior Architecture of houses and its effects on human brain, entitled "Solutions for improving the interior architecture of residential buildings with a neuroscience approach". Currently, she is working in a Green Housing Lab in IUST as a research assistant. The focus of their team is on architectural perception and cognitive neuroscience in architecture.

Abbas Agha Yazdanfar and **Seyyed Bagher Hosseini** are associate professors of architecture in IUST and the directors of Green Housing Lab. Prof. Yazdanfar has achieved his PhD from IUST and his focus is on the relationship of neuroscience and architecture. Prof. Hosseini is the head of architecture group. He has achieved his PhD from The University of Stuttgart. His main research area is residential architecture.

Mohammad Reza Daliri, is an associate professor of Biomedical Engineering and the director of the graduate school of Electrical Engineering in IUST. He has received his PhD in cognitive neuroscience from SISSA/ISAS, Trieste, Italy. . His research interests are Computational and Cognitive Neuroscience, Computer Vision, Pattern Recognition and Medical Image Processing

Interactive Architecture and BCI: Expanding the Relationship Between Space and User

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I. ABSTRACT

The intersection of interactive architecture and neuroscience expands the discipline of architecture by acknowledging a departure from the traditional notions of space and user. In this emerging context, the user is an active participant. As our world becomes increasingly connected and interactive, communication with our spaces and objects becomes progressively mediated through intelligent devices and interfaces. When considering this dynamic human factor, technology increasingly blurs the limits of the body's territory. The emerging field of sensorial spatial design explores how we can alternatively experience and potentially communicate with our environment. This paper explores the roles of Brain Computing Interfaces (BCI) and interactive architecture through an interdisciplinary research collaboration between the fields of Architecture, Neuroscience, and Dance as well as through ongoing experiments in the authors' interactive architecture seminar.

Brain on Dance is an interdisciplinary collaboration between the University of Houston College of Architecture and the Laboratory for Noninvasive Brain-Machine Interface Systems led by Dr. Jose Contreras-Vidal. This collaboration aimed to create a real-time emotionally responsive environment controlled by a performer's brain activity. Our research team developed a series of algorithms and graphic representations that paired the brain's emotive state with physical movement based on Laban's action efforts. These algorithms and graphic representations were translated to commands that controlled the hue, saturation, and intensity of the stage lighting providing a real-time interactive environment based on the dancer's emotive and physical states. The software developed for this research forms a closed –loop system that allows the audience, performer, and environment to all become participants in the performance. (Fig. 1)

In our interactive architecture seminar, students investigate not only the physical occupation of space but also the physiological occupation of space. (Fig. 2) These conceptually complex, often abstract and intangible, dynamic human relationships are introduced to students through very concrete methods of making at 1:1. (Fig. 3) Our students imagine not only the possibilities of interaction and response, but also design the physical mechanics and the procedural logic of the systems that quantify the behavioral data.

By engaging not only the predominant visual sense, but a user's neural activity, behavior, and experience, these explorations transform architecture into a real-time medium. Exploiting a participant's senses and behavior creates a multilayered experience that evokes time, space, memory and feeling. These projects rely on the performance of the participant and in doing so create new social relationships.

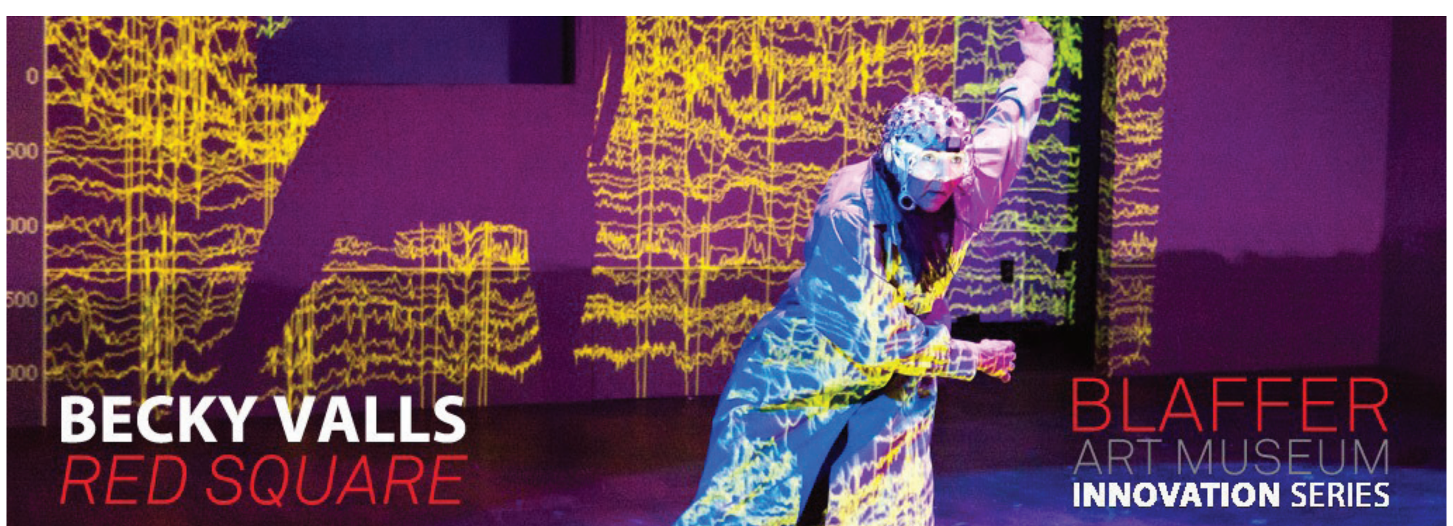

Figure 1 - Brain on Dance – Photograph by Lynn Lane Photography

Figure 2 - Interactive Prototypes - Student Work

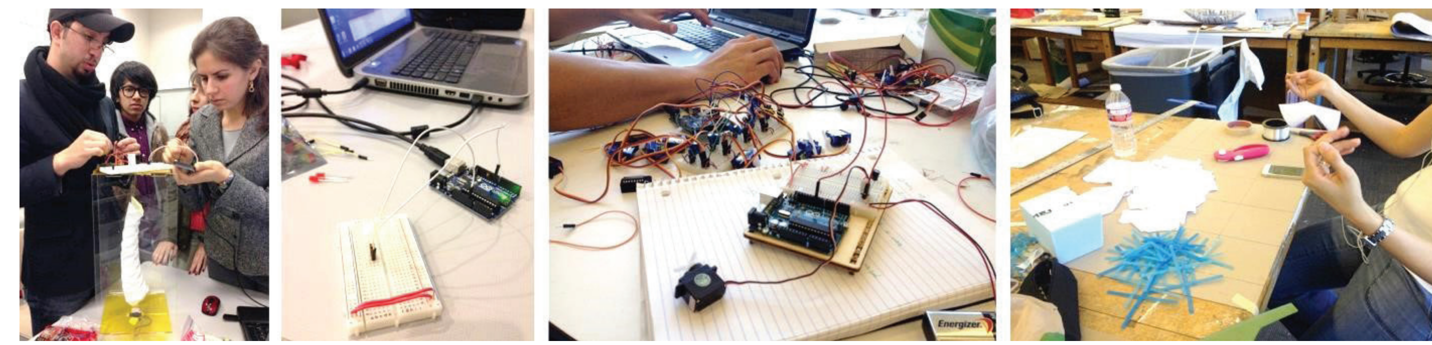

Figure 3 - Interactive Prototypes - Student Work

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3. AUTHOR BIOS

Michael Gonzales is an Adjunct Assistant Professor at the University of Houston, College of Architecture and Design. His research and work focuses on interactive media, computation, and digital fabrication.

Meg Jackson is an Adjunct Assistant Professor and Foundation Curriculum Coordinator at the University of Houston, College of Architecture and Design. Her research and work focuses on beginning design, design education, and materials research.

Behavioral Response of Autistic Children to Design Interventions

2015-16 Hay Grant Fund Awardee

Arathy Gopal
Architect / Planner, Kerala, India

Priyanjali Prabhakaran, Ph.D.[1], Jayaprakash R., Ph.D.[2], Syamlal S., Ph.D.[3]
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I. EXTENDED ABSTRACT

Abstract of work progress during the 6 months (January – June 2016) of research

In the first month of January 2016, detailed literature review of relevant research papers and books was done. The literature review was done concentrating on Autism, theories explaining Autism – cognitive and neural, visual perceptual differences in Autism and sensory subtypes. The research papers related to architecture for Autism were also reviewed. The second month of February 2016, a questionnaire was prepared for interviewing specialists and two interviews were conducted and reported. The literature review was continued to include the visual properties of built environment and also identified case studies on designing for Autism. In the third month of March 2016, formalities for getting institutional and ethical clearance in India were done. Also the assessment tools for primary study were finalized as CARS 2 for assessment of severity of Autism, Sensory Profile 2 for understanding the sensory difference and PSI – SF for quantifying parental stress as a measure of behavioral response and cases of validation in the Indian context were gathered. In the fourth month of April 2016, the design parameters for healing spaces in sensory design approach were consolidated from the extensive literature review done. Formulation of design parameters was done and which it was found could be finalized only after case studies/ observation studies of Autistic children. In the fifth month of May 2016, a case study format was prepared after discussions, pilot study and reworking. The month's work also involved the interview and interview reporting of another specialist. In the sixth month of June 2016, few case studies were done, which provided further insights into what could be the design parameters for Autistic children and also shortening of exposure period. Also, the preparation works for primary study involving initial assessments were done. The latter part of the month's work also involved preparation of interim report as well.

Timeline with modifications

	Month	Initially proposed work (at the time of application for fund)	Modified work schedule
Already done	January	Literature review	Literature review
	February	Interview of specialists	Interview of specialists
	March	Case studies /observation studies	Fixing upon tools for Assessment, sensory and behavioral aspects of sample, and getting ethical clearance
	April		Formulation of design parameters (tentative)
	May	Formulation of design parameters	Preparation of case study format and interview of specialists (contd.)
	June		Few case studies and preparation of interim report
To be done	July	Initial assessment	Finalization of design parameters after case studies
	August		
	September		Initial assessment of 3 tools (CARS, PSI, Sensory Profile), exposure for one month and final assessment of PSI after one month
	October	Final assessment after 3 months	
	November		
	December	Analysis of results	Analysis of results and report preparation

2. AUTHOR BIOS

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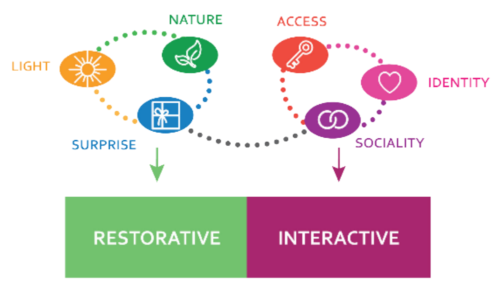
DESIGNING HAPPINESS: Nature, Light, and Surprise

Rebecca Habtour, Madlen Simon AIA
University of Maryland, College Park, Maryland, USA

I. EXTENDED ABSTRACT

A literature review of neuroscience and social science studies focused on happiness provided the content to frame six environmental factors with design implications. Three have restorative qualities: nature, light, and surprise, and three have interactive qualities: access, identity, and sociality. For each factor, selected findings are highlighted, then interpreted into potential design strategies. Both restorative and interactive experiences appear to be invaluable to human happiness, although they might not always appear compatible. Finding ways to draw the two together and integrate each into an individual's daily life is the design challenge this work is seeking to address. The focus here will be on the restorative interventions into urban and architectural design.



NATURE

Within environmental psychology, restorative theory has proposed that natural settings promote recovery from stress and fatigue. Correlations have been found between reported happiness and restorative experiences. Neuroscientific studies tested restorative theory by recording subject cognitive response while experiencing different environments. Nature has shown to have a restorative effect at every scale, from a plant in an office, to the greening of a playground, to time spent in green parks. Increased biodiversity draws attention without overstimulation. Frequent daily exposure to nature has the greatest impact. Selected design strategies applied to a test case include: Drawing people closer to nature in their daily commute through plant defined, park connected networks for bikers and pedestrians. Creating a biodiverse pocket park with a variety of seating, between transit stops and a density of uses. Bringing plant life and nature into indoor settings, through an urban public palm house and natatorium. The overall goal is to increase the frequency of biodiverse interactions of all kinds, at all scales, for all kinds of people, by providing places for people to commute, work, linger, and sit among nature.

LIGHT

Natural light cycles support vital circadian rhythms, provide our bodies Vitamin D and boost our serotonin levels, and are a known necessity for good health and happiness. Daylighting is associated with improved mood, enhanced morale, lower fatigue, and reduced eyestrain. Darkness plays an important role in healthy sleep cycles, which helps stave off depression. Meeting a need for contact with the outside living environment is also considered one of the important psychological aspects from daylighting. Design Strategies applied to the test case include: Connecting indoor spaces to bright, filtered natural lighting, and shaded spaces. Frequent, human scaled street lighting replacing auto oriented flood lighting, reducing the amount of lumens necessary to create a feeling of safety for pedestrians.

SURPRISE

Unpredictability correlates as a significant main effect with activity in the reward regions of the brain according to a study by Berns et al. In a study by Leyden, et al. the perception of living in a beautiful city had the strongest correlation with happiness. The possibility that architecture might afford a pleasurable surprise, an element of delight, or offer up an environment that is better

than expected encourages a pursuit of beauty for its intrinsic qualities. Design Strategies applied to the test case include: Creating engaging and evolving spaces by integrating nature, art, colored light filtration, and activity. Elements like water for swimming and habitat, and a rock garden for seating and play, facilitate pleasant discoveries. The integration of moments of impractical beauty, like an interactive art instillation mimicking fireflies at night, takes on new value. A distinctive structure offers a contrast to the urban fabric, and acts as a pleasant surprise as well as a cognitive marker.

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3. AUTHOR BIOS

Rebecca Habtour is a dual degree Master of Architecture and Master of Community Planning graduate from the University of Maryland's School of Architecture, Planning, and Preservation. She earned a bachelor of fine arts from Utah State University and a post-baccalaureate certificate in interdisciplinary arts from the Maryland Institute College of Art.

Madlen Simon AIA is an Associate Professor at the University of Maryland's School of Architecture, Planning, and Preservation and a registered architect. Professor Simon's scholarship, research, and creative practice are in the area of design – design thinking, design process, design education, design of buildings, and the application of design to issues in the area of environment and behavior. Professor Simon supervises graduate student research in this area. One design research track investigates design for disabilities, including visual impairments and autism, which involve differences in sensory perception of the built environment. Another research topic is design for happiness, exploring the effect of the built environment on sense of well-being.

AVERAGE IS IRRELEVANT.
Work and educational space design needs to be derived from different neurological workings of the brain.

Joanna-Maria Helinurm

One needs to consider the extremes - particularly if they carry an extraordinary cumulative effect. "Black Swan", Nassim Nicholas Taleb

I. EXTENDED ABSTRACT

Experiences alter the fine details of our brains, as our bodies are constantly looking to establish equilibrium within the environment. It is crucial that institutions and work spaces of innovation would have diverse spatial conditions to cultivate many different kinds of minds.

Yet innovation incubators as well as other contemporary work spaces often follow simplistic design visions. Crude schemes may provide adequate conditions for working, but at best, only for certain people.

It would not be wrong to say that continued use of these designs is both insensitive and discriminating towards diversity, and arguably inhibits innovation.

In order to nurture our inventive capacities, we have to understand how new thinking emerges and to use these findings to create a more dynamically fertile environments.

I argue that better understanding of how different brains function, can enrich and enhance the uniqueness and individuality of the users, to improve the work environments and create the ultimate effect of which to open unexpected paths to innovation.

"There is no longer any question that brain tissues create the potential for having certain types of experiences, but there is also no doubt that the experiences especially early ones, can change the fine detail of the brain forever." (Jaak Panksepp, 2004)

Expanding the user profile of the space from the average to the spectrum of extremes, taking into account variabilities in attention, perception, and anxiety levels, we can start to define the factors that can influence the design decisions.

According to Panksepp (2004) all of consciousness was built on affective value system during long course of brain evolution. Since our energy resources are limited we can only participate in the information which is vital for our survival. Therefor our brains are wired to ignore repetitive information, and events/objects in their surrounding relationships matter more than absolutes. (Helson, 1964)

Hubel and Wiesel found that that whereas retinal neurons preferred dots, an otherwise quiescent cortical neuron would respond vigorously if and only if a straight lines at 90 degree angle was shown. That means, our perception is put together by these primary visual cortical neurons that further in hierarchy add up to contours and shapes. To analyze a space in terms of visual stimulus we can use the theory of corners from the findings of neuroscientist Irving Biederman of the University of Southern California. He found that corners and high degree curves are critical to the recognition of everyday objects. (Martinez-Conde, S and Macknik, S. L. (2013) Dark and Bright Corners of the Mind. Scientific American Mind 24, no 5, 20-22)

"Brains develop concrete perceptual structures, capabilities and sensitivities based on PROMINENT FEATURES of the rearing environment, and then are more able and more likely to see those features in the world around them. "(WEXLER - LOOK UP BOOK)

Enriched environments force new neural connections and induce exploratory behavior. These spaces would be a good fit for people with traits of ADHD as they are more likely to carry dopamine D4 genes, which by nature results in personality traits of novelty seeking. From Donald Hebb we know that neurons that FIRE together WIRE together. Larger networks between neurons enable more complex and advanced thinking. larger amounts of dopamine in the brain, is thought to be especially at an advantage of making novel connections between ideas, as he has access to a larger pool of data in the working memory. One of the most remarkable features of contemporary enrichment studies has revealed that the changes in the brain can be detected even when the enriched experience is provided to an adult or aged subject.

(Nature review/Neuroscience. VOL1 December 2000. 191-198)

Yet, not everybody is able to handle enriched environments, or excessive visual noise.
At any given moment working memory is said to be able to hold 4-7 items in reserve. (Alan Baddeley 1970).

Future Work
It's about working short term memory as well as long term memory, which get fused with our subcoscious brain activity.

Idea Sketches as Traces of Cognitive Styles: The Case of Alvar Aalto

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I. ABSTRACT

While architectural historians have often noted the connection between design sketches and finished buildings, to date there has been little in the literature that relates these drawings to discoveries in neuroscience and visual perception. This paper will present an analysis of the drawings of the great Finnish architect, Alvar Aalto, that suggests how researchers might begin to unlock the mental habits of architects and designers to discover historical patterns of thought.

Drawing on previous research that traces what I have called "modes of conception" among prominent architects, I shall demonstrate the connection between drawings, cognitive patterns, and memory in the work of Aalto, one of the most influential "form givers" of the twentieth century. Because many of his sketches survive, along with detailed biographical and eye-witness accounts of his practice, it is possible to study Aalto's cognitive patterns in detail.

I shall conclude the paper with a hypothesis about the relationship between external memory triggers, or "exogons," and drawing types (modes of representation) that draws on the research of Merlin Donald, the Canadian psychologist. This thesis will form the basis for a forthcoming book that examines architectural drawings as keys to conceptual modes from the Renaissance to the present day.

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3. AUTHOR BIO

Mark Alan Hewitt, FAIA, is an architect, historian and teacher who has taught at Rice, Columbia, NJIT and the University of Pennsylvania. He is currently an adjunct professor at Rutgers University. He is the author of six books and more than a hundred articles on architecture and architectural history. His awards include Senior Fellowship at the National Endowment for the Humanities, Graham Foundation Fellowships, the Arthur Ross Awards, and teaching citations from three universities.

Keynote Speaker Title

Steven Holl, Keynote Speaker
Owner, Steven Holl Architects, New York, New York, USA

I. AUTHOR BIO

Steven Holl was born in 1947 in Bremerton, Washington. He graduated from the University of Washington and pursued architecture studies in Rome in 1970. In 1976, he joined the Architectural Association in London and established STEVEN HOLL ARCHITECTS in New York City. As founder and principal of Steven Holl Architects, Steven Holl is the designer of all projects ongoing in the office. Considered one of America's most important architects, he is recognized for his ability to blend space and light with great contextual sensitivity and to utilize the unique qualities of each project to create a concept-driven design.

Steven Holl has been recognized with architecture's most prestigious awards and prizes. He has received the 2014 Praemium Imperiale International Arts Award for Architecture, the 2012 AIA Gold Medal, the RIBA 2010 Jencks Award, and the first ever Arts Award of the BBVA Foundation Frontiers of Knowledge Awards (2009). Mr. Holl is a tenured Professor at Columbia University's Graduate School of Architecture and Planning. He has also taught at the University of Washington, the Pratt Institute, and the University of Pennsylvania. Steven has lectured and exhibited widely and has published numerous texts.

Towards a Critical Neuroaesthetics

Kurt Hunker, FAIA, Eve A. Edelstein, M.Arch., Ph.D. (Neuroscience)
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1. ABSTRACT

It could be asserted that, for all but the last century or so in the long history of the discipline, the singular role of architecture was to provide beauty and the primary task of the architect was the pursuit of it. To be sure, Vitruvius posited his definition of architecture ("A") as firmness (F) and commodity (C) in addition to beauty (or delight, D) ("A = F+C+D") and his formulation influenced generations. Succeeding commentators, however, narrowed the focus. John Ruskin, arguably the most influential critic of the 19th century, defined architecture precisely as those components of a building that were not necessary from a structural or programmatic perspective. A century later, the historian Nikolaus Pevsner set forth his famous assertion that "A bicycle shed is a building; Lincoln Cathedral is a piece of architecture." In attempting to differentiate architecture from mere "building", Pevsner determined that architecture's defining characteristic was, "A view to aesthetic appeal." And Robert Venturi explained the "problem" of modern architecture by perverting Vitruvius's definition thusly: "Firmness + Commodity = Delight."

If we accept the central role of beauty in architecture, we might also also accept the proposition that the role of architectural criticism lies in ascertaining beauty. That is no easy task, however, and its elusiveness may explain the difficulty architectural criticism has had as a professional pursuit and as an agent of architectural development or public promotion.

Now, neurobiologists use neuroimaging techniques to identify brain regions associated with processing and judging beauty. The field of neuroaesthetics and cognitive electrophysiology using event-related brain potentials provides an overall view suggesting that aesthetic experience is a multilevel process that includes visceromotor and somatomotor responses, with that visual experience of art characterized by the activation of sensorimotor areas, emotional and reward-related centers. Seminal studies demonstrating the plasticity of behavioral and neural responses to beauty after perceptual and motor training suggest important questions regarding the relationship between embodiment and aesthetics that are particularly important to the art of architecture, in which people move through space to experience design. As we learn about the distinct processes in the brain that are engaged, we can increasingly relate neural form to reveal the brain's function in aesthetic judgments of delight.

This movement in science offers interesting possibilities in a refreshed role for architectural criticism, incorporating an understanding of the brain's response to beauty. Can we create an evidence-based process leading inexorably to beautiful buildings? This illustrated presentation will explore neuroaesthetics while examining the challenges of defining beauty in architecture. It will interweave research from neural science revealing principles of sensation, perception, and emotion with criticism in its many guises (description, rhetoric, rhapsody, etc.) to offer a new view of architectural criticism as "critical neuroaesthetics" and suggest a place for architectural criticism, reconceived.

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3. AUTHOR BIOS

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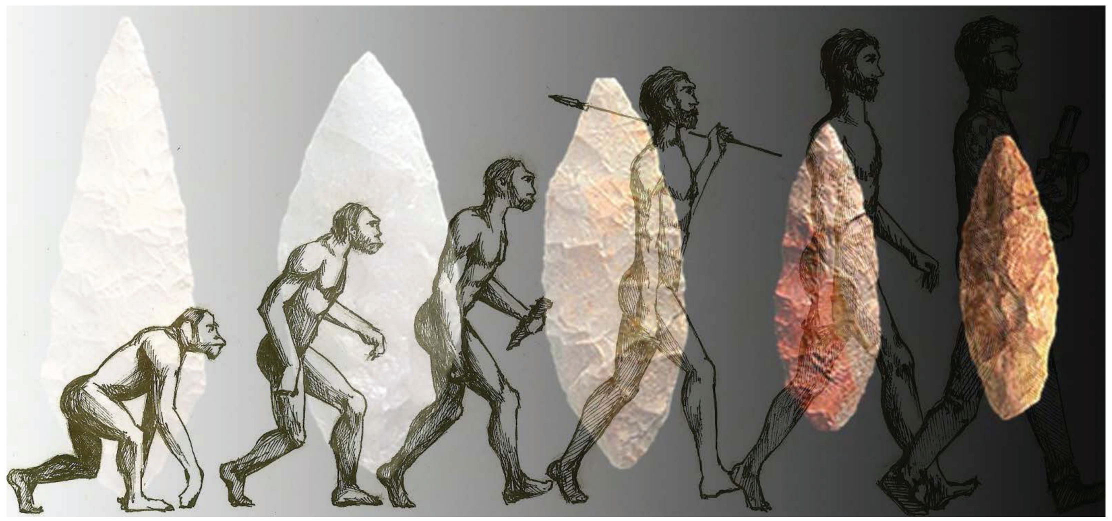
Eve Edelstein, Fellow of the American Academy of Audiology, is Research Director of the Human Experience (HxLab), and the BioAcoustic Neuro Group (BANG) of the Gadget Lab at Perkins+Will. Dr. Edelstein is faculty and participates with the Center for Healthy Environments at the NewSchool of Architecture and Design in San Diego, and leads the Design Health CoLab, part of the AIA Design + Health Research Consortium. Eve worked with ANFA and NSAD to develop the Neuroscience for Architecture curriculum. With the University of California, San Diego she created novel virtual visual and sonic simulations that synchronously measure the consequence of design on EEG and human outcomes. Eve's neurophysiological research and clinical practice applied novel intracellular, in-vivo, and clinical electrophysiologic techniques to diagnostic assessment of auditory and vestibular disorders of central and peripheral origin in adults and children. With degrees in neuroscience (Ph.D. Institute for Neurology, University College London), Anthropology (UC Berkeley) and Architecture (NewSchool of Architecture and Design), Eve now translates clinical and neuroscientific research into brain-based principles for design in all building types and scales, from rooms to regions, and including workplace, healthcare, educational, science and technology facilities.

Digital Craft in Architecture

Andrew Huss, Aaron Bolli
Kansas State University

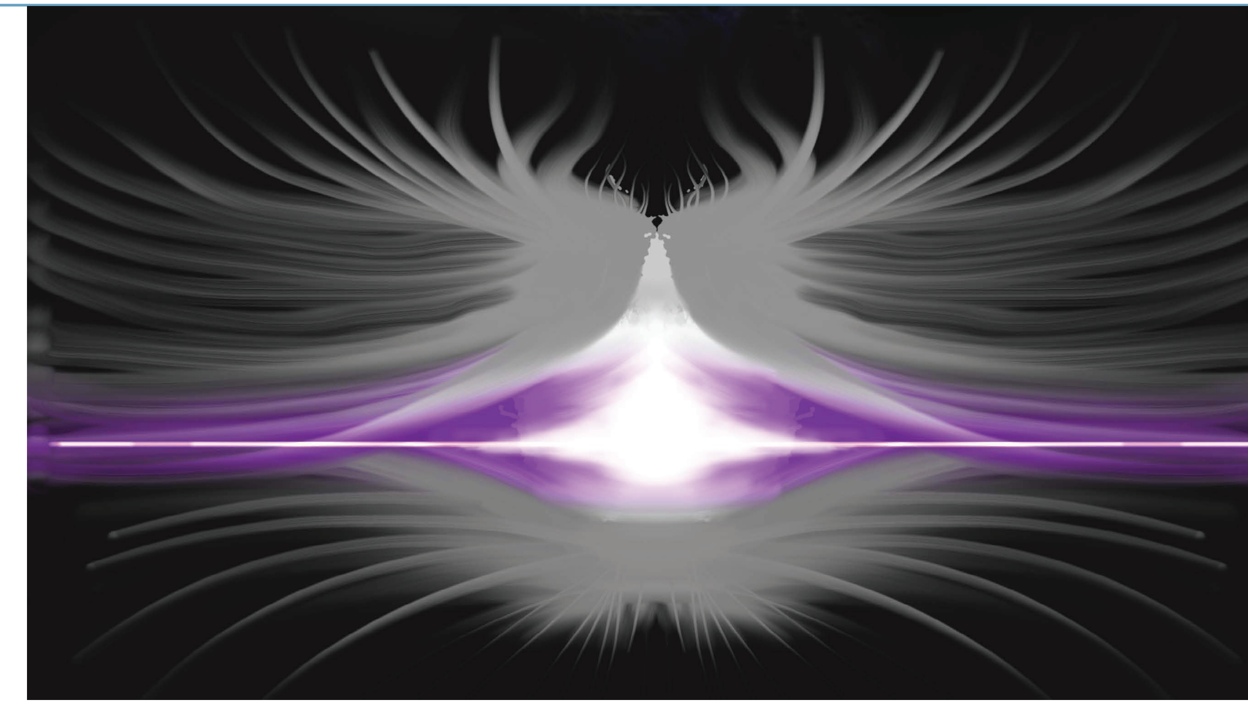
I. EXTENDED ABSTRACT

The mission of this conference is to "ignite change and unlock the potential of Neuroscience for Architecture." In this brief overview we address: I) How the digital era is rapidly reforming craft in Architecture via new tools; 2) Neurological implications of digitally reformed design, specifically craft and experience thereof.



Craft is a highly involved demonstration of skill with origins predating language. The bodily skills associated with craft have been passed down through a lineage of mimetic learning. Homo-sapiens pass down corporeal knowledge of tool-use from generation to generation.[1] Studies on japanese macaques demonstrate how tools may have been neurological extensions of the body.[2] Craft/tool use is neurologically understood and appreciated similarly today as it was at the dawn of mankind.I In this light the digital era has not reshaped how theorists view craft, but professionals, such as architects, who enthusiastically lend their profession to machines for better or worse.[3] Thus the digital age ushers in a diverse range of neurological implications from craft to aesthetic experience. Aesthetic experience of craft is defined by meticulous and masterful articulation of attractive materials. Electroencephalogram (EEG) studies in art have shown that aesthetic experience may be neurologically enhanced by: I) Pathologically gained expertise; 2) The perception of creative bodily motion.[4] Industrialization and development of digital tools has, through veils of false precision, beckoned architects to replace traditions of craft. From this point of view digital tools may be responsible for degradation in aesthetic experience. Dilemmas surface when CAD drawings, 3-D modeling, rendering, etc. fraudulently render corporeal design methods, namely sketching and modelcraft, obsolete.[1] The benefits of increasingly easy digital functions are favored while strengths in fabrication are ignored. Computers, as neurological extensions of the body, allow the architect innovative methods of production.[2,5] Digital is a medium through which architects may merge their design ideas with material reality.

Craft is the intimate process of engaging material reality to create objects. To craft as an architect is to toe the line between the architect and the contracter, between the theorist and the engineer, between the philosopher and the mason. Architectural craft is rooted in the human body through its actions and intentions. It is created through the movements of the craftsman and appreciated through the observer's understanding of objects. This is now corroberated by the discovery of mirror neurons.[4] Before the digital era, the tool hand was the sole proprietor of craft. A new emphasis on mind tools arguably results in the loss of identity and corporeality in design process. Notions such as industrialization and mass production detach users from crafted objects. However, the role of digital tools in the design process was not intended to replace human ingenuity, rather to assist in the production of material objects. With the rise of digital tools, designing buildings may have been becoming more of a visual art than a bodily one. Architects are using computers to craft visualizations instead of aesthetics grounded in embodied tectonic logic.[6] If the computer has a place in the design process, it is production. Computer fabrication is essential to the architect in particular, because of the nature of buildings and their numerous components. An architect must become more than a mere designer or a producer. Engaging modern tool development is an opportunity for architects to become more involved in the construction process, thereby, placing them more in control of the material world. The simultaneous engagement of creativity and production may allow the architect to reclaim the title of the master builder.



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I have always been drawn to working with my hands. Two years of collegiate engineering did not fulfill the wants of my hands; I transferred to Architecture. I have a multitude of construction experience. Grounded in the world of production we live in, I have been lured towards philosophy, science, and art. By keeping an open mind, I keep a creative mind. I am a knight of optimism, drawn to the dream of a better world for living.

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My father was a cabinet maker and currently a woodworking hobbyist. I have heard lively critiques of craftsmanship throughout my life. In high school I was drawn towards the arts and music. Early in college I stayed in my hometown to maintain a band. Meanwhile, I studied journalism. Detachment from hands-on visual arts left me disillusioned. Architecture afforded me the opportunity to express myself visually. Currently, I study at the Institute for Advanced Architecture of Catalonia (IAAC) in Barcelona to explore the urban role of the fablab. I will return to Kansas State for my final year of studies in the fall.

Experience of space/time in Tadao Ando and Carlo Scarpa's narrative architecture: The embodied-enactive view

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1. EXTENDED ABSTRACT

Architecture as an existential art accommodates at the same time both the living and the lived body: it houses the biological organism as well as man's world of ideas and memories because it is inextricably linked – through our embodied existence – to the way we think and behave (Mallgrave, 2013; Pallasmaa, 2013). In this sense, architect's design intentions are to be understood not only as a solution to functional requirements, but also as a scenario for users' emotional experience and physical expression of being-in-the-world.

This capacity for structuring our experience of space and time is nowhere manifested as strongly as it is in the case of narrative architecture - a design strategy of gradually unfolding spaces and views, which is with human movement transformed into a sequence of time (Arnheim, 2009). By employing such design principles, architectural masterpieces by Tadao Ando and Carlo Scarpa, like the Water Temple (Figure 1) and Brion Cemetery (Figure 2) respectively, invoke in the visitor intense emotional and memorable experiences.

By embracing the embodied-enactive perspective (Thompson, 2007; Varela, Thompson, & Rosch, 1991), we examine the relationship between the experienced passage of time and narrative spatial configurations with two aims in mind: first, to shed light on underlying bodily and emotional mechanisms, and second, to highlight significance of the subjective time component in understanding how people navigate in architectural environments. Therefore, starting from the premise that architecture is a designed interaction between life and form, we describe architectural experience as originating in the (pre-reflective) architecture-body communication, where the experiencing subject is conceived as enactive, embodied, emotional, and situated agent interacting with design intentions as spatial affordances (Jelic, Tieri, De Matteis, Babiloni, & Vecchiato, 2016; Rietveld & Kiverstein, 2014).

Accordingly, in the case of Ando and Scarpa's architectural works, the aesthetic experience of spatial narrative is identified as an anticipatory process of sense-making, where the subjective experience of time for each spatial sequence corresponds to a particular pattern of emotional activity (that can in turn modulate subsequent navigation choices), slowly building from the feelings of suspense to awe/wonder as the visitor moves through space. Thus, the perceived time dimension might be indicated as one of the key determinants of the overall quality of architectural experience.

Figure 1 (Left): Tadao Ando's Water Temple
Figure 2 (Right): Carlo Scarpa's Brion Cemetery

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3. AUTHOR BIOS

Dr. Andrea Jelic holds a PhD in architecture from Sapienza University of Rome for her dissertation "Architecture and Neurophenomenology: Rethinking the Pre-reflective Dimension of Architectural Experience" (2015). As an architect and researcher, her work focuses on the intersection of architecture, neuroscience, and philosophy, aimed at investigating issues of experience, imagination, and pre-reflective place-making in architectural and urban environments. Together with Dr. Vecchiato, Dr. Jelic contributed to this emerging interdisciplinary field through publications in scientific and architectural journals, including Frontiers in Psychology and Cognitive Processing.

Dr. Giovanni Vecchiato achieved his Ph.D. in Neurophysiology at Sapienza University in 2010. In his current research, Dr. Vecchiato investigates cognitive and emotional correlates of the EEG related to the observation of advertisements, emotional, artistic, and architectural stimuli. In 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 the author of several scientific publications in international peer-reviewed journals, book chapters and a book.

Thinking about effects of the environment on the developing mind and brain: the ABCD Study

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I. EXTENDED ABSTRACT

In late 2015, eight institutes and centers of the National Institutes of Health awarded funding to support a landmark nationwide study of the adolescent mind and brain called the Adolescent Brain Cognitive Development (ABCD) study. A national consortium of over 50 lead investigators and over 150 research staff members are collaborating to conduct this study. The Coordinating Center and the Data Analysis and Informatics Center are based at UC San Diego, and 19 institutions across the US will host research sites where participants will be studied. The ABCD Consortium aims to study 10,000 youth, enrolling them at age 9-10 and following them for 10 years, creating an unprecedented data resource for scientists to share for studies of the adolescent brain. Methods the study will employ include:

- School-based recruitment (at 19 sites) of a demographically representative national sample
- Multimodal neuroimaging
- Extensive health and behavioral assessment
- Additional assessments of activities and environmental factors.
- Sampling and storage of biospecimens for: genetics, epigenetics, hormones, substance use
- Novel wireless, web based, and nanoengineered assessment technologies

Some of the primary objectives of the study are to:

- Identify individual developmental trajectories (e.g., of brain, cognitive, and emotional development, academic progress), and the factors that can impact them.
- Develop national standards of normal brain development in youth.
- Examine the roles of genetic vs. environmental factors on development, (e.g., by analysis of data from 800 twin pairs who will be recruited as part of the cohort).
- Study the effects of physical activity, sleep, as well as sports and other injuries on brain development and other outcomes.
- Study the onset and progression of mental disorders, factors that influence course or severity; and the relationship between mental disorders and substance use.
- Determine how exposure to various levels and patterns of alcohol, nicotine, caffeine, cannabis, and other substances affect developmental outcomes and vice versa.

Neuroimaging reveals ongoing biological development of the human brain throughout childhood into early adulthood. Adolescence is also a time of significant ongoing development of cognitive/intellectual and social/emotional functions. This is an important, and often pivotal, time in the lives of young people. For many it is a time of dramatically increasing knowledge and skill - a time when youth find their intellectual and creative voices, if you will, and form strong bonds with friends and family that will support them throughout their lives. In other words, many emerge from adolescence engaged, independent, and resilient to life's challenges. Unfortunately, though, this is also a period during which the first symptoms of many serious problems appear, such as depression, anxiety, and psychosis – and some youth become disengaged, academically and socially. It is also a time of heightened vulnerability because, though it is typical, and healthy, for adolescents to begin to take more risks at this time in life, and to become more exploratory and curious, risky behavior can lead to problems for some youth – including serious injuries and growing dependence on self-destructive activities and substances. Previous studies have documented genetic, environmental, and behavioral factors that are correlated with positive or negative outcomes in adolescents. However, there is continuing uncertainty about the degree to which these correlations reflect causal effects of genes or specific environmental factors on these outcomes. The development of effective and personalized interventions to prevent or reduce adverse behavioral-health and neuropsychiatric conditions will rely upon accurate models of the effects of genetic and environmental factors, and interactions between these, in the emergence of these conditions. Unfortunately most previous studies focusing on these questions have been limited in scope, lacked statistical power to estimate multiple parameters in complex dynamic models, and have employed diverse methods that make it difficult to compare results across studies. The ABCD initiative hopes to overcome some of these limitations.

Advantages, Opportunities, and Challenges for ABCD:

- The large cohort size (10,000), duration (10 years), and high-dimensional datasets (petabytes of imaging, genome sequencing, behavioral-health data, etc) of ABCD create unique technical, informatics, and data science challenges but also great opportunities for discovery science.
- ABCD provides the resources to create a virtually unique, big-data infrastructure that can be leveraged in the future for large, multi-site behavioral/health, imaging, and genomics studies.
- ABCD could be dramatically enhanced by the addition of novel wireless technologies for passive, more ecologically valid, assessments of biomarkers, behavior, and environments.
- ABCD provides an opportunity to pilot and quickly validate novel assessment methods through academic collaborations and academic-industry partnerships within this high-profile study.

Focus on Environmental Effects:

ABCD represents a transformational approach, akin to the precision medicine approach, sometimes referred to as "population neuroscience". Here a carefully constructed and well curated, high-dimensional dataset is collected using an open-science model. This means that participants agree to broad data-sharing across the scientific community and including industry partners. One of the greatest challenges of a study like ABCD, however, is to decide what kinds of data to collect. From the ever growing biomedical toolkit, a feasible set of biomarkers has to be selected, and decisions have to be made about the best way to sample an even larger and more complex domain: human behavior. But probably the most difficult decision is to decide which aspects of the environments of our participants are impacting their development, for better or worse, and to measure them. In this talk I will describe the ABCD Study and the paradigm that it represents, and discuss the focus on environmental factors. I hope to learn from the attendees how they think learning and brain development might be impacted by the built environment, and how we might better define such effects – and the mechanisms by which they may be mediated - in our models.

2. AUTHOR BIOS

Dr. Jernigan is Co-Director of the Coordinating Center for the ABCD Study, and Professor of Cognitive Science, Psychiatry, and Radiology at the University of California, San Diego. For over 30 years, she has studied the human brain using noninvasive imaging. This work has focused on brain development and agining, neurodevelopmental disorders, neuropsychiatric and substance use disorders, and neurodegenerative disorders. For the last decade, her central research interest has been the developing human mind and brain, with a focus on the dynamic neurodevelopmental processes that give rise to human individuality - and on how these processes are impacted by experience, substance exposure, prenatal factors, and other risks. She has pursued this interest in collaboration with an interdisciplinary team as Director of the Center for Human Development at the University of California, San Diego. She also directs the Coordinating Center for the Pediatric Imaging Neurocognition, and Genetics (PING) Project - a publicly shared imaging genomics data resource with imaging, neurocognition, and whole genome genotyping data from over 1500 children aged 3 to 20 years. She is a member of the Council of Councils for the National Institutes of Health, and serves on the scientific advisory boards of sevveral research organizations in the United States and Europe.

The quest to undestand The Unconscious in Art, Mind, and Brain

Keynote Speaker: Eric Kandel
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I. AUTHOR BIOS

By probing the synaptic connections between nerve cells in the humble sea slug, Eric Kandel has uncovered some of the basic molecular mechanisms underlying learning and memory in animals ranging from snails to flies to mice and even in humans. His groundbreaking studies have demonstrated the fundamental ways that nerve cells alter their response to chemical signals to produce coordinated changes in behavior. This work is central to understanding not only normal memory but also dementia and other mental illnesses that affect memory.

Kandel's research has shown that learning produces changes in behavior by modifying the strength of connections between nerve cells, rather than by altering the brain's basic circuitry. He went on to determine the biochemical changes that accompany memory formation, showing that short-term memory involves a functional modulation of the synapses while long-term memory requires the activation of genes and the synthesis of proteins to grow new synaptic connections. For this work, the Austrian-born Kandel was awarded the 2000 Nobel Prize in Physiology or Medicine.

As a college student at Harvard, Kandel majored in history and literature, but he was drawn to psychoanalysis after befriending a native Austrian student whose parents were prominent psychoanalysts in Sigmund Freud's circle. Kandel went to medical school at New York University with the goal of studying psychiatry and becoming a psychoanalyst himself. But thinking that he should know more about how the brain works, he took a neurophysiology course that shifted his interest toward research into the biology of memory.

More recently, Kandel has expanded his studies of simple learning and memory in Aplysia to include more complex forms of memory storage in genetically modified mice. These studies have focused on explicit memory (the conscious recall of information about places and objects), revealing the importance of a balance of activation and inhibition in memory storage so that animals as well as humans do not store information in their memories that is not important to recall.

Environmental factors related to perceived stress in open public spaces

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1. ABSTRACT

Current city living has been related to various manifestations of stress and a higher risk for mental health problems (Lederbogen, et al., 2011). Lederbogen et al. (2013) have named a set of influencing factors to urban social stress including infrastructure, socio-economic factors, noise and environmental pollution. It remains an open question, which factors of the built environment are critical to influence subjectively perceived urban stress (PUS), how these factors interact and how they can be addressed by planning and urban design in order to maximize pedestrian comfort. This talk introduces a framework of environmental factors and spatial analysis tools shown useful to describe and predict PUS in open public spaces (OPS). In a first step, environmental properties have been constructed for a sample of OPS in the city of Darmstadt, Germany, using the space syntax framework (Hillier & Hanson, 1984). These were paired to users' ratings of spatial qualities such as loudness and subjectively perceived safety and stress (figure 1). Isovist vertice density has been shown to be weakly associated to users' ratings of safety (r=.365, p=.09, Pearson), while global and citywide integration of a street segment have been shown closely related to PUS (r=0.432, p=0.04, Pearson) (Knöll, Neuheuser, Li, & Rudolph-Cleff, 2015). In a second step, the data has been analyzed using different types of multivariate models with the aim to predict ratings of PUS with a highly explained variance and significance. Open space typologies (park, square, courtyard, streets) were found the best predictors for PUS, followed by building coverage ratio, isovist vertices numbers and syntactical characteristics. A model has been presented that uses a combination of environmental properties and achieves a predictive power of R2=54.6% (Knöll, Neuheuser, Cleff, & Rudolph-Cleff, 2016). These results are a first attempt to predict more complex emotions such as perceived urban stress by analyzing factors of the built environment and using standard planning tools such as GIS and Space Syntax. They extend existing models that have predicted tranquility in green spaces (Watts, Pheasant, & Horoshenko, 2014) or activities and spatial experience in streetscapes (Bielik, Schneider, Kuliga, Valasek, & Donath, 2015). The framework may be useful to architects and neuroscientists alike, who seek to identify urban configurations likely to be perceived as stressful and seek to further investigate pedestrian comfort by pairing environmental factors with geo referenced, psychophysiological effects.

Keywords: Open Public Space, Built Environment, Perceived Urban Stress, Pedestrian Comfort, Space Syntax

Figure 1 shows participants rating environmental properties in open public spaces (OPS) using a smartphone app (Halblaub Miranda, Hardy, & Knöll, 2015). In the centre, an isovist with a high vertices density (vertex number / isovist area2) is shown, which is weakly associated to users' ratings of an OPS as "safe". On the right, a map of Darmstadt shows the global integration (r=n) values of its street segments (red indicates high global integration), which are significantly related to ratings of OPS as "max. stressful" (Knöll, Neuheuser, Li, & Rudolph-Cleff, 2015).

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3. ACKNOWLEDGEMENTS

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Martin Knöll is Juniorprofessor at Technische Universität Darmstadt, Germany, Department of Architecture. He studied architecture and planning at Universität Stuttgart, where he gained his diploma and doctorate. Dr. Knöll leads the Urban Health Games research unit at TU Darmstadt, an interdisciplinary team of architects, environmental psychologists and computer scientists, who conduct basic research in health & urban design. His research interests include walkability, social inclusion and environmental factors to urban stress and diabetes self-management. He uses spatial analysis tools such as Space Syntax and GIS, and develops new participatory tools to gain geo-coded data on psychophysiological effects in urban environments.

Transparency as an environmental factor that influences cognitive visuo-locomotive experience in large-scale buildings

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The paper examines the relationship between the visuo-locomotive experience, the types of people's movement and the spatial memory. Two movement tasks (exploration and navigation) and their correlation to the environmental factor of transparency are analysed through a multi-modal perspective in a large-scale built environment, the New Parkland Hospital in Dallas.

Keywords: visuo-locomotive behaviour, navigation, exploration, memory, transparency

I. ABSTRACT
VISUO-LOCOMOTIVE EXPERIENCE | MOVEMENT | SPATIAL MEMORY

Embodied visuo-spatial interactions occur at discernible levels [Tversky, 2005]:

"that of the space in reach or in sight around the body, that of the space of navigation too large to be apprehended at once, and that of the space of external representations, of graphics constructed to augment human cognition."

From the standpoint of architectural theory, it is well known that the medium of interaction between people and their architectural environment is user's movement in space [Le Corbusier 1923]. As a result, investigating user's visuo-spatial experience is strongly connected with locomotive behaviour. As also Hoogstad [1990] summarised about the locomotive experience of an observer: Space = Time (+ memory) x Movement, which means that an observer in motion perceives changes successively and adjusts his knowledge. This environmental knowledge acquisition, which is directly related to spatial memory, is depended on spatial aspects as spatial perception, spatio-visual attractiveness, arousal and orientation [Altes & Steffen 1988]. The main aim of our research on visual perception driven Evidence Based Design (EBD) is to:

1. Explore the visuo-locomotive behaviour of users in unfamiliar large-scale built-up spaces, and
2. Identify the environmental factors related to visual perception which are significant for spatial knowledge acquisition in that context.

In particular, we are focusing on the visuo-locomotive experience of users in the context of two distinct movement tasks differing in their respective motives: (1) navigation task, involving wayfinding towards a destination; and (2) an exploration task, without any specific defined goal. We employ a range of sensors for measuring the embodied visuo-locomotive experience of users (eye-tracking, egocentric gaze analysis, external camera based visual analysis, questionnaires determining spatial ability, sketch maps) [Bhatt et al. 2016] to interpret fine-grained behaviour (e.g., patterns of gaze, route preferences, movement speed and pauses), correlate it with the outcomes pertaining to spatial knowledge tasks (e.g., recall, pointing, perspective-taking, distance estimation) and at last to create a new framework for visuo-locomotive behavior analysis targeting EBD.

A STUDY ABOUT THE IMPACT OF TRANSPARENCY TO VISUO-LOCOMOTIVE EXPERIENCE AND SPATIAL MEMORY

Movement in space is primarily governed by short-term working memory (e.g. visuospatial working memory is involved in route learning [Meilinger et al. 2008, Viswanathan et al. 2015, Garden et al. 2002]). Preliminary results from our behavioural analysis of a navigation task at the New Parkland Hospital (NPH) in Dallas (including eye tracking data, questionnaires, and orientation tasks) [Bhatt et al. 2016, 2014] support previous researches which claim that working memory benefits from navigation tasks and particularly the episodic visual memory plays a crucial role to wayfinding but this is not the case in exploration travel mode [Afrooz et al. 2014, Mondschein et al. 2008]. We hypothesis that after a navigation task a user is able to recall more accurately spatial characteristics which create an overview about the 3D built environment (e.g., geometry of the layout, geometry of the scene, number of junctions), whereas after an exploration task a user is able to recall better details of his successive visual scenes, (e.g., transparency features, visual patterns, visual details of color and texture).

Specifically, we investigate the visuo-locomotive behavior of participants in two long corridors of NPH, with and without transparent elements (figure 1) during a navigation task and after that, through a freely movement experience without a goal, where a guide-experimenter is showing the way. The ongoing analysis reveals differences at the visual patterns between the two movement experiences as well as between the two physical structures. For instance, extended fixation periods was recorded and in a wider surface towards the transparent element during the exploration in comparison to the exploration one. Post-experiment interviews also indicate the role of transparency to the memory and the spatial knowledge but there was no distinction between the two kinds of movement experience. Design for navigation and exploration, which are usually two overlapping performances in large scale built-up environments, is a challenging task for designers and architects. Conducting further experiments in a controlled immersive environment, the ongoing investigations aim to extract valuable evidences from user's visuo- locomotive experience and have an impact on EBD.

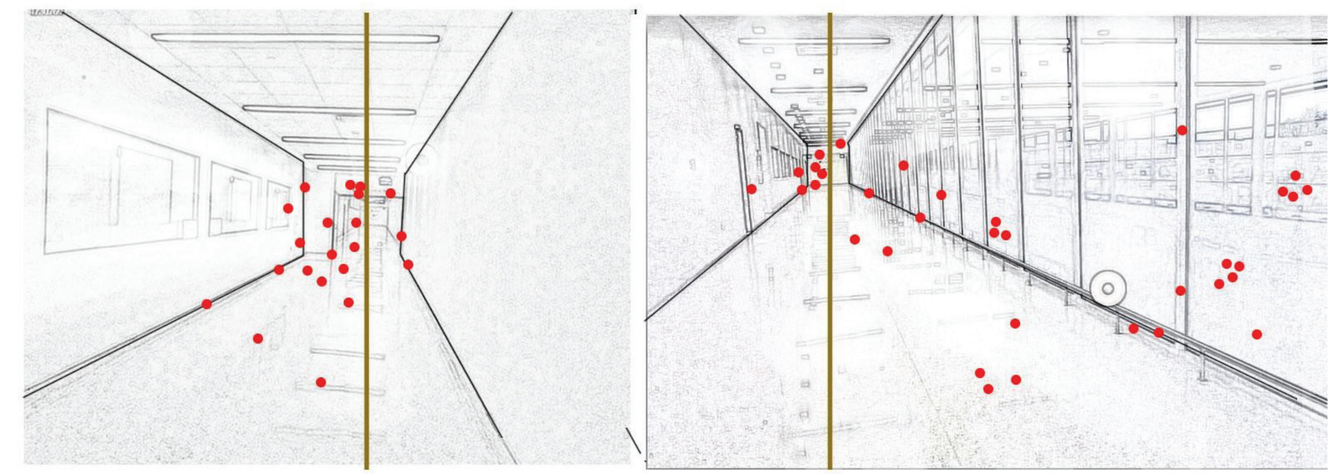

Fig1. The fixation points from the eye-tracking of a participant in the two different setting at the New Parkland Hospital in Dallas.

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3. AUTHOR BIOS

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Perception based architecture for contemporary health care design

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1. ABSTRACT

Over the last years, in part due to the demographic trend towards an older population, in part due to increasing numbers of environmentally triggered illnesses, the amount of admissions, as well as the average length of stay in Intensive Care Units (ICU) has been rapidly increasing. Unlike hospitality, the healthcare sector is interested in a shortened stay in the hospitals. In an attempt to find factors for the slow recovery process and at the same time to develop countermeasures, GRAFT was invited by the Charité, one of the most important hospital and research facilities in Germany, to develop a prototype for the ICU unit of the future.

Prof. Spieß from the Charité Hospital in Berlin is involved in research about the causes and condition of "delirium". She identified the relevance of stress factors such as noise pollution, distractions, the lack of views, of light, and of privacy as important factors that influence the healing process and patient outcome. A lack of daylight and insufficient lighting conditions, for example, generally triggers fatigue and dizziness during the day, which causes sleep disorders at night.

With this in mind two rooms were designed that are carefully tailored according to the perception of the patient, attempting to eliminate the above mentioned stress causing elements, usually present in the design of healthcare facilities. They are keeping the patient in a more familiar, soothing physical environment and within the natural circadian cycle, in order to support a faster healing process and lower remission rates.

Following consultations with specialists ranging from sleep researchers to experts in lighting and acoustics, the project Parametrische (T)Raumgestaltung was born.

The space on either side of the bed was freed up and all technical equipment was moved into a wooden headboard behind the patient. The flickering displays of the vital signs are therefore not directly visible for the patient and allow for a more relaxed experience in the ICU. A further significant decision was to remove alarm signals and sounds of vital data away from the patient into a so-called observation room that each patient can see into through a window. The patient is not distracted and petrified by the constant display of data, but at the same time can see all activities, which minimizes the feeling of uncontrollable dependence on staff and medical personal.

More than in any other spaces, the ceiling above the bed is the most visible surface. It is designed as a large-format LED media screen that bends, in order to cover as much of the field of vision as possible. A series of images, like blue skies, moving clouds or green leaves, was developed in cooperation with the media design agency Art+Com. Daylight-supporting measures that reinforce circadian rhythms during the day, indirect, warm light in the evening, and individually controllable illuminating content provide

doctors and patients with a broad spectrum of possibilities, with the aim of creating a comfort-reinforcing experience of space and time. These interventions are reported to improve melatonin suppression - helping patients to stay awake and focus during the day and sleep soundly at night.

The construction of the prototypes was finished in 2013 at the Charité Campus Virchow-Klinikum in Berlin, Germany. Currently a team of scientists and doctors is monitoring the outcome and long-term effects of the rooms as part of a three-year research program. Final research data will be available in early 2017.

2. AUTHOR BIOS

Christoph Korner is a founding member of GRAFT, an award winning design firm with offices in Los Angeles, Berlin and Beijing. Projects range from Master Planning, Urban Design, Architecture, Interior Design, Exhibition Design, to Product Design. In addition his work has been exhibited and published on several occasions and he authored articles and books. In recent years his dedication gravitated increasingly towards teaching and academia, culminating in his current position as Chair of Interior Architecture at Woodbury University in Los Angeles.

In 1998 **Thomas Willemeit** established GRAFT in Los Angeles together with Lars Krückeberg and Wolfram Putz. With further offices in Berlin and Beijing, GRAFT has been commissioned to design and manage a wide range of projects in multiple disciplines and locations. GRAFT has won numerous national and international awards and earned international reputation throughout its 18-year existence.

The Sound of Creativity: Correlating brainwave & psychometric changes with workplace acoustics

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1. EXTENDED ABSTRACT

The open office has been a central theme in contemporary workplaces, reasoned to provide flexibility, natural light, supervision, cost savings, transparency, democracy, and collaboration. While almost 70% of US workers occupying open plan or open seating settings (International Facility Management Association, 2010), this design strategy remains contentious (Kim & de Dear 2013). These settings may preclude privacy and concentration, evoke stress (Evans & Johnson 2000) and even influence attention, distraction and creative flow. Indeed, there are many physical features of the workplace that may influence the neural processes involved in creative and innovative activities.

This paper reports on findings from a controlled yet ecologically relevant study that investigates how sound may influence creativity. Creativity was assessed using psychometric tests and creative tasks that have been assessed and applied in peer-reviewed publications (The Cambridge Handbook of Creativity, 2013). Frontal lobe electroencephalographic (EEG) brainwaves were recorded while consenting participants completed alternate use tests, a creative product task, and post-test surveys in an office environment that was controlled to have no visual distractions and quiet control conditions. During the five test conditions, different recorded sound files were played to provide realistic yet repeatable sounds at levels measured in actual office environments. Tasks were scored according to the published protocols to reveal the impact on creative scores (originality, elaboration, flexibility and fluency) and were correlated with brainwave algorithms reported to reflect attention, mediation, and achieving 'the zone' when creative 'flow' occurs (Csikszentmihalyi, 2008). In addition, brainwave frequencies (alpha, beta, delta, gamma, and theta) were analyzed to understand the interaction between sound and creativity scores.

Initial findings show changes in creativity scores associated with different acoustic stimuli, and significant changes in alpha, beta, and gamma brainwave amplitudes during creative tasks versus inter-test intervals. These data suggest that face-to-face interaction, conversation and acoustic interruption may disrupt the the creative process. The experiment's progress and findings will add to the conversation of the impact and evolution of the open office workplace.

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3. AUTHOR BIOS

Eve Edelstein, Fellow of the American Academy of Audiology, is Research Director of the Human Experience (HxLab), and the BioAcoustic Neuro Group (BANG) of the Gadget Lab at Perkins+Will. Dr. Edelstein is faculty and participates with the Center for Healthy Environments at the NewSchool of Architecture & Design in San Diego, and leads the Design Health CoLab, part of the AIA Design + Health Research Consortium. Eve works with ANFA and NSAD to develop the Neuroscience for Architecture curriculum. With the University of California, San Diego Eve created novel virtual visual and sonic simulations that synchronously measure the consequence of design on EEG and human outcomes. Eve's neurophysiological research and clinical practice applied novel intracellular, in-vivo, and clinical electrophysiologic techniques to diagnostic assessment of auditory and vestibular disorders of central and peripheral origin in adults and children. With degrees in neuroscience (Ph.D. Institute for Neurology, University College London), Anthropology (UC Berkeley) and Architecture (NewSchool of Architecture & Design), Eve now translates clinical and neuroscientific research into brain-based principles for design in all building types and scales, from rooms to regions, and including workplace, healthcare, educational, science and technology facilities.

Throughout his professional and academic careers, **Luke Laverty** has focused on psychological interaction and the exploitation of technology to create progressive environments and experiences. His design passion is performance—in both human and environmentally-sustainable terms. In "Immersive Environments," his thesis explored 'flow'—the trance when one is so mentally absorbed with the current activity that the boundary between environment and inhabitant becomes transparent—and how sound can blur the inhabitants with their surroundings. Awarded a Perkins+Will Innovation Incubator grant, Luke uses psychometric and EEG brainwave sensors to explore the impact of environmental features on creativity and flow in workplace and other built settings. Luke's award-winning theoretical work was featured in the 2013 American Institute of Architects Center for Emerging Professionals Annual Exhibition. Luke holds a BS degree in Architectural Studies from the University of Wisconsin-Milwaukee and a Master of Architecture from the University of Cincinnati.

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ASI – Architecture for Sensory Integration; Architectural Intervention in Occupational Therapy

Fallon Lebedowicz, Gina Chang, AIA, EDAC
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I. EXTENDED ABSTRACT

This research proposes the use of architectural intervention in Sensory-Integration (SI) clinics to facilitate the environment in which SI therapy is conducted, so that the clinics respond to the unique nature of their users and are more conducive to successful treatment. Generally speaking, SI therapy requires very controlled environments to be effective, but many clinics providing this therapy are not designed to facilitate the required treatment. This paper will discuss how architectural design can meaningfully improve treatment results, by making more careful decisions with respect to the therapy space.

__Sensory Processing – In General.__ Sensory processing is easy to define conceptually, but hard to describe. It is often defined as the organization of sensory input (Ayres, 2005). Our senses help us differentiate between positive and negative environmental stimuli by processing sensory cues and utilizing motor skills. Some people, however, cannot accurately integrate information from their senses and are inundated by their experiences, creating sensory-processing disorders (SPD) that impact day-to-day functioning severely. These disorders can affect anyone, but most frequently affect children. Occupational therapists, physical therapists, and speech pathologists often treat SPDs in SI clinics that aim to isolate sense-specific stimuli in what is referred to as SI therapy. This therapy requires a controlled environment that can cater to each patient's individual needs.
Despite ongoing research in SI therapy, clinics continue to suffer from a lack of mindful design. One consequence is that extraneous stimuli (e.g., street noise, harsh fluorescent lights) obscure the goal of focusing on a patient's controlled senses. The most obvious solution to this problem is to eliminate excess stimuli. This may be as simple as turning off a light, or providing a "quiet" area with adequate sound insulation. But what happens when you turn off a light yet there is still a strong glare shining through a skylight window, or the "quiet" space is adjacent to a street where ambulance sirens and truck horns blare incessantly? Simple solutions become less useful if the space doesn't accommodate varying degrees of sensitivity.

__Intelligent Architectural Design for SI Clinics.__
Understand the Disorders and Treatment. The first step in creating a successful SI clinic is to understand the disorder, analyze the methods of therapy, and then carefully plan a space that addresses both. Since no two people exhibit sensory disorders in the same way, any clinical space must be flexible enough to cater to a spectrum of sensitives at any given time.

The Seven Senses. SI Therapy deals with the seven major senses of the human body: auditory (hearing), visual (sight), tactile (touch), olfactory (smell), gustatory (taste), proprioceptive (muscle/joints), and vestibular (gravity/movement).The vestibular and proprioceptive senses are unique in their complexity in that they communicate with each other and involve other senses.

Over and Under-stimulation. Any disorder in the senses can usually be categorized as "hypo" or "hyper," hypo being under stimulated and hyper being overstimulated.

Children Affected. Children are most often diagnosed with SPDs because symptoms occur between the ages of 0-7. SPDs are often co-morbid and occur with other disorders such as ADHD, Asperger's, Fragile X Syndrome, and most commonly Autism. As a result, SPDs are difficult to diagnose definitively and to treat. Each child presents their own unique set of sensory input which forces therapist to be flexible in their approach to practice as they adapt to every child's specific need.

Hypo -Proprioceptive
Have a high tolerance to stimulation, have difficulty relating to space. Often seek repetitive movements, spinning, rocking, banging into things, etc.

Hypo -Vestibular
Often thrill seekers, constantly moving, poor balance, hyperactive.

Hyper -Proprioceptive
difficulty processing information from joints and muscles, unaware of their own strength, clumsy.

Hyper -Vestibular
Deals primarily with balance, individual may have blurry vision, a regular feeling of vertigo, disorientation,

Figure 1- Characteristics of Hypo and Hyper Proprioceptive and Vestibular Disorders

__Research on Architectural Design and SI Clinics.__ Due to the unique nature of SI disorders and limited resources regarding SI clinics, qualitative research was used to acquire a critical mass of information to inform a basis of design for architecturally programming SI clinics. The objective was to develop an architectural guideline for SI clinics catering to children ages 0-16. The research was conducted by visiting a number of SI clinics in Los Angeles, creating observation reports, conducting interviews, and taking surveys. By applying this research to architectural design, strategic interventions can be made to a typical SI clinic to address both the needs of the patient and the therapist, while addressing the nuances of sensory stimulation.

__Design Criteria and Proposed Solutions__
SI therapy focuses primarily on motor skills, which requires specialized gross and fine motor gyms and unique learning environments. Most SI clinics were found to only have one or two standalone gyms. However based on observations, the clinical setting benefited most from flexibility and variety which was difficult to achieve in limited space. The proposed alternative is to design a clinic that has a multiple number of gyms varying in size and function. These gyms should be interconnected as opposed to independent of each other to maximize flexibility while providing a multitude of environments that can be easily traversed or isolated. In this case, gyms should be programmed according to the hypo and hyper sensitive child, and provide a variety of small pocket sensory spaces that can facilitate these users in addition to the larger gym spaces. With the gym as the primary space of the clinic it provides the foundation for which the remaining program can support, such as offices, waiting rooms, observations spaces, etc. In doing so, the hierarchy of programming is established to delineate the circulation of the occupants within the facility and ease wayfinding. Once these basic parameters are set, a more acute analysis can be applied to the materials, lighting, acoustics, olfactory sensations, etc. of these specialized spaces. However, without creating a symbiotic relationship between designated sensory zones one space can easily negate the other by causing sensory disruptions.

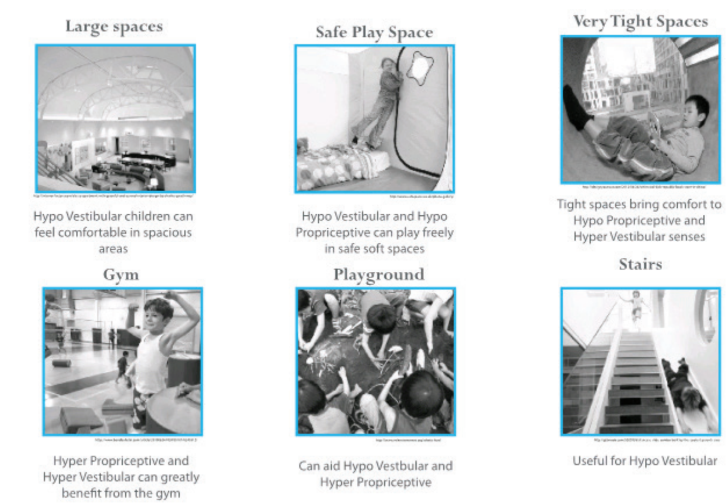

Figure 2- Examples of space types for proprioceptive and vestibular therapy

__Conclusion.__
Since SI therapy relies on controlling environmental stimuli to isolate specific senses, architecture and interior design can have a direct impact on success during treatment. Architects, researchers, and physicians must work together closely in planning these environmentally-sensitive clinics. By implementing these basic parameters we can further discover the impact of architectural design and the relationship to sensory processing therapy.

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Fallon currently works at CO Architects as a project coordinator for the design and construction of the new Outpatient Pavilion at the Health Sciences Campus at UCSD. She continues to pursue her passion for clinical design and hopes to further the link between architecture and sensory processing with evidence based research.

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Gina Chang is an associate principal with CO Architects, where she has served as project manager, healthcare architect and medical planner on complex projects with ambitious goals. With over 15 years of experience, she has planned and managed projects for UC San Diego Health, Kaiser Permanente, Palomar Health and St. Joseph Health in California. Gina is a strong advocate for evidencebased design and sees the opportunity to create a unique environment for healing and wellness in each project.

Age-related Cognitive Decline and Enriched Environments Examining Real-time Psycho-spatial Dynamics Using Virtual Reality

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1. EXTENDED ABSTRACT

Human life is embedded in physical space, which is increasingly a built environment. Environment can challenge human performance when insufficient lighting or obstacles increase risk of falls in older adults. Conversely, environment can empower people, fostering creativity and well-being by extending people's cognitive and physical abilities (Malinin, 2016). Bi-directional space-individual interaction, therefore, involves integration of physical, cognitive, and emotional cue by the nervous system. Our interdisciplinary research examines relationships between spatial designs and cognitive and brain health in aging.

Maintaining and enhancing cognitive performance in the face of age-related declines is one of the top priorities in our aging society. Demographic studies show adults leading active lifestyles, through exercise or unstructured activities like gardening, dancing, or walking, score higher on cognitive tests than sedentary peers (Blazer et al., 2015; Bherer et al., 2015, Hertzog et al., 2008). Physically active older adults have 'younger' looking brains; those who engage more often in higher intensity physical activity have less age-related lesions in their white matter and adults who spend less time sitting have greater integrity of white matter near the hippocampus (Burzynska et al., 2014). Research also suggests physical activity and exercise improve brain health even when started later in life (Burzynska et al., 2015). We consider how environments for aging may be enriched to promote user physical and cognitive activity through novelty, challenge, and engagement.

We examine impacts of three environmental conditions (low-sensory, high-sensory, and interactive-stimulating) on arousal, activity, and memory. Virtual reality (VR), our chosen testing environment, provides high experimental control and ecological validity (Rizzo et al, 2004), allowing generalizations to real-life situations. VR simplifies processes of environmental manipulation and gathering real-time physiological and neurological responses to design features. Our presentation outlines specific hypotheses, related experimental setups, and preliminary results of pilot research. We also discuss opportunities and constraints of using VR with older adults, including feasibility of combining VR with real-time neuroimaging. In conclusion, our interdisciplinary project lays a foundation for systematic study of spatial designs with brain function monitoring, which may result in important guidelines forincreasing physical and cognitive activity through architectural designs.

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3. AUTHOR BIO

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A licensed architect and cognitive scientist, my research is at the intersection of environmental design and brain science. I study how features and attributes of the designed environment (from rooms to cities) affect creative processes and how spatial design can help people make better choices for their health and environmental sustainability. The main focus of my work is to better understand how people think-in-action. I examine psycho-spatial dynamics – intertwined (e.g., bi-directional) process of thinking and doing –and how cognition emerges from interactions with physical artifacts in the world. This stream of research is informed by knowledge from psychology (emobided, embedded, and enactive cognition) and neuroscience and shaped by 25 years of practice in architectural design and education. I am driven by questions of how designed environments can support human creativity and wellbeing and what are the physically situated processes involved in creative decision-making. My recent publications include topics in design and creativity theory, workplace creativity, and reconceptualizing designs for learning spaces and healthcare settings.

Agnieszka (Aga) Burzynska, Ph.D.

As a neuroscientist and psychologist, I study the mechanisms of decline, maintenance, and plasticity of cognition, brain structure, and function during the adult lifespan. I focus on assessing the effects of lifestyle interventions (randomized longitudinal control trials with exercise, dance, nutrition) on brain integrity, cognition, and everyday performance. I employ multiple magnetic resonance (MR) neuroimaging techniques to measure white matter integrity (diffusion imaging, T2 imaging, and MR elastography), brain volume, as well as spontaneous and invoked brain activity (resting state and task-related functional MRI) along with behavioral measurement of cognitive process. My main focus is on the relationships between physical fitness, physical activity and the brain and cognitive health. I am interested in studying both typical low fit and low active aging populations, as well as exceptionally fit and well functioning older adults; for example, we studied teh brain of Olga Kotelko, nonagenarian athletehttp://well.blogs.nytimes.com/2015/09/02/physed-4/?_r=0. With my collaborators we are one of the first to use objective measures of physical activity in combination with neuroimaging. A related area of my research focuses on the effects of long-term training on the brain, such as in professional dancers.

Designing for Complex, Interactive Architectural Ecosystems Developing the Ecological Niche Construction Design Checklist

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1. EXTENDED ABSTRACT

This paper presents the rationale for and ongoing development of The Ecological Niche Construction Design Checklist[1], a designer's/ researcher's checklist for assessing the usefulness of potential environmental design features on cognitive and task performance during the conceptual phase of environmental design. The rationale for developing such a tool stems from a comparative integration of concepts from ecological niche construction[2], systems science[3], embodied cognition theories of mind[4,5], and Kirsh's writings on pragmatic action[6], activity space[7,8], and performance design[9]. The checklist is developed and tested via three case studies that entail designing interactive building environments. This mixed methods case study research is organized and evaluated using the Design Science Research Method[9] and the Validation Square research method[10]. Findings, lessons learned, and next steps are discussed, especially the strengths, weaknesses, and likely preferred use cases for such a method and tool.

This research contributes to the fields of architecture and neuroscience by: (a) developing a designer's method and tool that represents possible impacts on cognition of environmental features during early conceptual design; (b) demonstrating a research framework for specifying, developing, and evaluating a cognitive method and tool; (c) and addressing a significant, emerging set of design challenges. These emerging design challenges entail degrees of complexity and interactivity that make them orders of magnitude more difficult to represent during design than traditional static environmental design challenges.

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Joe's goal is improving the capacity of the built environment to enhance human health, well-being, and cognition. He develops representational schemas, design methods, and tools for representing and analyzing the impact of potential environmental design features on user cognitive and task performance. His work engages the following frameworks: complex and dynamical systems science, embodied cognition theories of mind, Edelman's Theory of Neuronal Group Selection, Kirsh's concepts of epistemic and pragmatic action and activity space and performance design, Chua's theory of a cognitive dynamical system, cognitive task analysis, socio-technical systems, cyber-physical systems, ultra-large scale systems, ecological niche construction, neural networks, graph theory, and symmetry breaking. Joe's background includes: architecture, cognitive psychology, human factors, information architecture, and sustainability.

Effect of Experience on Wayfinding in a Large, Complex Environment

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1. EXTENDED ABSTRACT

This presentation will provide a review of the literature on wayfinding in large, complex, multi-level facilities and will describe a correlational research study that assessed the wayfinding performance of twelve subject matter experts (patient transport personnel) of varying experience in a 1.8 million square foot, complex, regional hospital facility. This presentation will also present and discuss possible underlying cognitive and perceptual mechanisms that may contribute to how humans encode spatial and navigational knowledge [1, 2, 3, 4, 5, 6, 7, 8].

This correlational study uses a mapping task, a pointing task, and a route diagramming task in order to assess participants' survey knowledge and procedural knowledge. This study presents a unique contribution to the fields of architecture and neuroscience because of its assessment of performance of patient transport personnel in a large, regional hospital. One limitation of existing studies is that few utilize a facility of the scale or complexity of a large, regional hospital. Another limitation of existing studies is that most participants were unfamiliar with the facilities used prior to participating in the studies. Of the participants who were familiar with the facilities used in the studies prior to participating, most had a few days to a week's worth of exposure. In only one study did the 'familiar' participants have 1-2 years of exposure to a facility. But even in that case, the extent of their exposure to the entire facility (as opposed to their assigned area) was unclear. Conversely, the present study uses wayfinding subject matter experts (patient transport personnel) with full-time, daily wayfinding experience throughout their respective facility ranging from 4 months to 8 years.

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Robin Farr
Robin is the Supervisor of Patient Transport at Greenville Memorial Hospital, part of Greenville Health System, in Greenville, South Carolina.

Johnell Brooks, Ph.D.
Johnell is a Human Factors Psychologist who develops driving simulators that are used as rehabilitation and training tools for clinical settings and classrooms for diverse patient populations ranging from seniors to wounded warriors to young adults on the Autism Spectrum Disorder. She is also part of the Deep Orange program which immerses graduate automotive engineering students into the world of a future OEM and/or supplier. Working collaboratively, students, multidisciplinary faculty, and participating industry partners focus on producing a new vehicle prototype each year.

Lee Gugerty, Ph.D.
Lee is a professor of psychology with research interests in causal reasoning and critical thinking, attention during realtime tasks and spatial cognition. He is also coordinator of the PhD program in Human Factors Psychology at Clemson University.

The Making of a Place – the Courtyard: An Architectural Typology that Simultaneously Enables Safe Social Aggregation and Reconnection to Nature

Ilaria Mazzoleni
Founder, im studio mi/la

Richard Molina
im studio mi/la

1. EXTENDED ABSTRACT

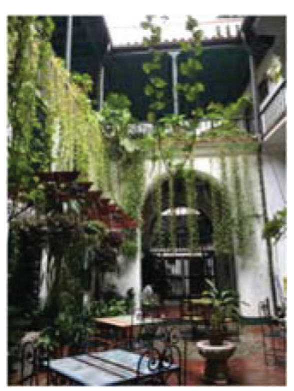
The courtyard, an architectural space and outdoor place, enables the human desire for social aggregation in a protected environment as well as facilitates our biophilic* call to be in nature.

The courtyard brings a sliver of nature within the confines of a building or home. It is a protected quarter, thus safe, exposed to the elements and serves many functions. The perimeter walls of the building guard social gatherings, while allowing nature to filter through it seamlessly, and the outdoors to penetrate effortlessly, sustaining and enhancing our biophilic reconnection to nature.

In our work the inclusion in the design of courtyards - be it a single-family house with an open area (fig. 3), a condominium with a communal patio (fig. 2), or a city block such as the one we see in Barcelona's plan Cerda' (fig. 4) - provide significant architectural cues on how to articulate, distribute, and organize the enclosed spaces surrounding them. We design the framing of nature and enhance the connection with nature and its biodiversity by means of volumetric articulation and the use of apertures – i.e. windows and openings. Southern California's modern tradition of architecture in contact with the outdoors (fig. 5) provides a fertile ground for case studies and speculative conversations about contemporary architecture and its quest for sustainability.

By presenting case studies of courtyards from our work, as well as historical and contemporary projects by others (fig. 1-6), we will extrapolate degrees of successful architectural connection with the outdoors, as places for aggregation and connection with multiple life forms.

The aim is to ignite a conversation and spark possible future collaborative research with regards to the neurological response to the social aggregation and biophilic reconnection with nature in an eco-logic vision in which humankind is part of all living organisms (fig. 7). By strengthening buildings' relationship between the indoors and outdoors spaces in our cities, the aim is to improve: human comfort, our coexistence with nature, and to amplify our awareness of the environmental crisis induced by human kind; thus prompting a shift towards its resolution. This goal is best achieved with an understanding of the neurological factors that attend this state of the mind in its relationship with the built and unbuilt environment.



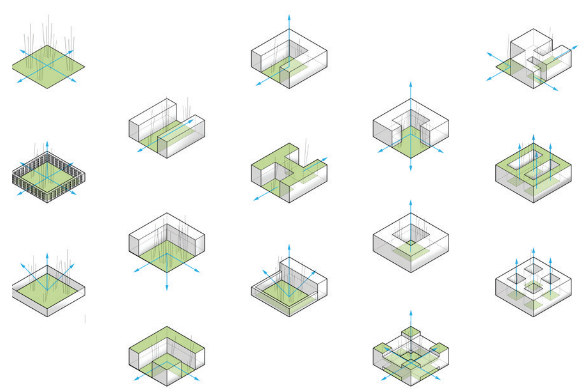


Fig. 1 - Court of La Acequia. Palacio de Generalife, Alhambra, Granada, 1309. Historic example of Arabic courtyard house where the water is used as a mechanism for evaporative cooling, and it facilitates cross ventilation. (Photograph courtesy of L. Pretorius)

Fig. 2 – Courtyard in Colonial House, La Habana Cuba. Nature's presence harmonically coexists with the public function of this building now restaurant. Its presence provides a biophilic sense of place within the city center.

Fig. 3 - Study of courtyard typology for public spaces: from enclosed to fully open and connected w/ outdoors. Levels of safety: perceived or real vary. (im studio mi/la)

Fig. 4 - Plan cerda' – a.&b. original scheme – open spaces within the block. c. later occupied by different functions, limiting or eliminating the connection with nature.
b - http://www.failedarchitecture.com/behind-four-walls-barcelonas-lost-utopia/
c - http://www.lemaitredelolympe.com/phpBB3/viewtopic.php?f=1&t=3734

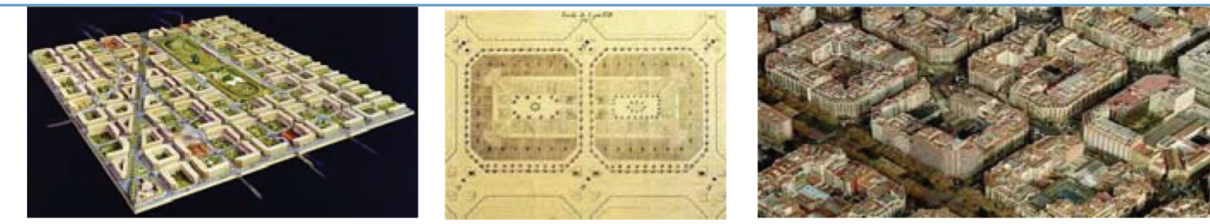
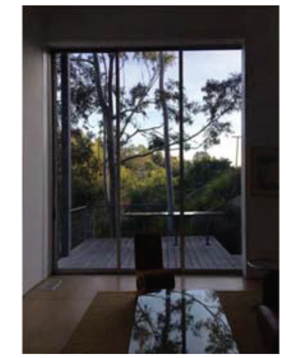
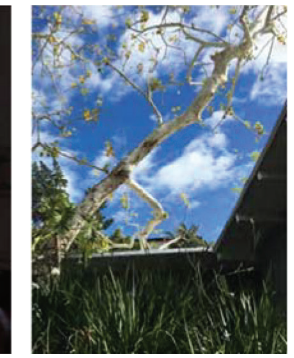
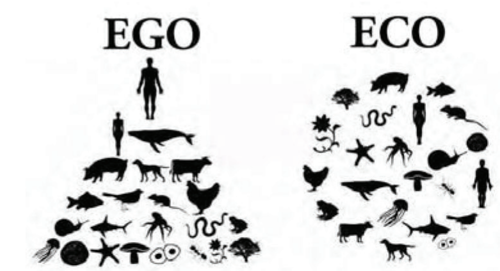


Fig. 5 - AGPS house – the indoor-outdoor-indoor connection with nature using large glass openings. Hollywood Hills, Los Angeles. The modern tradition in SoCal architecture, also a mechanism to frame nature.
Fig. 6 – Modern Courtyard house in the Hollywood Hills with lush vegetation and the typical blue sky of SoCal.
Fig. 7 – EGO-ECO, social-ecological (robust) system. Humans and nature are strongly coupled - Not in a pyramidal structure but in an ecosystem-like one.







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3. AUTHOR BIO

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Special thanks to Neuroscientist Walid Soussou, PhD for his contributions and insights.

The Impact of Biomorphic Design on the Memorability of Interior Environments A Preliminary Study

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I. EXTENDED ABSTRACT

This preliminary study tests three hypotheses that address these conference themes: the relationship between spaces and memory, as well as emotion, empathy and neuroesthetics in the built environment. The first hypothesis is that images of environments primarily containing elements of biomorphic architectural design are more intrinsically memorable than images of environments that primarily contain elements of formal rectilinear minimalist design. The second is that architectural design elements are expected to impact intrinsic memorability through their effect on participants' feeling of pleasantness. It is also expected that as visual attention to the architectural design elements increases, the intrinsic memorability of those architectural elements also increases.

To explore these hypotheses, this study compares the memorability of interior environments that are designed using a biomorphic design approach, inspired from organic shapes and forms (Kellert et.al, 2008), with interior environments designed using a formal rectilinear minimalist design approach, characterized as simplified designs with "rectilinear" forms, the use of boxes, and the rejection of ornament and decoration. This study measures three things and assesses them using linear-regression and signal detection analysis. First, it measures intrinsic memorability of designed environments, using a cognitive memory task to see which types of design images are more memorable. Second, it measures participants' points of view, using a Likert Scale questionnaire, to assess participants' emotional responses to biomorphic design and formal rectilinear minimalist design. Third, it measures participants' visual attention, using eye tracking technology, to identify which specific design elements the participants are? looking at.

Intrinsic memorability describes how much a visual stimulus can be remembered regardless of the individual differences between observers (Bainbridge, 2013). In this study, the intrinsic memorability of designed environments will be operationalized through displaying images from interior environments. It has been shown that some images are consistently more remembered or forgotten than others (Isola et al., 2011); there is something intrinsic about the content of an image or photograph that increases or decreases its memorability. Theoretical studies have attempted to explain the biological significance of how biomorphic design positively impacts human recognition and memory (e.g. Feuerstein, 2001 and Joye, 2007). Considering human environmental cognition process, factors that influence intrinsic memorability of designed environments include the aesthetic and preference aspects of environmental design, as well as the contribution of visual attention in perceptions of place.

If the findings of this preliminary study show that biomorphic design positively impacts intrinsic memorability of designed environments more than formal rectilinear minimalist design, this suggests that a biomorphic design approach leads to more memorable environments. This methodology can be applied to similar questions, such as clients' preferences for design elements, differences between demographic groups, or wayfinding cues.

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Atmosphere, wellbeing and health in residential architecture: linkages to neuroscience?

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1. EXTENDED ABSTRACT

The aim of this case study is to explore and illuminate connections between residential architecture, well-being and health, in a small residential area, in Sweden. We have conducted deep interviews with residents in order to analyze connections between architecture wellbeing and health. Perceived quality of architecture will be investigated using the structure developed by a semantic concept analysis of atmosphere as well as additional attributes defining residential architectural quality (Nylander 1998). Findings will be compared to neuroscientific knowledge about perception and spatial orientation (Sternberg, Wilson 2006). The results aim to contribute to a better understanding of the connections between residential architecture, atmosphere, wellbeing and health with an ambition to further explore the linkages between neuroscience and the experience of architecture (Tidwell, Arbib 2013). This knowledge would be applied in future residential architecture design processes.

Research within healthcare architecture has indicated a relation between built environmental design and healing capacities (Sternberg 2009, Ulrich 1984). However, we still need to explore how residential architecture influence our wellbeing, in light of the growing knowledge of how spaces influence our emotions and physical reactions (Sternberg 2009). This case study recognizes this need, and investigates the architecture of the home and how it affects the residents´ sense of wellbeing and health.

We use the concept of atmosphere, which has been proposed as a way to describe architectural quality (Pallasmaa, Havik et al 2014, Zumthor 2006). In a previous study, this concept was adopted to perform a semantic concept analysis and the results from that analysis form the theoretical basis of this investigation. In addition, we take a standpoint in previous research that presents attributes significant for our perception of residential architecture: Materials and detailing, Axiality, Enclosure, Movement, Spatial figure, Daylight and Organization of spaces (Nylander 1998).

Furthermore we recognize the growing body of knowledge within neuroscience concerning attributes significant for our perception, and neuroscientific knowledge about "perception and spatial orientation and [...] physiological, cognitive and emotional effects" (Sternberg, Wilson 2006).

The aim of this case study is to explore and illuminate connections between residential architecture, well-being and health, in a small residential area, in Sweden. We have conducted deep interviews with residents in order to explore and analyze connections between architecture wellbeing and health. Perceived quality of architecture will be investigated using the structure developed by a semantic concept analysis of atmosphere and the additional attributes described above. Findings will be compared to neuroscientific knowledge about perception and spatial orientation (Sternberg, Wilson 2006). Health and wellbeing as perceived by the participants will be investigated by using the WHO definition of health (1948).

The results aim to contribute to a better understanding of the connections between residential architecture, atmosphere, wellbeing and health with an ambition to further explore the linkages between neuroscience and the experience of architecture (Tidwell, Arbib 2013). This knowledge would be applied in future residential architecture design processes.

Keywords: atmosphere, neuroscience, residential architecture, wellbeing & health

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Facades of building significantly modulate EEG signals of brain cortical lobes

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

1. EXTENDED ABSTRACT

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

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3. AUTHOR BIO

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

HXS: A journey of an architecture firm to create a human experience lab in the hub of architectural practice

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

I. EXTENDED ABSTRACT

The relationship between architecture, perception and brain behavior is no longer in debate (Eberhard, 2008; Arbeib, 2012). What remains a challenge is investigating these relationships, outside of academia, in the hub of architectural practice. Within the scope of practice it can be a challenge to do deep dive, generalizable research with strictly controlled conditions. What practice can, however, serve as, is a test bed for experiments within the scope of real projects, that are pilots for more systematic investigations with academic/industry partners. It can also serve as a testing ground for research that has been established in academic settings but not applied in practice.

It is with this thought that HKS, a global architecture firm, has invested in a new 200 sq ft space for rapid prototyping, sensor-based assessments, and simulations. The concept of the lab/studio has evolved over a couple of years through a series of internal experiments including:

Experiment Lvl 1: Using full scale mock-ups to get user feedback to 3-D built form prior to design. Using Full Scale Mock ups to simulate physical space and behavior scenarios to change space layout.

Experiment Lvl 2: Merging human activity data into a sequence simulation tool. Using data from field research to inform parametric planning tools that are integrated into revit platforms.

Experiment Lvl 3: Using EEG signals to manipulate physical form. Utilizing commercially available EEG hardware and building a custom interface for it with CAD software, exploring the possibilities of manipulating a digital models based on thought input.

Experiment Lvl 4: Developing a prototype for a sensory Design Lab. Tracking human responses to environmental changes in real time with continuously monitored environmental and physiological outcomes.

The idea for a physical space, a hybrid lab/studio emerged through a need to create tangible, physical, three dimensional environments which we can test with evolved sensor technology. Three critical components were initially identified:

1. **Think Space:** A space where designers and researchers can come together and ideate on exploration and innovation.
2. **Make Space:** A space where designers can create three dimensional realities based on dialogues with research teams
3. **Test Space:** A space where researchers can test the efficacy of design solutions to inform new iterations

In practice- the three spaces may overlap, just as the role of the designer and researcher may merge. However, the science of systematic inquiry must be balanced with the art of creative thinking – so where do the two meet? We will explore this question with the audience. We will also honestly share the challenges we have gone through in the creation of such a space including:

1. Framework Flexibility
2. Cost vs. Value
3. Sound proofing
4. Building walls vs. leaving open spaces
5. Understanding scale of relevance for VR- from oculus rift to full 3D immersion.

We would like to use the session to have an open dialogue with the academic and industry partners in the room to discuss how a research based "studio" can be created- one that puts human experience and response at the center- and crafts environmental and spatial scenarios around it, positioned to test a dynamic boundary between biometrics and parametrics. We also seek to understand how a lab like this, situated as it is in practice, with a "test sample" of 500+ architects/designers can benefit ongoing studies in the academic community. Our intent is to step outside inward looking investigations to creating bridges to path-breaking discoveries and innovations so we can be both test bed, and agent, for change.

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3. AUTHOR BIO

Dr. Upali Nanda is the firm wide director for research for HKS and the executive-director for HKS supported non-profit Center for Advanced Design Research and Evaluation.

Jennifer Kolstad is the firm wide director of interior architecture for HKS. Her role is to bridge architecture and interiors to elevate design across sectors.

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Jon Bailey is a designer and researcher in the HKS LINE (Laboratory for INtensive Exploration) studio where he focuses on advanced modeling techniques, robotic fabrication, parametric and algorithmic modeling, architectural theory, and data driven performance modeling in architectural design.

Awe-Inducing Interior Space: Architectural Causes and Cognitive Effects

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1. EXTENDED ABSTRACT

Recent work applying a Darwinian perspective to religious monumental architecture (RMA) has argued that by eliciting awe, churches and other RMA structures foster religious openness and facilitate social cohesion (Joye & Verpooten, 2013). Other recent work has found that feeling awe increases both belief in supernatural control (Valdesolo & Graham, 2014) and spiritual intention among people who are religious or spiritual (Van Cappellen & Saroglou, 2012). These findings led us to ask whether religious building designs might capitalize on such effects to promote or facilitate religious feeling. In order to elucidate how church interiors elicit awe and otherwise shape affective and cognitive processes, we investigated how built spaces induce awe. Specifically, we developed a rating scale for the measurement of physical properties of interior spaces in order to determine which architectural properties in an interior space can predict a sense of awe (Study 1). The scale was used to measure 24 architectural properties of 60 different interior spaces. Participants then viewed these 60 pre-rated images and reported their affective response to each. Their emotion ratings showed a predictive relationship between architectural properties and elicited emotion. Properties reflecting size, age, contour, and ornament significantly predicted a feeling of awe. The results from Study 1 guided the selection of stimuli for Study 2, in which we explored the effects of visually priming participants with photographs of high and low awe-inducing architectural interiors on time perception and spirituality, as well as the effects of priming participants with photographs of religious and non-religious building interiors on participant religiousness. Feeling awe led to an overestimation of time in a time-estimation task, confirming earlier findings that feeling awe expands one's sense of time (Rudd, Vohs, & Aaker, 2012). This work establishes an initial understanding of cognitive processes underlying affective and social responses to the environmental cues of church interiors.

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Van Cappellen, P., & Saroglou, V. (2012) Awe activates religious and spiritual feelings and behavioral intentions. Psychology of Religion and Spirituality, 4(3), 223-236.

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Hanna Negami is a doctoral candidate in cognitive neuroscience in the Department of Psychology at the University of Waterloo, and is a member of Dr. Ellard's Urban Realities Lab. Her research focuses on how the aesthetics of our immediate environment shapes our cognition and behavior. In addition to researching awe as induced by built environments, she also explores, from a cognitive perspective, how people perceive and interact with public and private spaces.

Colin Ellard is a cognitive neuroscientist in the Department of Psychology at the University of Waterloo, and the director of its Urban Realities Laboratory, which focuses on research at the intersection of experimental psychology and architectural and urban design. Ellard conducts research on the human response to built spaces both using simulations in immersive virtual reality and in real settings using field methods. In both streams of his research, Ellard combines traditional psychological methods with data from psychophysiological sensors to develop rich characterizations of the interplay between an individual and their surroundings. In addition to his basic research, which he has published in peer-reviewed journals for 30 years, Ellard contributes to the public discussion of urban and architectural design through his work with museums and the media, and through his books aimed at a general audience (You Are Here, Doubleday, 2009; Places of the Heart, Bellevue Literary Press, 2015).

Eye Tracking Architecture: A Pilot Study of Buildings in Boston

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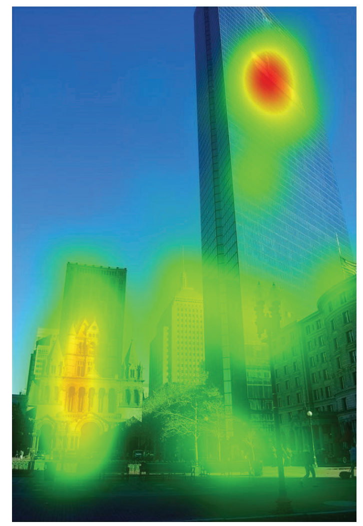
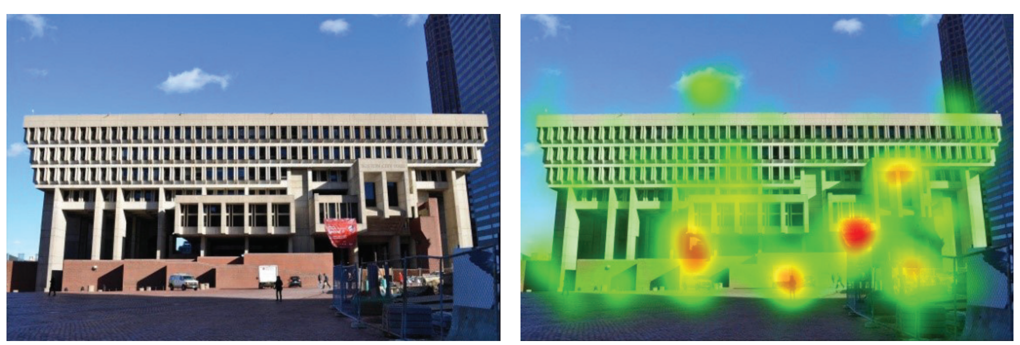
I. EXTENDED ABSTRACT

We performed this study to better understand how people see their world and answer a key question: would eye tracking, a method used in cognitive science, be a useful addition to an architect's toolkit? What might it tell practitioners and students that is otherwise overlooked? How easy is it to do?



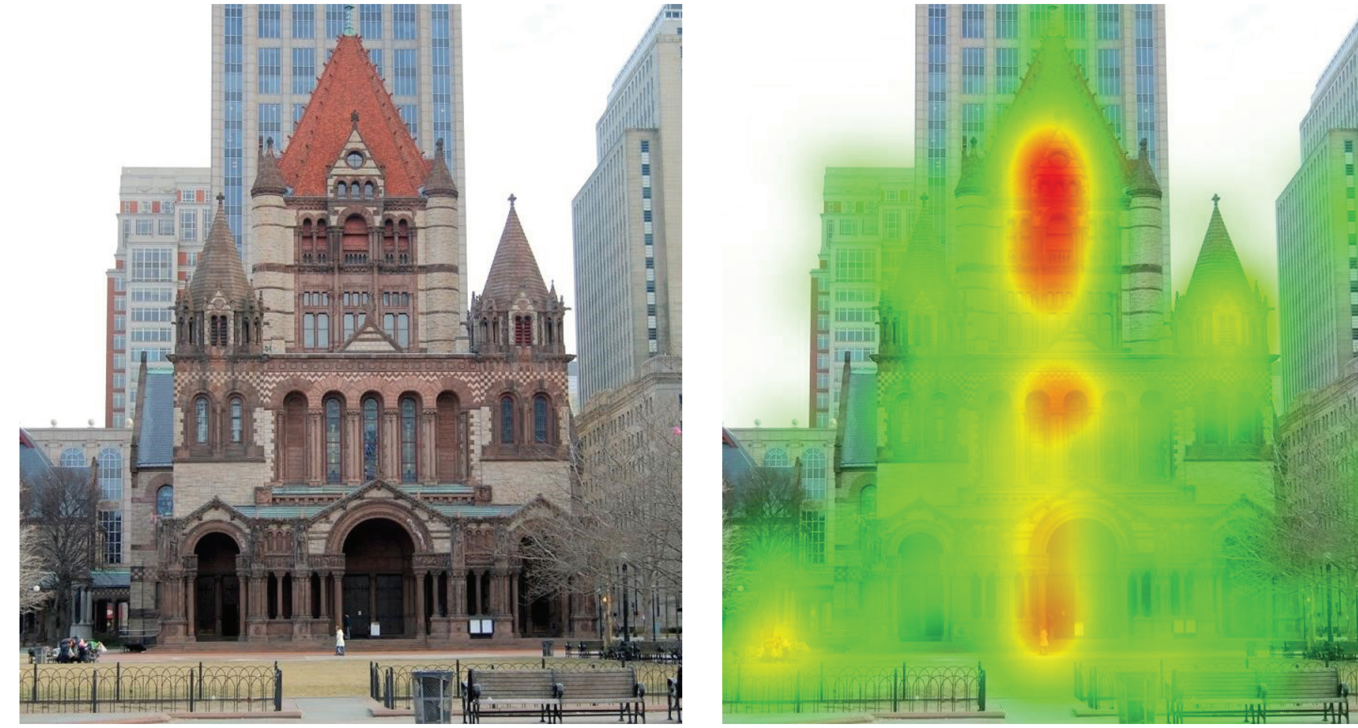
In a collaboration between architecture, interior design, and cognitive science, we conducted an eye tracking study at the Institute for Human Centered Design, a non-profit in Boston. Our thirty-three volunteer viewers, ages 18 to 80 and from various occupations, looked at 60 images on a computer screen for 15 seconds each. Half of the images were photos or renderings of Boston buildings, interiors and exteriors. Remaining images included faces and landscapes. We tracked volunteers' eye motions using an off-the-shelf Eye Tribe eye tracker and iMotions analysis software. Our aggregated data created compelling graphic representations: heat maps and spotlight images which revealed common looking patterns, and videos of individual gaze paths. Other metrics recorded included "Time To First Focus" on an element, and "Revisits": the number of times volunteers looked at the same area.

Results showed how astonishingly human-centric our perception is; no matter the building, viewers tended to seek out people and faces first and focus on them if present. Even architectural renderings with shadow figures of people were viewed differently from those without.



Observations also suggested that each of us looks at the world uniquely, and indicated differences between the way designers and non-designers take in architecture. Similarly, some buildings generated nearly identical looking patterns for all viewers, whereas other buildings did not.

Eye tracking, we found is a fantastic tool for understanding visual aspects of our experience. Our observations reveal potential for more research and applications. Architects can use eye tracking to see through the eyes of non-architects. Communication of design to the public, scholars, students, and clients, can benefit from knowing how viewers look at images and renderings of buildings, for example with and without people. Insights about perception of architecture can also inform teaching of architecture design, theory, history, and criticism.



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Ann Sussman has a long-standing passion for understanding how we connect to the built environment and how buildings influence our bodies, brains, how we think, and even what we think about. An architect, she co-authored Cognitive Architecture, Designing for How We Respond to the Built Environment with Justin B. Hollander.

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[Architecture Without Vision] challenging the societal dependence upon vision in perception

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1. EXTENDED ABSTRACT

Our dependence on vision is crippling our other senses. Are the blind handicapped because they cannot see? Or are we, the sighted, handicapped because our dependency on vision inhibits us from using our other senses in perception? Experiencing architecture is not merely a sighted activity. We inhabit a space with our whole being. As Juhani Pallasmaa states, "The impact of architecture on the human experience is too deeply existentially rooted to be approached solely as an element of visual design.[1]"

Imagine a life where you would need to interpret your surroundings without the thing you depended on most – vision. What is architecture in a world without vision? How can someone move throughout space without seeing it? How might we perceive space if we ignore our dominant visual sense to focus on the other often ignored senses?

We began to address these questions through a literature search, analysis of buildings designed for the visually impaired, and interviews with blind individuals and those who work with the blind. This initial research informed the development of a set of principles for multi-sensorial design of built environments. Space. Edge. Path. Transition. Threshold. Landmark. These design principles are intended to enable people, no matter sighted or blind, to navigate spaces using multi-sensory perception. We tested the viability of these principles through application to the design of a proposed building, a "Creative Co-Lab," in which blind and sighted users would come together on the Baltimore waterfront to create collaboratively and learn about perception without vision.

Further development of this work requires collaboration between neuroscientists and architects. Validation of the design principles could be possible through testing user responses to the various types of architectural interventions. What aspects of brain function are involved in navigating architectural spaces and how does the brain respond to the variety of sensory input involved in the navigation process? What changes when visual stimuli are either augmented or replaced by other sensory inputs? Collaboration between architects and neuroscientists is required to address these questions.

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3. AUTHOR BIO

Betsy Nolen, Associate AIA (speaker)

Betsy Nolen is an Architectural Designer at Beyer Blinder Belle Architects & Planners. She graduated from the University of Maryland with a Masters of Architecture in May 2015, preceded by a Bachelor of Science in Architecture degree completed in May 2013. Her Master's Degree thesis research focused on a way to design architecture that reinforced use of all the senses. This research crossed into varying categories – phenomenology, perception, cognition, and architectural strategies in materials and acoustics.

Madlen Simon, AIA

Madlen Simon is an Associate Professor at the University of Maryland's School of Architecture, Planning, and Preservation and a registered architect. Professor Simon's scholarship, research, and creative practice are in the area of design – design thinking, design process, design education, design of buildings, and the application of design to issues in the area of environment and behavior. Professor Simon supervises graduate student research in this area. One design research track investigates design for disabilities, including visual impairments and autism, which involve differences in sensory perception of the built environment.

Designing Multisensory Therapeutic Environments: Invention in the General Hospital of Chania | Greece

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1. EXTENDED ABSTRACT

The project's objective is the application of innovative design technologies that aim in the amelioration and acceleration of the recovery process of patients at the General Hospital of Chania, Greece. The intervention regards the creation of a therapeutic environment in the recovery room of patients with severe brain injury in the Neurosurgical Clinic of the General Hospital of Chania.

At this stage, our project has been approved by the Administrative Committee of the hospital and we are proceeding with the intervention part.

Theoretical background

Previous research has shown that the environment in typical hospitals may impede or delay significantly the therapeutic outcomes and the patient's well being because of the exposure to stressful conditions, the lack of stimuli and isolation. However, elements like e.g. views of nature and other spatial stimuli could greatly improve the recovery process (Ulrich, 1992).

Our hypothesis is that at the crucial stage of recovery-restoration after a severe brain injury, and because of brain plasticity, reinforcing mental, physical and psychological health of the patient could be done through enriched environments. The counterbalancing spatial factors could not only surpass the negative environmental conditions but also favor positive experiences and therapeutic results.

Research Innovation

Our multidisciplinary team combines research approaches from different fields like architecture, cognitive neuroscience and computational mechanics in order to introduce a model that will upgrade the therapeutic context of the recovery room of patients with severe brain injury. Our proposal is to design and test an application – structure installed in the recovery room of the patient that will offer multisensory stimuli. The innovation relies on the fact that for the first time a multidisciplinary therapeutic context will be created, that will boost the recovery process through enriched environments.

Structure description

This is an evidence-based design intervention and concerns the design-construction of a structure that will propose varying spatial transformations depending on the activity and needs of the user.

The structure will be adjustable and will surround the patient's bed. Its function will be based on the principles of the Therapeutic Environment Theory. Specifically, a collection of action possibilities will be presented to the patient through multisensory stimuli. An action example that could offer relaxation and better recovery outcomes is the simulation of nature through the use of spatial qualities such as organic geometrical forms, illusions of refuge - prospect and discrete nature sounds. Smooth changes in lighting depending on the time of day could give indications for the patient's disturbed circadian rhythms. Structure transformations could give possibilities of privacy and socializing. The stimuli presented will be personalized depending on the patient's background and preferences, to offer familiarity and positive distraction.

The efficiency indicators of the intervention will be measured through a combination of physiological records, time of recovery, amount of painkiller consumption that will be compared with those of patients that did not receive the intervention.

Epilogue

We collected the elements that were shown to have beneficial effects in previous research and we proceeded by introducing a spatial intervention that will boost the therapeutic psychological and physical outcomes of a patient at the recovery room of the Neurosurgical Clinic of the General Hospital of Chania. Our aim is to create a structure – prototype that could be adjustable to fit in every hospital. This structure changes the phenomenological meaning of the environment, from a strict Cartesian model to a more dynamic one that immerses the user by proposing multisensorial therapeutic atmospheres.

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Neuroscience Research of Design Features in Learning Space

Stephanie Park
Gensler

I. EXTENDED ABSTRACT

Today, with ever-growing amount of data from all different types of research available, the field of Architecture is changing in response to the demand for solutions that have meaningful effects on occupants. There are opportunities to utilize and apply data from other fields, such as behavioral and cognitive psychology in a design process. This project strives to understand how neuroscience research can inform the design process in the future, especially in learning spaces, with the attempt to answer the following questions:

- What are the possible environmental features in learning spaces that can help inform the design process, and what types of neuroscience data can be analyzed and applied?
- How will the design process in the field of architecture change as we gain access to information on those features through neuroscience research?

In the analysis, various physical elements in a classroom setting were identified. For each element, existing studies were documented, as well as potential behavioral, cognitive or neurological studies that can be used to inform the design process.

This project was presented at the Miller Gallery at Carnegie Mellon University. At the exhibit, two stations were set up for the users to experience being in a classroom setting from a child's point of view. Each station was equipped with the photo panels and audio files that were retrieved from the Children's school at Carnegie Mellon University to provide a dynamic and enhanced experience.

Use of data in design opens a wide range of questions that make us wonder about the future of design. Discussions about this project at the Miller gallery included interesting future ideas, such as the possibility of incorporating the data in the design softwares such as the existing 3D modeling programs (Revit, Rhino, etc.). Below are some questions that might lead to interesting speculations about using data in design process in the future.

- What will happen to the users when every space is programmed for our brain and body to react a certain way?
- What will happen to the field of architecture as we discover how each of the spatial qualities affects our emotions, thoughts, performance, and actions?
- How will our brains change in response to the change in technology?
- What if we knew exactly what about a space was affecting our thoughts and actions?
- What if the building responded to our feelings or needs in real-time?
- What if we could track a person's state of health, to which the spaces
- responded in real-time?
- What will happen to the users when every space has an expected goal?

It is already established through organizations such as ANFA, that there is a growing interest in using neuroscience data in architecture. With the technology today, the desired knowledge in neuroscience is obtainable, and the research is accessible. However, it is important to imagine how we will apply the knowledge and research into design process. As more possibilities are explored and developed, it will facilitate the communication and translation of the data use to the practical use in architecture.

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3. AUTHOR BIO

The author graduated from Carnegie Mellon University with a dual degree in Architecture and Psychology. As an undergraduate, she has worked with both architecture and cognitive neuroscience faculty to explore ways that design decisions can be informed by neurological and physiological data. She currently works at an architecture firm, Gensler, as an analyst and researcher to apply behavior and spatial research to inform evidence-based design process.

Variation in Intuitive Geometric Construct of Spatial Perception during Navigation

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1. EXTENDED ABSTRACT

1.1. *Background*

Geometry (Stanislas Dehaene 2006) and non-perceptible Euclidean geometry (Veronique Izard 2011) constitute core set of intuitions understanding environments. Psychology researchers identified patterns of comparison and spatial inference in visual problem-solving (Andrew Lovett 2012) (Charles E. Bethel-Fox 1984) which could play key role in spatial perception and navigation. We propose to study how intuitive geometric constructs can enhance human environment interaction by capturing behaviourally relevant aspects. We start from (Peponis J 1997) space partitioning to axial lines, isovists, and (Turner A 2001) isovist of regular tessellation with grid centroids, defining visibility graphs (Batty 2001) to understand how humans can construct space syntax models describing features of spatial relations. Graph-based spatial-mental-representation explains way-finding behaviour, and methods in architecture have gained plausibility by complementing these cognitive methods (Gerald Franz 2005).

1.2. *Methodology / Procedure*

A cohort (N=10) aged 19 years were studied through three experiments. (1) Participants choose from given options that complies an outline shape previously shown, (2) Outline of geometric/freeform shapes are shown to construct shapes within, (3) Similar outline of complex geometric shapes are marked with two points blue (start-point) and green (end-point) and participants construct a path.

1.3. *Outcome / Discussion*

Results: In the first experiment analysis, mode of choice show overall performance of 62% (68%-53%; simple to complex), indicating derived-constructs (Intuitive) vary from constructs through geometric principles (determined-constructs). Subsequent experiment on relations of determined-constructs to derived-constructs shows negative correlation, participants using minimal derived-constructs while opting for determined-constructs and vice-versa. It appears that the participants perhaps divided shapes into parts using nodes, edge and mid-points. In the third experiment (way-finding) the ratio of determined-constructs used is 0.5 that of derived-constructs of which, significant 81% constructs are segments and resultant-references (fusion of derived & determined).

1.4. *Conclusion*

Spatial perception widely varies from simple to complex forms and during navigation features are convoluted. Derived-geometry dominate determined-constructs in simple forms with egocentric behaviour while in complex there seems to be shift towards allocentric, observed in second experiment participants. In third experiment, participants are dominated by egocentric behaviour constructing convoluting features maintaining allocentric using determined-constructs. We also find variation in intuitive geometric constructs of spatial perception through resultant-references during navigation.

Keywords: Intuitive geometric constructs, Human environment interaction, Navigation, Allocentric and Egocentric

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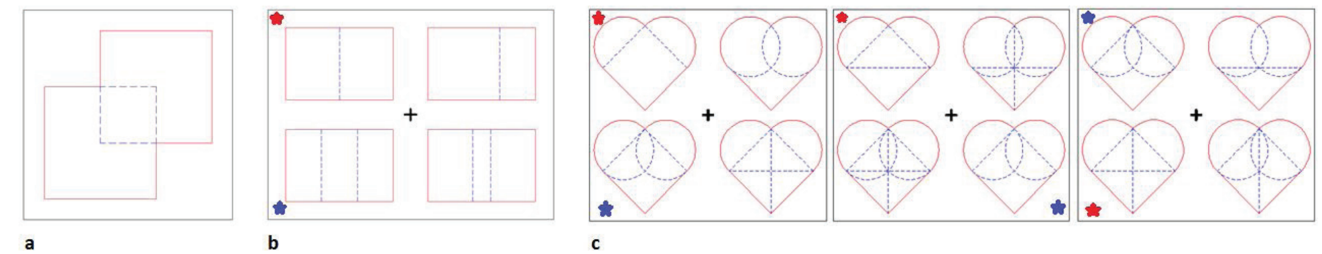

Figure 1: Geometric shapes used in first experiment. Central black cross indicate fixation point. (a) Response of most subjects and complies geometric construct (b & c) Red star is the participants' choice, whereas the blue star is geometric construct.

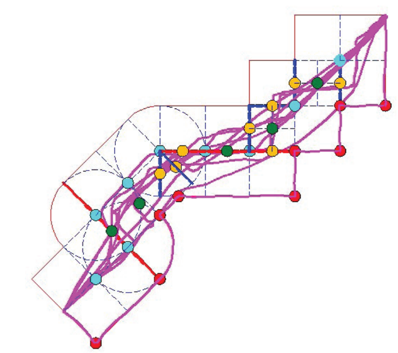

Figure 2: Typical example used in third experiment. Magenta colour lines represent the subject's path. The blue circles are determined constructs, orange - segments of geometric shapes, green - resultant references and red are edges.

3. AUTHOR BIO

Sudhir Kumar Pasala

Faculty in Department of Architecture, Andhra University, Visakhapatnam, India. Research interest is, human performance in built environment applying cognitive neuroscience principles in the areas of working memory, attention and decision making relevant to intelligent spatial design for performing daily activities, in particular navigation.

Mehdi Khamassi

Research scientist at the French National Center for Scientific Research (CNRS) in the Institute of Intelligent Systems and Robotics at Université Pierre et Marie Curie, Paris, France. Research interest is the interface between Neuroscience and Robotics focusing on animals' reinforcement. How the brain efficiently coordinates different learning systems in parallel, with the hippocampus-prefrontal cortex network detecting different states of the world and different performances to adaptively choose appropriate learning system.

V.S. Chandrasekhar Pammi

Centre of Behavioural and Cognitive Sciences (CBCS), University of Allahabad, Allahabad, India worked at several research institutes, viz., Max Plank Institute for Biological Cybernetics, Tuebingen, Germany, Emory University, Atlanta, USA and ATR Labs, Kyoto, Japan on application of functional magnetic resonance imaging (fMRI) technique to understand different cognitive processes. Current research involves investigating interactions of emotion, attention and motivation with the process of decision making and cross-modal skill learning.

ANFA NYC : A Model for Collaborative Neuroarchitecture

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1. EXTENDED ABSTRACT

abstract: Developed as a University of Maryland Masters of Architecture thesis between September 2015 and May 2016, "ANFA NYC: A Model for Collaborative Neuroarchitecture" is a design and research proposal focused on cultivating new means for the collaboration between neuroscience and architecture to occur. The proposal explores and puts forth solutions and methods in two predominant categories: those of the built (architectural) and those of the unbuilt (informational).

built: The hypothetically built portion of the proposal, located on Roosevelt Island in New York City, defines a small complex of three structures designed as a place where architects and neuroscientists can work side by side. These structures include a Neuroarchitecture "incubator" building with shared access to integral neuroimaging facilities, an adjacent private study tower, and the repurposed ruin of a 19th Century Smallpox Hospital. While providing a means for direct interaction between neuroscientists, architects, and the public, each structure applies principles of Neuroarchitecture in its design. Collectively, they generate a rich variety of environments through which Neuroarchitects can conduct research on site. Principles woven into the design of each structure include recent research in Neurogenesis, Chronobiology, Wayfinding, and Empathy, and a new synthesized concept titled "Relation".

unbuilt: The unbuilt portion of the proposal explores three methods concerning the application of Lidar technology to Neuroarchitectural practice. Predominantly used for archaeological and forensics purposes, Lidar instrumentation allows for the rapid collection of data pertaining to an environment's space, materiality, and color. This proposal not only deploys Lidar as a graphic means, but explores the varying implications and data analysis methods for its use in Neuroarchitecture. Results concluded by these methods find the instrument's data to be especially beneficial in the rapid creation of immersive virtual environments used in CAVE systems, an innovation to which is explored in the proposal. More importantly, the study suggests that these spatial analysis methods may allow the development of a more direct working language between neuroscientists and architects: that of data.

In concluding, it becomes evident that a stronger collaboration between neuroscience and architecture can and should be reached in a variety of both built and unbuilt and ways. The results, however simplified, however intuitively obvious, may help achieve a profession, society, and legislation that more effectively understands, simply put, how we should build.

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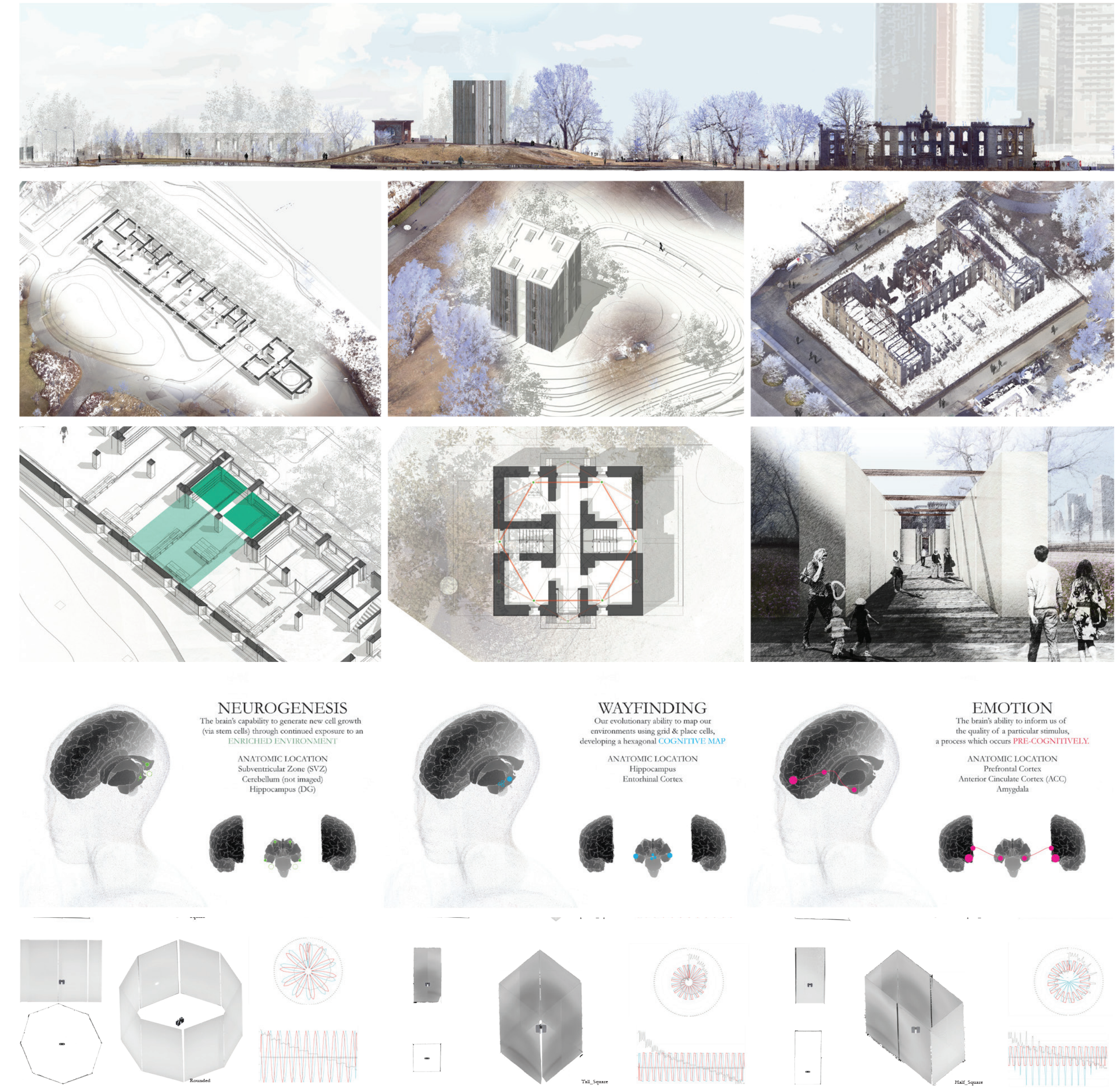

From top to bottom (left to right): North-south section through intervention site, axonemetric Lidar composite renderings of Neuroarchitecture Incubator building, Study Tower, and Smallpox Hospital, supplemental views of each structure, informational diagrams of neuroscience principles applied to each structure, and sampling of Lidar spatial tests and spatial data analyses

The Tool Sculpting The Designer
Cognitive Influence of Digital Tools in Shaping Contemporary Architectural Practice

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1. EXTENDED ABSTRACT

Architecture, and the consequent individual and social performance it situates within itself, first springs up as a response in the architect's mind to the design task at hand. Computer aided assistive technologies for design (Bhatt, Borrmann, Amor, and Beetz, 2013) have not only revolutionized the architecture of the contemporary era, but have also totally changed the ways in which architecture is conceived, designed, realized, viewed, and evaluated (Bhatt and Schultz 2015; Bhatt, Schultz, and Huang, 2012). These digital cognitive assistive technologies have enabled the architect to perform many of their tasks easier; for instance, through a variety of tools, assistive technologies present analytical information to inform design decisions and help design and create building documentations of built forms with previously unthinkable sophistication.

Indeed, it is conceivable that in the process of cognitive assistance, assistive technologies in particular, and computer aided design tools in general, have also influenced the creative thinking and analytical problem solving process of designers. More broadly, this also has ramifications on architectural discourse, practice, and aesthetics of contemporary architecture.

In this ongoing research, an attempt is made to make an overview of various assistive technologies in architectural design that are employed by students of architecture design school. Furthermore, we also strive to critically evaluate the cognitive impact of these tools on the intuitive creative process as well as logical design thinking. This study uses the fundamental principles of human Visuo-Spatial Cognition, Cognitive Science, and Human Computer Interaction, and recent researches reviewed (Eberhard, 2008a, 2008b, 2009; Mallgrave, 2010) in these areas to analyse the influence of assistive digital tools in the design process of young architects and their designs. We also study possible approaches in informing the future design and implementation of human-centered assistive design technologies that are minimally intervening in the early creative stage of the architect.

Keywords: Assistive Tools in Architecture Design, Cognition in Design Education, Human Centered Design, Human Computer Interaction, Computer Aided Design

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3. AUTHOR BIO

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The authors bring in a mixture of expertise from design, research and teaching in Architecture, Cognitive science, Human Computer Interaction, Assistive Technologies for design etc. This enables a cross disciplinary study, across the domains of Architecture Design, Software Design, Cognition in Design etc., looking at more human centered and intuitive approaches to evolve Assistive Technologies for a more humane Architecture.

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Towards Quantifying the Impact of the Built Environment on Human Experience: Elements of Experimental Design

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1. EXTENDED ABSTRACT

It has always been argued that the built environment affects our thoughts, feelings, and performance (De Young, 2013). However, this interrelation between the built environment and neuroscience, and the extent of how the built environment influences human performance have not been fully understood yet. As people spend more than 90% of our time indoors (Höppe, 2002), there is a crucial need to assess the built environment and how it influences human performance and responsiveness. Few research studies explored architectural design characteristics (e.g., way-finding cues) and their effect on the emotional and psychological responses of human beings (Edelstein et al., 2008). However, most of the current research is focusing on evaluating the impact of individual design features (e.g., color, size) rather than taking a holistic approach to understand and quantify the combined impact on human experience. Hence, there is a lack of research in quantifying the influence of design features on human experience. The goal of this research is to quantify the impact of an identified set of architectural design features on human physiological states, and provide empirical evidence with further insights on the interrelations between architecture and neuroscience. Towards the vision to quantify the impact of design elements on human experience and performance, this paper reports the findings on the initial phase of the research that sheds light on the required elements of the experiment design. These elements include architectural design features (e.g., topological connections in spaces), the sensations they result in human beings (e.g., sense of spatial orientation), parameters (e.g., activation in middle frontal gyrus) and technologies (e.g., EEG) that can be used to measure such sensations that should be used in the experiments. A triangulation based approach has been followed to identify the elements of the experimental design, including a rigorous literature review, crowdsourcing based elicitation from general public and expert feedback with focus groups conducted with architects in practice. Initial findings reported in this paper suggest that architectural design features that are associated with the same physiological sensation and parameters can be grouped for the quantification phase of the research.

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The impact of positional configuration of a desk in a room on attention and creativity measured by behavioral and neurophysiological recordings

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I. EXTENDED ABSTRACT

The significant architectural features such as window, ceiling, floor, or wall likely influence on behavior and neurophysiological states of individuals. In particular, a recent study (Meyers-Levy, 2007) has shown that ceiling height evokes concepts of freedom or confinement that in turn influence relational processing or item-specific processing. However, the neurophysiological alterations depending on freedom or confinement are not examined yet. In this study, we investigated the degree of attention and creativity of 40 participants in various desk positions; sitting toward versus against a wall in the room, on condition that the surroundings provide reasonable saliency to the priming of concepts (freedom- versus confinement-related) without any additional installations (i.e. hanging lanterns from ceiling). During the task performance, we used a portable EEG device to measure EEGs in participants to determine how openness versus closeness of space influences behavioral and neurophysiological states. We demonstrate that desk position in a room affects attention and creativity and their EEG profiles are significantly different depending on the desk position. We suggest that this result potentially provide a guideline about how to configure workplace, conference room, private room and classroom in accordance to various purposes and thereby improving job performances at work or school.

Keywords: desk position, creativity, attention, openness or closeness, EEG

The influence of human distractors with different desk position configurations in a sharing office on the performance of tasks requiring attention and creativity

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I. EXTENDED ABSTRACT

Performance and productivity of the task requiring creativity and attention are likely affected by distractors (e.g., people) and noises (e.g., clock ticking or phone ring sound) from surroundings, particularly in a sharing office. However, its behavioral and neurophysiological influences are not clearly investigated yet. Further, it is assumed that personal interactions and degree of distractions might be modulated by the configurations of desk position. Thus, the aim of the current study was to assess the influence of human distractors in different desk position configurations on task performance. 40 participants were instructed to perform two cognitive tasks requiring attention or creativity, while another person is working in various desk positions with reference to the desk position of the participant in the same office. During the cognitive task, their EEGs were recorded using a portable, EEG device. The influences of human distractors will be examined by gender and big five personality (i.e., openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism). Power spectrum and entropy of the EEG were estimated to investigate potential relationship between the degree of distractions and neurophysiological changes. We demonstrated that the desk positions of coworkers significantly influence performances of both tasks requiring attention or creativity. Further, the power spectral profiles are quite different depending on the desk position. We suggest that neuroarchitectural investigation can provide with an insight into the most suitable positional configurations of desks in the office depending on the goal or style of job in a corporate.

Keywords: distractions, creativity, attention, desk position, EEG

Home to School Path - Wayfinding by Children Ages from 8 to 10

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1. EXTENDED ABSTRACT

As a part of my dissertation topic at the Vienna University of Technology I am engaged in research with school children from one school in one urban neighborhood in Banjaluka, Bosnia and Herzegovina and two schools in one urban neighborhood in Vienna, Austria.

Research in Banjaluka, Bosnia and Herzegovina was done between October 26th and November 1st, 2015. Research was conducted with 109 children participants ages 8 to 10.

In period from April 4th until April 28th, 2016 research with school children in Vienna was done. There were 112 children participants ages 8 to 13.

The research consisted of three parts:

1. Drawing a path from home to school.
2. Drawing a favorite outdoor place to play.
3. Walk through neighborhood and visit to different playgrounds.

In all research parts discussion with each individual child was held. The voice was recorded and the discussion was written down. Walking through neighborhood and observing it was essential part of this research.

Here the focus is particularly on interpretations of school children drawings on their way from home to school. In this regard different parameters on wayfinding and attention focusing were observed.

Child was encouraged to submit the drawing when he/she thinks it is finished. It took approximately 15-30 minutes, in some cases up to 45 minutes, to do so. Children's individual participation was encouraged, meaning it was said that their own opinion is important and that drawings should be coming from them, their own thoughts, and not their colleagues. Children had freedom of using desired utensils and freedom of expression.

It was questioned what children remember the most on the path from home to school and which elements are important to them.
While being able to express their thoughts on paper, children also spoke about their environmental impression.

In interpretation of drawings the whole drawing was observed. This was done because the position of drawing on paper, color usage, drawing complexity, presence or absence of connection between elements, might show how well are children adjusted to their neighborhood.

It is questioned how form and color influence children's attention and their capability in finding ways and orienting themselves in their neighborhood by describing environment and the spatial structure of environment in particular.

Emotions and attachment to place play an important role in remembering of sequences and places visited as well as situations and actions that trigger imagination.

During research, and by analyzing children's drawings slight difference in the attention and environmental perception between younger and older children was noticed. Younger children pay more attention to details and use of color in their drawings than the older age group. Responses received from younger children were more descriptive and detailed in comparison to older children group.

Drawings are analyzed with the purpose of identifying parameters which would help in building and planning the child friendly environment.

Discussions held with each individual child about their drawings and environment they live in as well as theoretical analysis of the literature on the subject matter serve as a support in forming the conclusions.

On their way from home to school it seems that emotions play an important factor in forming a relationship with environment. Some orienting points for children were nature elements, threes ("There is that strange tree"), people ("There is that strange woman"), basically things which were out of "order". For children which were traveling to school via bus or a car, other things such as bus stop, river and bridge were orienting points. Sometimes bakery was referred as orienting point or even parking poles in front of the school yard. "There Is the blue fence", meaning there is school. As an orienting point children would often refer to a house where their familiar (friend, aunt, etc.) lives.

Relationship between neuroscience and environment perceived by individual is without a doubt mutual and feedback happens all the time. As much as human being is able to change the environment, environment is able to change human being.

By choosing different path from home to school, a child could change thought pattern and experience different stimuli.

Society is based on information exchange. There are always informational inputs or outputs from individual to surroundings and VV. By improving people correspondence with architectural, natural, and biological environment within individual, the whole system, which we are part of, could properly function.

Questions for further research:
Can environmental diversity and staying in nature help in brain development? Can environmental diversity help in wayfinding and orienting? What kind of stimuli benefit brain development and problem solving capabilities?

2. AUTHOR BIOS

Dajana Rokvic was born in 1988 in Sarajevo, Bosnia and Herzegovina. She is a Master of Science in Architecture from Vienna University of Technology and Architecture Engineering graduate from University of Banjaluka, Bosnia and Herzegovina. For her study efforts she has received many scholarships including a prestigious Herder Stipendium im Rahmen des Alfred Toepfer Stiftung, F. V. S. Temporarily she is involved in Doctoral programme in Engineering Sciences Architecture at Vienna University of Technology.

A problem which Dajana addresses in her research is the lack of child friendly spaces, i.e., environmental conditions that provide possibility for unhindered creative and physical activities and free expression of a child by allowing socialization among peers and free exploration of their neighborhood. Dajana is interested in pursuing research on influence of architecture and built environment on human being, in this particular case, children. She is a member of IAPS (International Association for People-Environment Studies). In her free time, Dajana enjoys spending time in nature and writing.

Architecture and Neuroscience: towards spatial atmosphere and sensory experience in a phenomenology-based design methodology

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1. EXTENDED ABSTRACT

As reflection is forced out of architecture schools by the realities of the workplace (MALLGRAVE, 2013), building design courses tend to privilege solving programmatic, functional and technical issues. This paper discusses a diverging strategy that brings neuroscience and architecture together in the design process. It describes a phenomenology-based methodology in which spatial atmospheres (ZUMTHOR, 2006) and sensory experiences are pursued through the understanding and use of natural light, hence the protagonist in the process.

Light and vision are tightly connected: the latter has a primary role in experiencing space, but it depends on information conveyed by patterns of light, mostly originated by reflectance from physical surfaces (ALBRIGHT, 2015), indicating that light becomes visible only by interacting with matter. Acknowledging our multisensory presence (MALLGRAVE, 2010; PALLASMAA, 2005), the intention is not to favor vision in detriment of other senses, but to use natural light as a means to achieve the intended ambience.

The methodology relies on the rational that students can conceive a particular space – through cellular spatial experiments – and expand the concept to the entire building (LAWSON, 2005), a crematorium bordering a 19th century cemetery in Recife, Brazil. Three phases are carried: (1 – NAVIGATION) based on the notion that space is comprehended only when we perceive it through embodiment (CONDIA, 2014), students register sensory stimuli elicited during site visits to burial and religious places; (2 – EXPERIENCE) test possible spatial atmospheres by manipulating light and massing through physical models; (3 – DESIGN) develop building design by applying prescriptive spatial ambiences and sensory experiences, including specific lighting effects, employed according to the nature of spaces they act upon: crystal veils, luminescence, atomization, procession, evanescence and environmental silence (PLUMMER, 2009).

As a result, design proposals have reached a strong sense of place in regards to defining introspective atmospheres, potentially favoring concentration and inner reconcilement, keys aspects in spiritual environments. We also verified that this spatiality strongly relates to designs adopting regular contour orientations derived from familiar geometric shapes, perhaps mirroring the fact that our cortical system tends to favor regular visual patterns (ALBRIGHT, 2015).

The merging of neuroscience and architecture seems to open way for varied studies, such as the exploration of light discussed here, which attempts to facilitate the understanding and use of this natural agent in the design process, allowing for buildings that help stimulate sight and, consequently, improve the multisensory potential of architecture. Although we dealt with step-by-step procedures, the process was reduced to previewing lighting effects through limited resources. One further exploration to possibly minimize the ever-challenging gap between designer, users and spatial experience would be the use of immersive virtual reality environments to simulate and test the intended effects in relation to the sensory stimuli they elicit upon users.

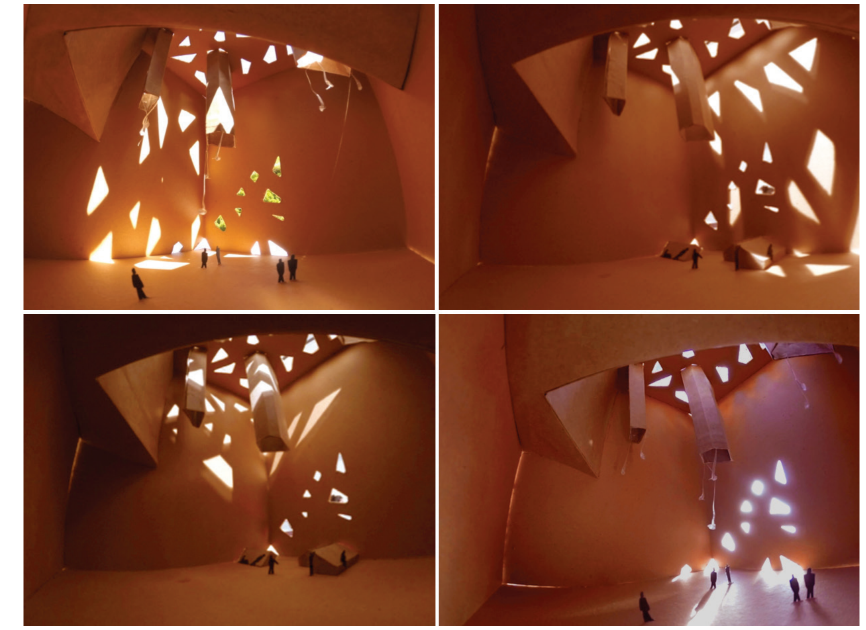

Figure 1: Phase 2 of design process depicting manipulation of light and massing. Photo credit: Stephanie Gonzaga.

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Investigating Stress Triggers and the Built Environment

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1. EXTENDED ABSTRACT

The physical environment influences mental healthl and inevitably well-being. While exposure to natural environments shows salubrious health benefits among those who maintain a consistent connection,[2-8] little is known about how urban environments impact mental health. As urbanization increases worldwide, it is essential to understand the linkages between urbanized environments and public health. This project is guided by the research question: How do different environmental characteristics affect stress-related responses in users?

The study will guide individual subjects (n > 30) to walk a designated route, exposing them to different architectural and environmental elements in downtown Manhattan, Kansas. Physiological biofeedback sensors, including electrodermal activity (EDA) and heart rate sensors, will be used monitor physiological behavioral changes[9-11]; GPS will provide spatial location; and a GoPro camera will provide real-time first-person experience. Data from these sensors will be integrated into a temporal-spatial analysis to ascertain correlations between architectural and environmental elements in space and associated stress responses. Upon completing the walk, participants will take a brief survey asking for their perceptions, both quantitatively and qualitatively, of the different environments they encounter on the walk.

Raw data collected from the biofeedback devices will be refined and analyzed spatially using GIS mapping software. This will allow us to visualize any associations between design characteristics and the elicited behavioral responses in order to determine the environmental characteristics that may illicit heightened stress responses. Analysis of the survey data will seek to identify any correlations between physiological and perception-based responses.

The intent of the research is to provide a foundation for further studies into how public policy can be better informed and augmented to mitigate potential public health issues caused by urban design. Results will also inform architectural and engineering decision-making processes to further improve urban design by identifying characteristics that may improve or decrease mental health of those living and/or frequenting urban environments.

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Parker Ruskamp is a graduate student studying landscape architecture at Kansas State University. His focused interests include placemaking, resiliency in design, and the integration of cultural influences into the design process. Investigating Stress Triggers and Characteristics of the Built Environment was his first foray into independent research. By studying the relationships between psychophysiology and the built environment, he set out to gain a greater understanding of what drove personal perceptions and responses to different environments and how design plays a factor in human preference.

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Brent Chamberlain joined K-State in 2013 as an Assistant Professor. His research spans a variety of topics, focusing mainly on developing geospatial and geovisualization tools and information to conduct spatial science and improve spatial planning through more informed knowledge. His publications span a variety of topic areas, including: applied artificial intelligence techniques, environmental psychology, spatial planning, wastewater management, forest planning (and aesthetics), forest conservation mapping (Brazil), highway design and driver experience, and ecosystem service-oriented decisionmaking. He was previously a Postdoctoral Fellow at the Institute for Resources, Environment and Sustainability at the University of British Columbia (UBC).

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Bob Condia, AIA, is an architect and design partner with Condia+Ornelas Architects, Manhattan, KS. A professor of architecture at Kansas State, he teaches architecture as an art form with due considerations to: neuroscience and architecture; the real; the ancient works of man; a building's terrestrial and celestial alignments; metaphysics and poetics of architectural design. He has been a studio critic for 30 years in both architecture and interior design. In 2008 he received the Commerce Bank Distinguished Undergraduate Teaching Award and in 2015 AIAKansas' Schirmer Award for service. His publications range from monographs on the works of progressive architects to theoretical articles on the experience of space as well as a catalogue of his own surrealist illustrations. Of particular attention are his recent work on neuroscience and architecture, the biological basis of aesthetic experience, and the craft of teaching architects to teach.

The Use and Perception of Black in Architecture

Marina Russo-Schtcherbakoff-Kodakoff

I. EXTENDED ABSTRACT

Black is at the same time a color and not a color. It is defined as the absorption of light, the absence of electromagnetic radiation as well as the equal combination of the three primary colors. Black is loved and hated. Black can make a house almost disappear when built in a complete organic environment and emphasize a colored feature or a particular space inside a building.

The use of black in Architecture should not be perceived as a decorative feature but more as a technical and psychological tool. Beyond cultural perceptions, it always have a strong impact on people whether it be a positive or negative one.

Through different case studies we can see how the clients were reluctant to use black at first and ended up very pleased with the effect it created.

The aim is to explain how to make good use of black in order to create the intended effect and also to identify its physiological and psychological influence. We will see that we can actually produce different blacks using light, texture, reflection, etc. that will all induce various emotions.

Bridges from colors to psychology and neuroscience have been extensively researched, however, black is the opposite as it is the absence of light. How is lack perceived by the human eye and the optic chiasma? Why does it have such a strong impact on people if it is only "nothing" to the human eye? What is the difference in our optical and neuronal perception between the "color" black (used on walls, ceilings, floors...) and the black, void, total absence of lighting?

Different leads such as the reaction to obscurity and absence of daylight of the suprachiasmatic nucleus controlling the circadian rhythms, sending information to the pineal gland and resulting in the production of cortisol and melatonin will be explored.

2. AUTHOR BIO

Born in the s outh of France I travelled for many years. After graduated from the University of Derby, England in Architectural Venue Design and Digital Innovations I returned to France. As early as the first years of studying I was struck by the very little consideration we gave to human beings in the architectural practice. I thought buildings should be built for humans and therefore humans should be in the center of our thoughts while designing them. At the end of my studies, seven years ago, I wrote a dissertation on the following subject: "The correlation between architecture and human psychology". Five years ago I opened my own architectural firm and have carried on researching on psychology and neurosciences applied to architecture, making extensive search and use of artificial lighting, colors, volumes and numerus different features. Probably because it is unknown in France, clients are usually skeptical and reluctant to this approach but by applying what I discovered to my work and projects I have noticed clear results in human perception, well-being, emotions, cognitive behavior, sales revenues, etc. Recently I happened to use black in many of my projects, which led me to extend the research.

Embodied Adaptive Architecture
An overview of research conducted at the Mixed Reality Lab

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1. EXTENDED ABSTRACT

Buildings have become adaptive. They adapt to their environments with the aim to be more sustainable and to provide more comfortable conditions for inhabitants. They adapt to inhabitants to, for instance, make spaces more convenient, information rich and more useful. Adaptivity is typically achieved through the integration of ubiquitous computing technologies and the building fabric. There are many adaptations that would be described as mainstream, e.g. those that control the internal climate or lighting. There are also much more radical ideas, suggesting that buildings become mobile, change form, become affective or indeed that they become an interaction partner. Both streams have been captured in numerous publications over the last 10 years [1] [2] [3] [4]. However, there has been very little reflection on the impact on people (e.g. their perception, their behaviour, their well-being) of interaction-centric adaptivity in buildings, and this lack of investigation is also observed by Malgrave, even in the context of standard architecture [5].

This presentation focuses on the contribution that research conducted at the Mixed Reality Lab makes to the emerging space of Adaptive Architecture [6], conceptually, technically and interactionally. Generally, we approach this research by building novel architectural prototypes and interaction mechanisms, which are then studied in the lab and in deployment. This talk will present ExoBuilding [7] as one such prototype. ExoBuilding is a room-sized, mechanically actuated fabric structure, which can respond to people's physiological behaviour, for example their respiration, their heart rate or skin conductance.

Through a first study that linked a participant's breathing to the up and down movement of ExoBuilding, we have indicated how this biofeedback environment can trigger reductions in respiration rates and increases in relaxation[8]. A second study has shown how experiencing respiration mappings from the inside triggers much more strongly felt experiences, than experiencing the same mappings from the outside [9]. A third study (currently unpublished) demonstrates a method to influence people's physiology through regular oscillations, following a period where participants had been in control of the movement. The possibility of such manipulations raises ethical questions in the context of more widespread use. In participatory design work we have then set out to explore how this approach can be used for the teaching of yoga with breathing at its core, studying the teacher-student relationship and how this becomes affected by interaction with the environment [10].

The presentation will conclude with a reflection on the more generalised feedback loop that is created between occupants and the adaptive building, and how we begin to see the two as interaction partners. We frame this by reflecting on embodied interaction, drawing on work by De Jaegher and Fuchs [11] [12], arguing that the biofeedback loop leads to 'mutual incorporation' between inhabitant and prototype and that 'interbodily resonance' can explain the way that both are adjusting to each other. We are discussing this in the context of Arbib's 'Neuroscience of the Experience of Architecture' [13] and more broadly in the context of people experiencing architecture emotionally, i.e. precognitively.

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Nils Jäger, PhD: Nils Jäger is Research Fellow at the Mixed Reality Laboratory, University of Nottingham, where he investigates the inhabitation of adaptive architecture. He received a Masters in Architecture (MArch) from Ball State University in 2006 and a PhD from the University of Nottingham in 2015.

EEG Pattern Recognition and Classification for Thermal Comfort

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1. EXTENDED ABSTRACT

In this paper, electroencephalogram (EEG) techniques were adopted to evaluate thermal comfort of human subjects. According to ASHRAE (2004), thermal comfort is defined as "condition of mind which expresses satisfaction with the thermal environment", which suggests that thermal comfort is closely related to emotion. EEG pattern recognition and classification methods are widely used in human-computer interface, especially in emotion research (Frantzidis et al. 2010; Chanel et al. 2005), which allow identification of emotion regardless of the human facial expression, behaviour, or verbal communication. In this research, a 14-channel EEG headset was used to detect electrical activity in the brain and power density in different EEG frequency band was collected as features. Different numbers of features were used to build LDA/SVM algorithm classifiers. This enabled classification of human subject's mental state under different thermal conditions in built environment and the classification rates were above 90%. This new approach helps to better understand the impact of architectural spaces on building occupants. Further exploration provides possibility to improve the human-building interaction which facilitates the development of future intelligent buildings where occupants are able to control the indoor environment through this human-building interaction process.

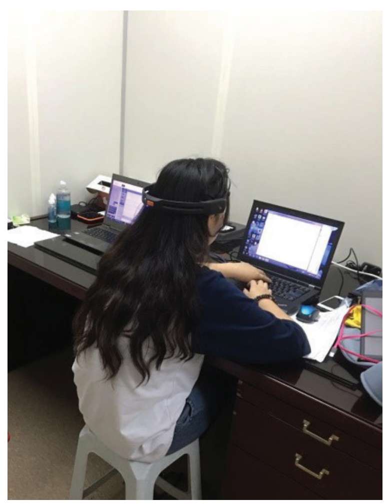

Figure 1 - *Experimental setting in a normal office room*

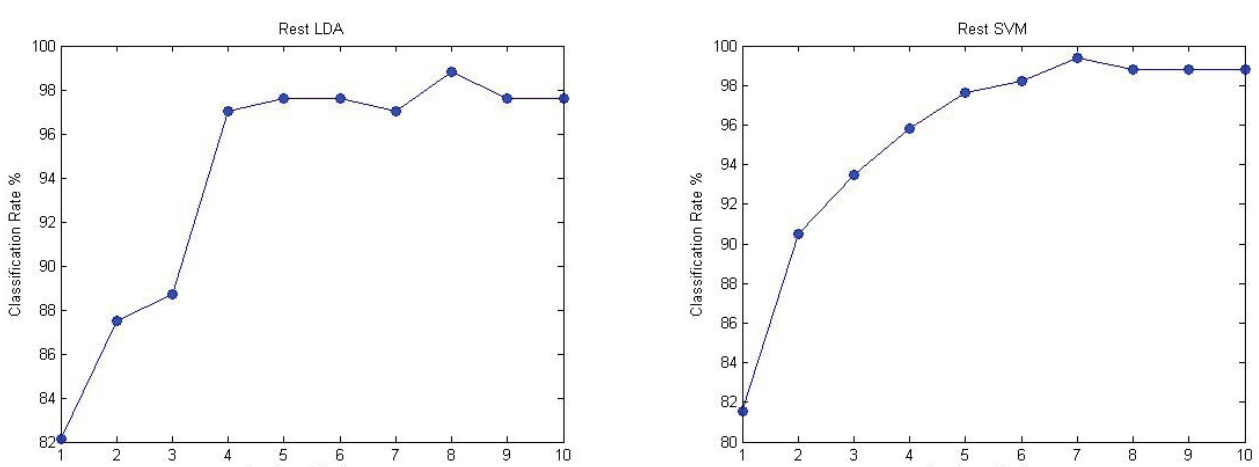

Figure 2 - Classification rate with increasing number of features

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3. AUTHOR BIO

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Biographical narrative for the speaker: Xin Shan is currently a PhD student with research interest in indoor environment and building-human interaction. He got his Bachelor degree in Civil Engineering (First Class Honours) from the University of Hong Kong in 2013.

Architecture and the Senses: A Sensory Musing Park

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Our sensory organs are mediators between what happens in our brains, and what happens in the world around us. However, our brain doesn't directlyperceive anything. Diane Ackerman describes the paradox of our brain's dependency on the senses, as a silent and dark recipient, transmitting only electrical impulses.[1] This perspective uncovers the critical importance of our sensory abilities. If the brain is ineffective without information gathered by the senses, why aren't our environments tailored to clarify and illuminate our sensory experiences? If we can understand over time, as John Zeisel explains, how people's minds work in response to their physical environments, then those environments can be designed to support health, creativity, and life.[2]

1. EXTENDED ABSTRACT

This thesis studies the relationship of architecture and the senses. The first part of the document explores sensory characteristics and how they work. It defines their importance in allowing humans to navigate complex environments. The second part looks directly at environmental stimuli. It seeks to qualify and associate physical variables with particular sensory responses. The third part of the document studies sense-stimuli relationships and the various outcomes.

Research draws from scientific, psychological, architectural, and philosophical contributions, including work by environmental psychologist, Harold Proshansky; architects, Steen Eiler Rasmussen and Charles Moore; and anthropologist, Edward Hall. The goal of the research is to create a set of principles by which architecture can design "for the senses".

These principles are then applied to a series of architectural installations, located in the "Parco della Rimembranza", in Rome, Italy. Each installation deconstructs a particular sensory experience, in order to isolate and examine the stimuli involved. The sensestimuli relationships that comprise each installation use natural and man-made variables to activate the visitor's experience. Each installation is part of a larger constellation that can be sequenced in a variety of ways, experienced uniquely each time, and even added to by visitors and artists.

This thesis provides a framework for clarifying and enhancing the built environment. It employs the human senses as a common denominator, through which practitioners from all ends of the occupational spectrum can contribute. By cataloging and analyzing the interplay between architecture and the senses, it evaluates human experience and offers a set of standards by which architecture can contribute to the benefit and welfare of humankind

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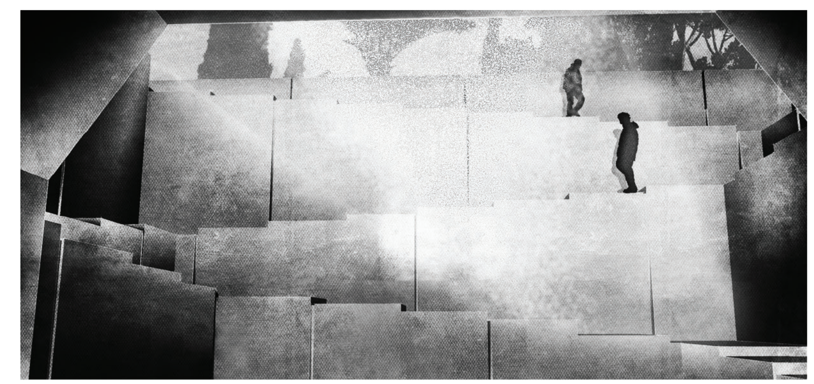

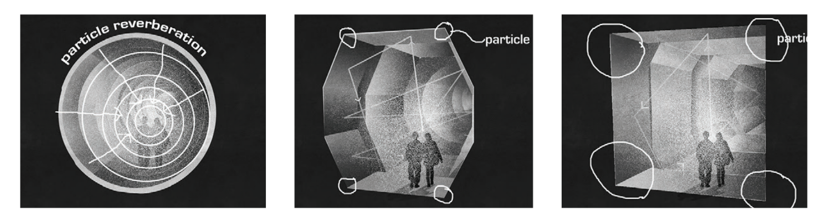

TOUCH

Development	**Immediate Receptor** Touch is relative to movement, temperature, and tactile qualities. Touch is an immediate receptor, unlike any other sense, requir-ing direct contact to convey information
Types	**3 Types** Diverse sense that can be understood in three different ways: kinesthetics, thermal, and tactile perceptions. Each of the three 'touch perceptions' deal with direct contac between ourselves and the environment and, perhaps, offer the most intimate form of experiencing an environment
How It Works	**Muscular, Pulmonary & Nervous** Proprioceptors and exteriorceptors, located within and on the surface of the skin, record muscular, thermal, and tactile infor-mation and transfer it through nerve impulses to the brain
Benefits	**Time & Place** Recognizing and understanding movement within a space can ex-pand design opportunities. Furthermore, engaging natural quali-ties like sun and wind can connect people to a specific place at a specific time
Issues	**Understimulation** Channeling experiences, by limiting the number of distractions and regulating elements that separate us from the environment, might serve to heighten those experiences
Phenomenology	**Cognitive to Corporeal** Touch is particularly important for connecting us to time and place. We refer to 'tangible' things as 'real' things, things we can physically confirm. The validation of an environment is particularly important in linking us with our existence and connecting us to the "here and now". Emotion, a cognitive process, is translated into a bodily experience via thermal perception. Conversely, touch perception can take bodily experiences - like tactile feeling, move-ment, and temperature perception - and turn it into a cognitive process
Architectural Applications	**Juxtaposition** Hierarchy of intensity or simple alternation of contrasting items juxtaposes opposites to bring out particularities
Shape	**Kinesthetics** Round spaces are inward focusing St. Benedict's Chapel, Sumvigt creates a forward thrusting iner-tia through the oblong shape of its structure
Color	**Thermal** Color, through the form of light waves send nerve impulses to the hypothalamic region of the brain. In short, color temperatures are as follows: Red - hot and arousing; Orange - warm and luminous; Yellow - warm and exciting; Green - cool and calming; Blue - cool and restful; Violet - cool and subduing
Light	**Emotion** When light enters the eye, it activates energy pathways to the brain. Though emotions are based in our conscious, they are in-fluenced by the corporeal. This burst of energy is often the cause of lifting a mood and soothing depression
Acoustics	**Vibration** Sound is actually experienced through touch. The resonance of sound waves against our eardrums creates sound. The feel-ing of a sound, its vibrations through a medium, are amplified or dampened by the shape and materiality of space
Material	**Tactile** Materials conveys information to us through touch. Textural qual-ity enriches the haptic experience by stimulating proprioceptors and exterioceptors, located within and on top of our skin

From lef to right, top to bottom: Centering Plaza Section Perspective. Illustration by Sarah Stein;
Cave Entry - Well. Illustration by Sarah Stein;
Sound Diagram - Circle, Octagon, Square. Illustration by Sarah Stein;
Sense-stimuli chart- Touch. Diagram by Sarah Stein.

Dreaming Architectural Spaces into Reality
A Digital Platform for Generating Architecture Form from Cognitive Responses

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I. EXTENDED ABSTRACT

The tools that we use to design architectural spaces have evolved dramatically over the past twenty-five years. The evolution in the technology of design tools has shifted the expected skills and expertise required in the architecture profession as well as shifting architectural aesthetics based on the evolving digital mediums.[1] Despite the many changes in technology, in both mechanical and digital paradigms, the use of our hands and sight have continued to play the most primary role in creating a design. A change in the emphasis in design from the mastery of fine motor skills to a post-handeye generative process that uses only a cognitive practice has the power to innovate the current aesthetic and functional norms of architecture.[2]

Quantifying the relationship between architecture and cognition for the purpose of innovating design processes is an evolution of the epistemological ideals of phenomenology and architecture that have been actively explored since the late nineteenth century by Heidegger, Husserl, Dreyfus, and Merleau-Ponty. The pursuit of evolving phenomenology to a more quantitative practice allows architectural design to be derived from an intentional creative process that removes itself from the often questionable happenstance of architectural form-making. The form-making manifesto of the "iconic" structure was a turn of the century ideal of the micro (individual) and the macro (citywide) level "brandscaping" agenda. The new architectural manifesto being realized today responds directly to the needs of society, through digital connectivity, social agency, and the functional improvement of existing environments. The digital realities of new technology and their rapid integration into society demand a reinterpretation of personal and social spatial "needs" that include improving existing environments as well as respond to the experiential values and the growing demand for systems of immediate materialization. A digital manifestation of phenomenological experiences is pertinent to a future generation whose social culture reflects a desire to visually define individualistic epistemological inquiry and address inevitable digital futures, while embracing the continued importance of real life experiences.

Using a cognition-based digital platform, designers of the future will have the ability to solely use the powerful human function of cognition to form a architectural space that creates a meaningful spatial experience for both the designer and user of an occupiable form. Emotional responses to existing environments and built architectural forms trigger brain activity which can be measured using portable EEG brain scanning or stationary fMRI equipment.[3] Using the quantitative figures from cognitive responses to architecture in conjunction with eye tracking and visual recording technology, we can begin to map a taxonomy of existing forms which prompt particular emotional recourses.

Using this architectural categorization of emotion evoking forms, we can create a computational framework which uses a series of pre-formulated shape grammars and successive geometries to create individual architectural manifestations which are formed from EEG brain activity data engendered by spatial occurrences or emotional experiences of a user. The digital manifestation of a psychological experience mediates between a personalized existential realization and the real life experience of one's surroundings. The architectural result of the cognitive tool acts as a intermediary between an emotional experience and the physical space which might inspired those thoughts.

The cognitive design tool is developed using a historical taxonomy of forms connecting neural activity with spatial conditions.[4] Human subjects are then used to collect EEG and visual tracking data from a controlled set of experiences. Test subjects re-watch their set of experiences and self-report on their emotional thoughts at specific moments in order to combine both quantitative data from EEG scanning with the qualitative data of self-reporting on emotional activity. This data is used to quantify spatial instances that are captured using the visual tracking eyewear. The data from this phase is used to create the taxonomy of architecturally specific forms which link particular emotions with specific spatial conditions.

Computationally programming a series of shape grammars and progressive geometries combining the elements of the architectural form taxonomy with the multitude of complex series of emotional states provides the digital tool will a library of optional instances that are produced by a combination of neural activity. The design tool produces a 3D model of the combined architectural forms as a result of a brief timeline of cognitive activity.

The intention of this cognitive design tool is to: a) transform our notion space by developing an entirely new tool for realizing architectural design; b) train designers to have more diligent control of their cognition by assigning form making algorithms associated with neurological stimulation; c) create meaningful and unique spaces that have not been created before due to learned aesthetics in the architecture practice today; and d) open up the practice of design to those who are limited from using their hands or sight in the design process.

The results of this design inquiry can be used to initiate a series of individualized experiences of architectural sites which respond to the visitors emotional states. This cognitive design tool is only a stepping-stone to visually articulate architecture which is responsive to the constant fluctuations of human thought and emotion.

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Useful Level of Explanation: Understanding Connections between the Brain, Behavior, and the Built Environment

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1. EXTENDED ABSTRACT

The importance of studying human behavior in context in the real world cannot be overstated. Kurt Lewin's field theory (1946) proposed that behavior is a function of both the individual and its environment B = f(P, E), and strived to apply psychological knowledge to solve real-world social problems. Since the 1960s, environmental psychologists and other behavioral scientists have collaborated with design professionals (e.g., Envirognimental Design Research Association) in an effort to understand how people respond to their everyday physical environment and to apply their knowledge in the design of the built environment that would satisfy the users' needs (i.e., human-centered design). More recently, the explosion of neuroscience research and the development of new measurement techniques, such as fMRI, have expanded the methods, and consequently the types of questions that can be asked, regarding the brain bases of behavior as it relates to the individual and its environment.

Architects are increasingly asked by clients to provide evidence-based designs. We argue that the best approach to understanding the relationship between the brain, behavior and environment is to use a level of explanation that is appropriate, useful and predictive for the specific phenomenon at hand. In many cases, the most useful level of explanation is behavioral; that is, with our current understanding and methodologies additional useful insight could not be gained from molecular, cellular or systems level investigations. Basic research that seeks to understand the connections between the brain and behavior and cognition is nonetheless valuable in its own right.

We seek to provoke the ANFA community through constructive discussion about practical approaches to applying scientific knowledge among the design professions. We will review the historical development of environment-behavior research and the neuroscience for architecture movement. We will discuss why and how neuroscience and psychology can contribute to our understanding of people's interaction with their everyday built environment. Considering the impact that the built environment can have on our well-being and the educational focus of the design professions, we believe that applied research is immediately relevant to the design process but less pursued and we urge researchers to collaborate with design professionals to identify key research directions.

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3. AUTHOR BIO

Margaret Tarampi Ph.D. Assoc. AIA is Post-doctoral Researcher at the Center for Spatial Studies, University of California Santa Barbara (UCSB). Previously, she was a Junior Research Fellow in the SAGE Center for the Study of the Mind at UCSB and a postdoctoral researcher working with Mary Hegarty in the UCSB Department of Psychological & Brain Sciences. She received her Ph.D. in Cognitive Psychology from University of Utah. Her interdisciplinary research investigates the cognitive and neural mechanisms that underlie space perception and spatial cognition in select populations including individuals with visual impairments and spatial experts such as dancers and architects. Other research interests include spatial thinking, perception and action, perspective taking, joint action and kinesthetic imagery.

Prior to her current research work, Margaret was already developing a unique background that was truly interdisciplinary. She graduated from Carnegie Mellon University with a Bachelor of Architecture and minors in Psychology and Architectural History. Her interests in the effect of architecture on quality of life issues brought her to the American Institute of Architects in Washington DC, then the Academy of Neuroscience for Architecture in San Diego CA and the Salk Institute for Biological Studies in La Jolla CA.

Cheuk Fan Ng, Ph.D. is Professor of Psychology at Athabasca University, Canada's Open University. She received her graduate degrees in psychology with a focus in environmental psychology from the University of Victoria in Canada. Prior to that, she studied and worked in the real estate appraisal field for the Government of Hong Kong for five years.

Cheuk Ng's research projects and interests have revolved around noise, crowding, and privacy in the workplace and in housing, immigrants' use of space and acculturation, retail environments and telework. She is a regular reviewer for the Journal of Environmental Psychology and was the Section Chair and newsletter editor of the Environmental Psychology Section of the Canadian Psychological Association for several years. Also, she is on the Expert Review Committee of the Council on Tall Buildings and Urban Habitat, based in Illinois. She is a member of and has presented at the Environmental Design Research Association, American Psychological Association, and Canadian Psychological Association.

Affect(ive)(ed) Design

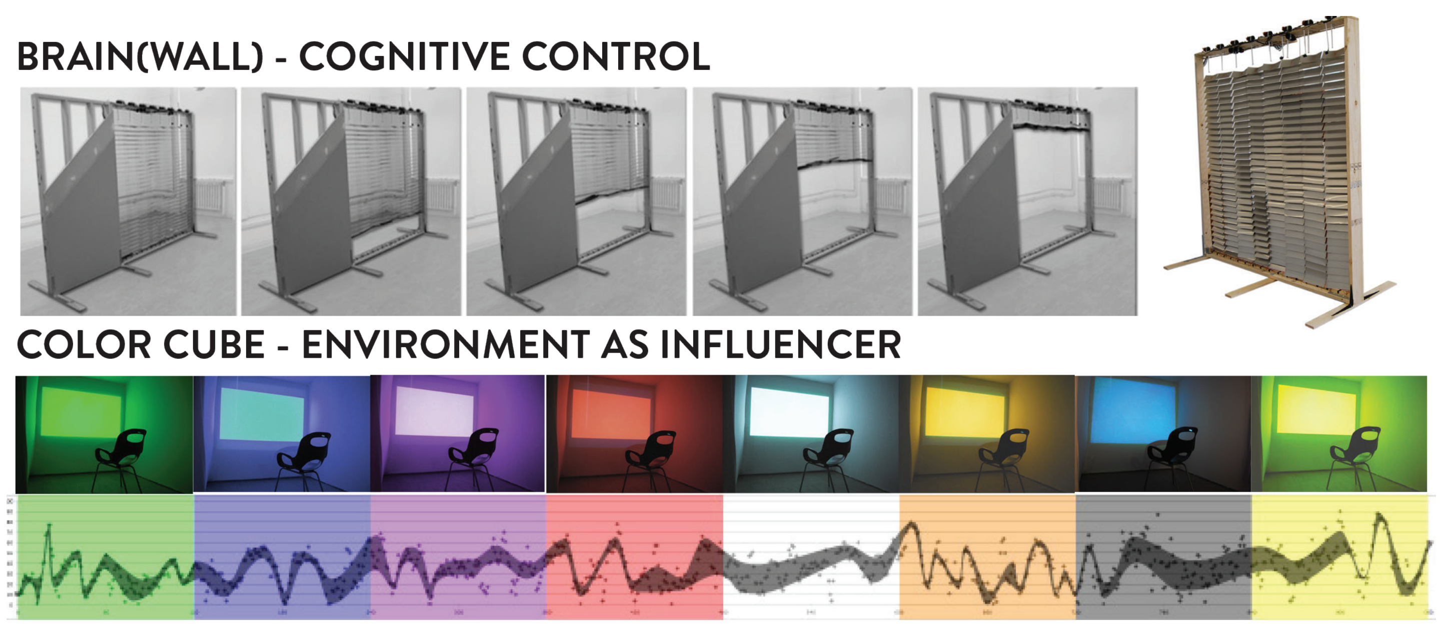
Aaron Tarnowski

I. EXTENDED ABSTRACT

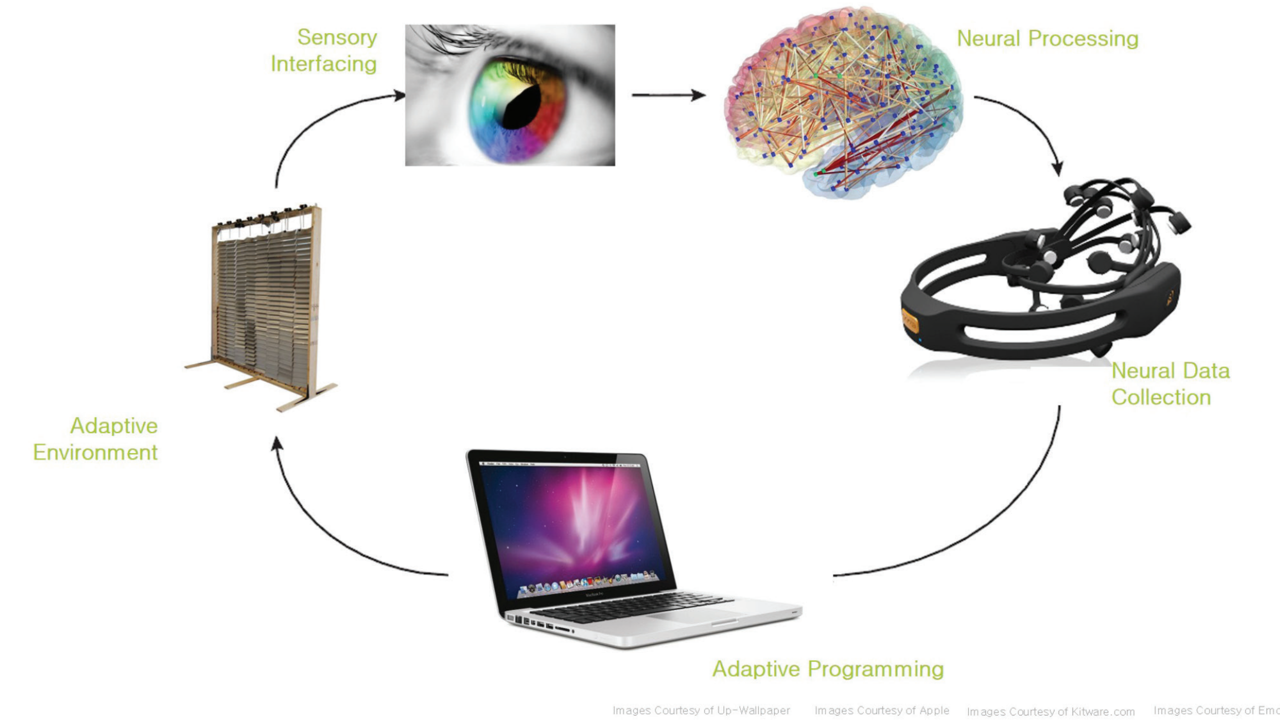
The advent of smart devices has brought about an age which allows for a great amount of personal control and an unprecedented enhancement of lifestyle based on behaviorally predictive and intuitive technology. Although still in an infant stage, this is beginning to include the environments we live in with a greater amount of controls that allow us to dictate on a personal level the preferences of our surroundings. There is yet another level of interactivity yet to be achieved, and that utilizing sensory and neural based biometrics to interact with a responsive environment capable of learning and adapting to the intrinsic needs and commands of the environment's user.

At this time there is a number of different commercially available EEG headsets which allow us to with an acceptable degree of accuracy develop an explorative interactive interface between the environment and our own neural activity. When this interactive neural technology is combined with a programmable environment, a fascinating relationship is developed where we can begin to create spaces which can be controlled not only on a cognitive level, but also can begin to learn our desires, needs and personalities on a far deeper level than behavioral based technology alone.

The goal of this discussion is to present a number of probing experiments conducted by an architectural designer which begin an exploration of this dynamic relationship between the brain and the environment. From the level of environmental cognitive controls to environmental learning based on the brain's electrical activity, these explorations delve into investigating and studying the opportunities and advantages provided by creating a more neural-focused design and responsiveness. The experiments include studies done both in academia at the graduate level (Illustrated) and further pursuits continuing to enhance an understanding of how with the technology available to us today we can already begin having the discussion of bio-responsive design.



Cycle of Neural Interactivity



2. AUTHOR BIO

Aaron Tarnowski graduated with his Bachelor's and Master's degrees from the University at Buffalo in 2011. While there he participated in the Situated Technologies Research Graduate Studio with a primary focus on the development of a neuro-responsive environment. Currently, Aaron's profession career includes working at FKP, a firm which specializes on Healthcare and Higher Education. He chose healthcare design as it provides both a unique opportunity and challenge to design an environment which has the ability to significantly affect the wellbeing of its users. Over the course of his career Aaron has been progressing his work on the promotion of a neuro-conscious design approach with a goal of raising awareness and speaking on the benefits of neuroscience in the architecture and interior design fields. Adding to this, he has continued his exploration into the development of neuro-responsive and smart environments pushing the boundaries of our current perceptions on the relationship between the body and the environments we live in.

SynaptiCity: The Power of Weakness in the Construction of Place

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1. EXTENDED ABSTRACT

Globalization, increased mobility, and fast urban growth, jeopardize our relationship with people and places that used to be important to us. As a result, we feel often displaced and try constructing the sense of place through a connection to the physical environment. Yet, contemporary predominance of virtual connectivity reduces attention to the physical environment and sensory engagement. This paper seeks to understand how can architecture facilitate the construction of place in a world of limited resources.

This is particularly acute in the Pearl River Delta, home to the fastest and largest extension of continuous urbanization in the world. Furthermore, the region's urban population is confined to barely 10 per cent of its territory, making it extremely dense. This fast and uneven growth is one of the greatest challenges faced by Chinese society and calls into question traditional modes of planning cities, raising the urgent need of alternative strategies.

Assuming that the construction of place has a strong affective foundation, this paper studies affect in the experience of space to identify the architectural qualities that contribute most to place attachment. The research combines insights from architecture, phenomenology, environmental psychology, and neuroscience; in order to investigate the processes associated with the 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' (Vattimo, 1983; Solà- Morales, 1987; Pallasmaa, 2000; Casagrande, 2012) with its inherent frugality and ambiguity as a means to trigger composite emotional states (Damásio, 2010), generally less intense but more engaging, facilitating the construction of place while saving resources.

The analysis is based in the study of a site-specific architectural intervention in a public space in Hong Kong and some other cases from Taipei and Macau. In loco behavioral observations were conducted to assess movement patterns, physical and social interactions with the object. Interviews were performed to assess attention and affect. This provided insights into the identification of the spatial cues that operate within and outside consciousness and make affect and sensuousness necessary to the processes of attention, connection, and ultimately attachment to a place.

2. AUTHOR BIO

Diogo Teixeira is a doctoral candidate in Architecture at the University of Lisbon (Portugal). Since 1993, he collaborates in various projects in Europe, Africa and Asia, and is also an active researcher with a particular interest in affect and public space, namely understanding how architecture results in meaningful places. He conducted research at the Institut d'Urbanisme de Paris (France) and at the Laboratori d'Urbanisme of the Polytechnic 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.

Menno Cramer is a neuroscientist at heart but works with designers and architects. He is fascinated by the experience of physical stimuli leading to responses, physical and non-physical. He is interested in how humans act, react and interact with the physical and digital world. Former PhD student in Neuroscience and Design, seeking to evaluate the role of built environment in which we live on primarily human behavior and health. Currently working in Lisbon to obtain work experience in the field.

Resonant Form: The Convergence of Sound and Space

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"Listen! Interiors are like large instruments, collecting sound, amplifying it, trasmitting it elsewhere." - Peter Zumthor

Human spatial perception is a sensual experience of the world we inhabit. While we experience architecture through all of our senses by varying degrees, the process of design has long preferenced the visual at the expense of other modes of perception. This body of research and proposed design methodology aims to focus on acoustic aesthetics to create spaces which manifest sonic phenomenon that not only elicit psychological responses for inhabitants but also induce shifts in brain states toward meditative and/or mystical experience. As humans are sonic instruments themselves through use of our hearing and vocal range, the engagement of our sonic qualities within a sensitively designed aural architecture creates the potential for a truly transcendent and immaterial experience. It is in this way that this design proposal strives to enlist the resonant natures of architectural forms to deeply engage and expand the sensory awareness of human spatial perception.

I. EXTENDED ABSTRACT

I.1. Background

Inspired by powerful sonic phenomenon manifest in architecture found around the world and specifically at the Hypogeum Hal Saflieni in Malta, this design proposal acts as a speculative exploration into the creation of aural architecture. The findings of neuroscientific research show that sonic phenomenon created by the resonant chamber of the Oracle Room in the aforementioned Hypogeum act to induce shifts in the human brain through sensory expansion (Cook, 2008). Such shifts toward meditative or trance states are a powerful effect of the influence of sound on the brain and body. Just as the captives in Plato's cave, our sensory perception defines the limits of how we understand ultimate reality. If architecture can act as a tool to extend such limits of perception, so to may it enable an extension of our understandings of the world around us. Architects have a critical role in the creation of future spaces which leverage this sonic ability to expand human sensory perception, and by proxy create spaces fine-tuned for contemporary enlightenment.

I.2. Methodology / Procedure

Just as Plato sought to discover the generative forces of the universe through mathematical rationalism (Platonic Solids), this project searches for generative processes hidden within the mathematical formulae which define nature. Rather than seeking purely geometric ideals though, this work mines the blueprints of creation through physics, specifically cymatics – a subset of modal vibration phenomenon. Through the creation of an algorithm which maps the motion of sonic frequencies, the designer is able to use sound as a generative force within the design process. The resulting 3 dimensional formal arrangements, or Nodal Structures, each represent a particular frequency mapped in space. Through this design process, the designer is enabled to use sound as inspiration not only in the poetic sense, but also through literal means as form-giver.

By applying the lessons behind various sonic precedents including the Hypogeum Hal Saflieni, the designer seeks to create spaces which are hyper resonant to particular frequencies. Through a choreographed series of sonic experiences composed of disruptive sonic input along with patterning forces such as entrainment, the designer could formulate spaces intended to shift brain states to specifically predetermined patterns. (Crowe, 2004) Such a tunable space would open the doors to potentially powerful sonic effects on human cognition and sensory perception.

I.3. Continued Testing

Since exploring such a generative design process, the designer continues working toward methods of acoustic testing and verification by which to drive further innovation and development. Through advanced 3D modeling processes and algorithmic design, the designer continues to probe the potential effectiveness of various spatial arrangements to manipulate resonance and reverberation. Examples of ray tracing processes explore the movement of sound within the generated forms while mathematical measurements of scale and dimension inform the potential resonant frequencies based on wavelength calculations. All of these are checked against frequencies which exhibit manipulative effects in the realms of sensation, perception, emotion, and affect; all toward the aim of creating formal arrangements which act as instruments for altered mental states.

2. IMPLICATIONS FOR FUTURE WORK

While this body of research and design currently remains in the realm of proposition and experimentation, the exploration acts to exhibit how lessons learned through cross-disciplinary research might be applied into the built environment. Potential programmatic uses for such architectural spaces would include sensory laboratories, sonic therapy chambers, sonic exploratoria, use in theater design, church/sacred spaces, and even urban follies offering a sonic oasis from a disastrous urban soundscape. The built results of such research may someday offer the opportunity for further acoustic testing. Such a focus on the power of sound to effect brain states could offer exciting new insight into the role of architecture in creating healthy spaces; or taken to its furthest extents, create tools for meditative experience and instruments for expanded sonic perception.

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4. AUTHOR BIO

Shea Trahan holds degrees in architecture from both the University of Louisiana at Lafayette and Tulane University. His graduate research combined interests in sensory neuroscience, architectural acoustics, and algorithmic design. Shea's architectural process focuses heavily on the experiential interaction between architecture and the senses, most notably hearing. His award-winning explorations into algorithmic design and 3D printing have been featured at the New Orleans Museum of Art. He has spoken on the topic of sonic architecture as part of the ULL Art/Tech Fusion Conference as well as a 2015 TEDx talk.

Shea is a project manager at the New Orleans based firm of TrapolinPeer Architects where he focuses on the design of theater projects along with cultural/museum designs. Most of his projects also incorporate adaptive reuse of historic buildings allowing for a fusion of contemporary design within historic contexts. In addition to architecture, Shea maintains a modestly respectable vinyl record collection and has a lifelong passion for both analogue and digital photography.

Overview of Scientific Aspects of Spatial Cognition: Significance in Architectural Design

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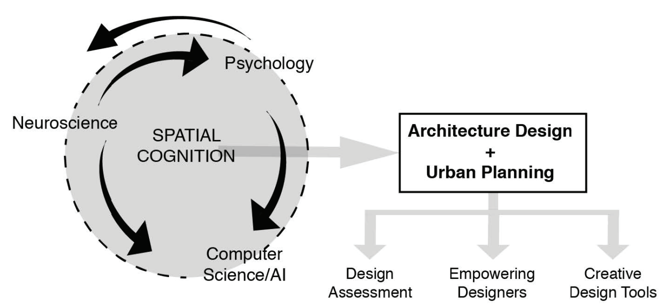
1. EXTENDED ABSTRACT

1.1. Summary

In order to understand the implications of spaces on human behavior and vice versa, it is first imperative to understand the process of spatial cognition and its computation in the human brain. Spatial cognition is an essential aspect of our social behavior in different spaces and also plays an elemental role in our spatial perception, psychology and memory. However, the merits of understanding spatial cognition are not limited to fields of neuroscience and social sciences, but also extend to architecture and urban planning. In this paper, I argue that it is essential for architects to understand various scientific aspects of spatial cognition in order to design spaces that invoke the spatial experience intended by the designer. Further, I investigate the current literature on various aspects of human spatial cognition and highlight the implications of these findings in the process of spatial design and planning. I also summarize the different computational models of the cognitive process developed for applications - such as robotic exploration in unmapped regions and for human interactive interfaces. The paper concludes by proposing a framework, which is predominantly driven by spatial cognition, and aims to redefine the modality of design and creative design pedagogy.



1.2. Scientific Aspects

Human beings, in addition to being social species, are also spatially sensitive in a significant way. Our spatial cognition apparatus, not only assists in spatial navigation and orientation, but also influences our emotions and associative memories. This cognitive process can be argued as being of multi-modal nature, as we perceive our environment through various senses – brightness, noisiness, smell, openness/ vastness, symmetry, repetition and other such design features. As we sense our environment through various modes, we also form a spatial representation of these places in our memory called the "spatial image"[Loomis, 2008]. This symbolic representation commonly forms an associative memory link between the senses and emotions – called as "place attachment" in psychology [Lewika, Maria, 2011], and often measured quantitatively in Psychometric and Likert scale. Scientist Nancy Kanwisher [2009] and her lab have successfully located the region in our brains called PPA – the parahippocampal place area, which responds not only to spatial environment, but also images of scenes and places. Her paper informs how this region is significant in tasks wherein humans rely solely on layouts of spaces (and not objects or landmarks) to reorient themselves in an environment after they are disoriented. The modes of encoding structured spatial information in human brain are mainly classified as egocentric and allocentric frames of reference [Pailiard, 1991]. Behavioral studies on the egocentric and allocentric cognition processes show that these mechanisms assist not only in our navigation ability, but also govern the levels of attention required for correct perception of spaces.

1.3. Relevance in Design

Architectural design and planning impose significant emphasis on properties of symmetry, axial orientation, sequential alignment, optimized placement, proximity and other such characteristics for building circulation, program placement, city planning, urban landuse etc. While most of these designs emerge from an intuitive understanding and knowledge of spatial experiences, I argue that a scientific basis of developing spaces – in particular user and use specific designs would go a long way in creating efficient solutions in varied ways (e.g., spaces for visually impaired, or university design focused to enhanced learning or city planning). As a designer, I maintain that there is a significant difference in concepts and processes of cognition of places and spaces. Places form the physical attributes of environmental information like location, orientation, etc. while spaces are embedded with abstract

information involving emotions, feelings etc. If we understand the process of acquisition of information of a physical place, its cognition by our innate cognitive apparatus and encoding of this perceptive information into our spatial memory, we can be better equipped to hack this process to create spatial environments that produce a seamless transition between place and space perception.

Architects and designers can also leverage the scientific observation of difference in attention demands (in different spatial environments) to instill the feel of awe and emphasis in creative architectural designs. By governing which aspects of spatial use can be designed as egocentric and which aspects can be forced to be allocentric we can quantitatively assess successful use of spaces designed by the architect for a particular purpose. Additionally, by measuring the accuracy of spatial updating while traversing through a given space using different modalities like sound, vision, touch or plain blind navigation, one can measure or compare performance and behavior of users of spaces. This aspect of spatial cognitive theory is crucial not only in defining success of architectural designs for users of varied disabilities, but also provides basis for framework of quantitatively assessing design space efficiency. Using this concept of spatial updating along with computational models of neurological cognition of users in space, designers can simulate and predict the user behavior in their specific designs and correct inefficiencies. These concepts can further be used to evaluate multiple iterations of design and can be coded into computational systems designed for user specific models.

1.4. Contributions

In conclusion, this paper shifts focus on significance of acquiring the scientific knowledge of spatial cognition from the different fields of neuroscience, psychology and computational science. The concept of creative intelligence is a significant one, and this paper suggests that the empirical interdisciplinary studies of spatial cognition would enhance the creative intelligence of designers especially in shaping environments.

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3. AUTHOR BIO

Dishita Turakhia is an architect and computational researcher studying at MIT with interest in computation in creative design. Her current research focuses on using artificial intelligence (AI) to develop humanlike socially cognitive architectural systems.

The Scope of "Empathy" in Architecture From the design process to the user's experience and back

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I. EXTENDED ABSTRACT

The phenomenon of empathy (and its related processes) can be considered at very different level in architecture, due to the domain's complexity. In this presentation I am going to review these various levels mainly from philosophical and cognitive points of view.

Along with personal empathy, which refers (in a narrow sense) to an affect-based understanding of another's inner life, there seems to be a form of empathy directly based on the perception of objects rather than persons, namely objectual empathy. The notion of personal empathy being conceptually and explanatory prior to the notion of objectual empathy, the latter is always an indirect way of understanding other (real or hypothesized) human beings.

First, I am going to discuss five types of object-based understanding and ask whether any of them illustrates the phenomenon of objectual empathy: objects as affordances, imaginative explorations of objects, bodily projections onto objects, objects as traces of action, objects as traces of emotion. Then, I will examine the relevance of these examples to architecture. One might ask, e.g., whether the perception of an architectural drawing can engage the same empathetic abilities that are enabled by the perception of the actual building itself, whether on the side of the designer's experience (embodied simulation of the future users) or on the user's (ability to understand the architect's intentions as a client in a commercial context or as a visitor in an architecture exhibition).

Finally, I would like to show that empathy can be educated through experience and teaching. In this respect, the use of images, artworks and other representational media often plays a significant role in the development of empathy. It has been argued that our experience of representations can evoke empathetic responses that our perception of the world beyond representations does not. Through learning, a high-level cognitive ability can become implicit and spontaneous, even if it was initially explicit and deliberate.

The study of empathy for the architectural object, its makers, its users, and even its representations, opens the way to future significant discoveries of great interest particularly in the context of architectural education.

Keywords: affordances, aesthetic experience, architecture, design process, empathy, representational media

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Anne Tüscher was trained in philosophy before becoming an architect in Switzerland. She earned a PhD in cognitive science (Philosophy Major) by studying simultaneously psychophysics of space perception at the LPPA (Professor Alain Berthoz' lab at Collège de France) and philosophy of mind at the Institut Jean Nicod in Paris. She was a postdoctoral research fellow at the Neurosciences and Cognitive Sciences department of the Hanse-Wissenschaftskolleg in Delmenhorst (Germany), working on the visual and neural underpinnings of parallel perspective representation. Currently, she occupies a Lecturer position in Humanities at the École Nationale Supérieure d'Architecture de Paris La Villette (France), where she teaches philosophy and cognitive science to architecture students. She is a full member of the UMR CNRS MAP-MAACC and an associate member of both the UMR CNRS Institut Jean Nicod and the UMR CNRS CRAL. Her research interests focus on spatial perception and representation, mainly through graphic artefacts. She published essays in architecture journals as well as in philosophy reviews.

Utilizing Architectural Diagrams to Create Geometric Forms that Anticipate User Responses

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I. EXTENDED ABSTRACT

I.I. Introduction

The Diagram is an architectural design tool that operates between conceptual ideas and resultant geometry, between design intent and a building's shape. What if we could harness the power of diagramming to make a building appeal directly to human neurological processing? By inserting an honest exploration of diagram to control geometric forms via analysis of program, circulation, context, and environment, we can potentially organize architectural geometry to more effectively coordinate with expected human responses, our collective visual memories, and cognitive mapping. By the agency of contextual learning, a building's users should be able to determine their route and occupation of a space without the need to have a floorplan or view copious signage. Many architects have been experimenting with this technique without specifically identifying the neurological research implications.

In Peter Eisenman's book Diagram Diaries, theorist Robert Somol explains the unique character of what defines a diagram: "it appears in the first instance to operate precisely between form and word," and it is primarily "a performative rather than a representational device." To understand the potential of utilizing diagrams to create responsive forms, we can assess the classification, characteristics, and the evaluation criteria of their application. We can also evaluate both the historical utilization of this architectural technique and its implementation in more recent examples.

I.2. Classification

I. Analysis. Analytical diagrams are frequently created post-construction or post-concept, to either compare or explain the spatial qualities of a particular piece of architecture. Typically, these types of diagrams are in search of patterns to reveal spatial divisions or some other spatial device such as phenomenal transparency. This is primarily a mathematical exercise, evaluating standard architectural elements: column, floor, wall, and roof. Colin Rowe was a frequenter of this type of diagram, and Peter Eisenman employed a series of analytical diagrams when generating his house plans during the earlier part of his career.

2. Performance. Of greater concern to neurological research, diagrams should indicate building performance. Typically, a performance based diagram is considered during the conceptual design phase, and, optimistically, before notions of form and typology are generated. Performative diagrams can be characterized by their adherence to three main attributes:

- **2a. Operation.** These diagrams concern the exhibition of programmatic relationships, environmental concerns (daylight, ventilation, solar gain, etc.), and circulation (pedestrian, vehicular, entry, etc.). Contemporary diagrams frequently consider zoning issues, adjacent context, views, and site features.
- **2b. Geometry.** These are the forces that may influence a building's shape: the plasticity of form absent of meaning. This includes geometric manipulations such as: "expand, extrude, inflate, branch, merge, nest, offset, bend, and skew." Architects frequently employ arrows to indicate which geometric forces are employed.
- **2c. Translation.** It is important for the investigation of the operative intent to inform the geometry of the building. One of the major distinctions of what defines a diagram is that it is essentially a drawing in search of a relationship between geometry and some outside force, what Eisenman calls an "external agent." This is the attribute most important for studying human neurological interpretation for architectural practice, where there is a literal connection between the diagrammatic ideas and the form.

I.3. Characteristics

Simplification. The simplification of the diagram is an essential step. Without it, the complexities of the diagrams begin to elicit too many intentions and interpretations. **Hierarchy.** The strategic determination of the sequence in which forces operate on the geometric form. **Drawing Type.** Diagrams may be plan, section, axonometric, or perspective; orthogonal or curvilinear; hard-lined or freehand. They can be singular, simultaneous, or sequential. **Spatial Elements.** Meaning can be injected into geometry via landmarks, pathways, nodes, volumes, areas, edges, and architectural elements.

I.4. Evaluation Criteria

Relevant Scale. The direct relationship between the scale of the investigation and the scale of the architecture within such a building. **Symbolism.** The correlation between a symbolic reference and a building's shape. **Plasticity.** A truly plastic design technique would ignore existing tectonics and typologies. Standard architectural elements: column, wall, floor, can be reduced to their core functions, which might be: gravity displacer, space divider, and gravity positioner, respectively. **Behavior.** Designing for a particular behavioral response. **Transparency and Legibility.** Revealing the diagram experientially within a building to effectively communicate an intended response by a user. **Gestalt.** The visual expectations of humans to form impressions via how the architecture is organized and expressed. **Cognitive.** Human tendencies for comfort and security.

I.5. Historical Examples

Panopticon. A simple and reductive idea: a central guard can view all cells of a prison simultaneously. **Guggenheim New York.** Wright developed a continuous loop for exhibition with an honest investigation into the conduct of a museum visitor. **Carpenter Center.** The centralized promenade is designed so that there is a gradual revealing of the programmatic pieces within the building.

I.6. Contemporary Examples

The Broad. The Architects' investigative procedure involved a direct correlation between their concept: the "veil and the vault," and the programmatic requirements: the display and the storage of artwork. **The Spiral at Hudson Yards.** Extending the adjacent High Line Park into the construction of the tower, every floor has an outdoor terrace with park-like qualities. An office tenant may intuitively feel connected to the adjacent office floors and the High Line below. **The Couch.** Compiling programmatic needs can create legible forms for user groups. This project elucidates how buildings can be more acrobatic, simultaneously responding to multiple influences at one moment via versatile geometry.

I.7. Author's Research Projects

Frogtown Riverside Center. An investigation into a site's most prominent feature, a recreation path, yields a curvilinear multi-story geometry accommodating multiple user groups. **ONE Archives at USC Libraries.** A programmatic investigation yields distinct interpretable geometries: the archives (solid and closed), an exhibition loop, and modular research and operations spaces.

I.8. Further Research

Testing may determine if average people can passively commit geometric diagrams into their spatial memories for using a building. There are parallel investigations into cognitive mapping and the cortical mechanisms of visual processing that could be mutually beneficial. How can we identify evaluation criteria to determine the success of this architectural technique? Possible studies could include evaluating the experiences of two groups within a building, one of which has been given the circulation or programmatic diagram. Another possibility is to test cognitive mapping by exploring the utility of color and edges to delineate clear zones and circulation paths in existing diagrammatic buildings.

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3. AUTHOR BIO

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B.Arch. Cornell University, M.Arch. University of Pennsylvania. Michael is the President of IntuArch, a Los Angeles based architecture firm which focuses on developing innovative geometries in response to research in programmatic, environmental, circulatory, and contextual analysis. Previously, as Director of the Los Angeles Studio of MADA s.p.a.m., Michael acquired his focus on creating effective design strategies while working for the Dean of the USC School of Architecture, Qingyun Ma. Michael is now a jury critic at USC.

Approach to a Scientific Design Method for Programmable Schools towards 'NeuroArchitecture'.

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I. EXTENDED ABSTRACT

This project synthesizes an ongoing experimental inquiry, the "Programmable School Research Project", exploring the interaction between the brain, body, built and natural settings to inform affordable but high performance school design for Brazilian rural areas. In combination with biosensors (i.e. EEGs, physiological nanosensors) and environmental sensors (i.e. beacons, SAW, light, humidity, temperature, wind), the impact of school design on pupil outcomes could be measured on-site in both virtual reality visualizations and built settings by means of site-specific advanced design and low-cost prototyping through digital fabrication. Cutting-edge innovations from NBIC approach like algorithmic and generative design, artificial neural networks, rapid prototyping and digital fabrication, scientific visualization and acoustic innovations will allow researchers, pupils and their educational community to experience the consequences of design before it is built by testing their responses to specific learning tasks dealing with classroom attentiveness, privacy, socialization, wayfinding or familiarity.

METHODOLOGY

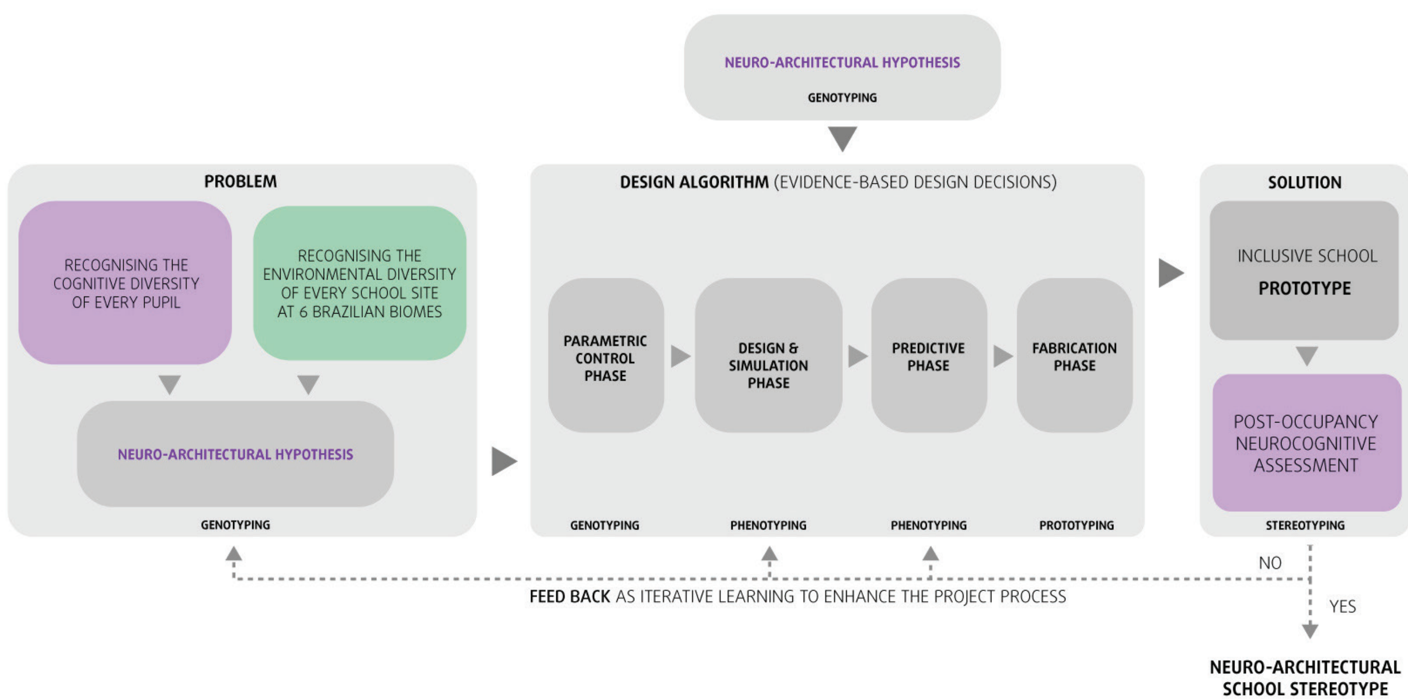

Figure I: Draft of the method's diagram for a Programmable Schools.

To achieve those objectives, this Project approaches and tests a scientific design method for a convergence between neurosciences & architecture, grounded on the logic of semiotics, towards the design of programmable schools throughout Brazilian diverse territories, interacting with the particularities of every biome and every pupil. A so-called 'Programmable Architecture' or 'NeuroArchitecture' would be that emerged from this project method integrating convergent techno-sciences (NBIC: Nano, Bio, Info, Cogno) throughout every architectural process to deliver school facilities: the project (from ideation to simulation through immersive virtual reality), the execution (through digital fabrication & assembling logics) and the use (from interactive performance to management & dismantling).

Relevant bibliography is compiled among Spanish, Portuguese and English literature for the groundings of such a epistemological framework for programmable architecture that could inform a synthetic diagram representing a future school's design, manufacturing and performance scientific methodology and its practical consequences, relating concepts and theoretical approaches to specific, real problems.

FUTURE IMPLICATIONS

Nowadays, immersive technologies are mostly used for virtually experiencing already built architectures; the approach illustrated here takes advantage of the generative features of algorithmic and parametric design and computer graphics, to test a bunch of possible future school designs (the candidate 'offspring') before a single atom is manufactured. In this way, programmable architectures could enable modifying spatial and neurocognitive parameters in real-time to check interdisciplinary correlations.

Customization of school design and educational facilities is attracting great expectations, following neurocognitive high performance levels and understanding architecture as an interpretative, responsive menbrane between the human cognition and the natural environment.

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Designing bio-wearable computers to expand interactions between bodily spaces and physical environments

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1. EXTENDED ABSTRACT

This research presents and discusses the Design-Neuroscience cooperation in the design of organic interactions with the physical environment afforded by wearable bio-computers. It is based on the contributions of studies related to the paradigm environment / behavior / neuroscience [1] and emotional processing in the human brain [2, 3, 4, 5, 6, 7] regarding the identification and recognition of neurophysiological information relevant to design research and practice. It also discusses the Neuroscience-Design relationship in the projectual practice of the biowearable computer NeuroBodyMimeses addressing the interaction between the body's user (neurophysiological signals and brain waves), the digital technological system and the physical environment by employing wearable bio-computers. [9, 10, 11, 12, 13]

According to Poissant [14], interfaces are becoming more natural and may take, alternately or simultaneously, extensible, enlightening, rehabilitative and filter functions or act as agents of synaesthetic integration. In the opinion of Bureaud [15], interfaces, seen as sensory organs, generate a deconstruction of the usual modes of perception, as a kind of fragmentation/displacement of the body that leads to reflection on these modes of perception, to questions about the nature of space in which this body exists and fundamentally redefines itself as human.

As a device focused on the social interaction in physical space, the wearable biocomputer NeuroBodyMimeses establishes a direct relationship between the physical environment and the user's body, from the real-time detection and interpretation of the user's emotional state. In situations of increased anxiety and stress, for example, this wearable bio-computer modifies the visual appearance of its surface, in immediate response to the user's neurophysiological changes due to their interaction with the surrounding space, and it can even mimic the visual standards of this environment. Thus, this device intends to give to the user's body the "regency" of social visibility in physical environments, releasing it, for example, from facing confrontational situations when it is not prepared for such, from the neurophysiological standpoint.

Figs. 1 and 2. NeuroBodyMimeses Wearable Bio-Computer (© 2012, Zuanon & Lima Júnior)

As "agent of stable mediations between thought and matter, thought and sensibility" [15], NeuroBodyMimeses enlarges the notions of complexity, affectiveness and naturalness to an organic scale, in which the neurophysiological information (biological signals) of the users is translated as digital data. It is done to configure an interaction that responds to their emotional state in order to match their body state specifically at that moment of their interaction with the surrounding physical environment.

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3. AUTHOR BIO

Dr. Zuannon is the coordinator of the PhD and Master's Design Program at the Anhembi Morumbi University, Brazil. Researcher and professor in the same Design Program, she is also a designer and media artist. CEO of the All Affective Design for Innovation and of the Zuannon Integrated Solutions. Head of CNPq research group of "Design, Creation, Language and Technology" and Brazil leader in the research project "Tremors Time Interactive Convergent Project", focused on the development of innovative wearable interfaces for games held in international cooperation with OCAD University (Toronto), Xenophile Media (Toronto) and Zuannon Integrated Solutions (Brazil) and supported by ISTP | FAPESP. Author of several scientific works, she had presented her research in EUA, Canada, China, Japan, Singapore, Taiwan, Germany, Greece, Portugal, Turkey, UK, Vienna, and many other places around the world. She is also an Ad-hoc Assessor for the most important Brazilian Agencies for scientific research support, as FAPESP and CAPES. She is dedicated to research in design of bio-wearable computers since 1998. In 2010, in PhD and Master's Design Program, she founded and since then she coordinates the Sense Design Lab – a laboratory dedicated to support researches focused on Design and Neuroscience relationship. She was granted the privilege of displaying the "Neurobodygame - Co-evolving affective wearable computer #4" artwork as FILE PRIX LUX 2010 finalist at SESI-SP Art Gallery Exhibition. In 2008, featured "BioBodyGame – Co-evolving affective wearable computer #3" artwork at Gameplay exhibition, held by Itaú Cultural. In 2007, she won Rumos Artes Cibernética prize with Biocybernetic Relational Object - Co-evolving affective wearable computer #2. In 2006, she had the artwork "Co-evolving affective wearable computer" exhibited at Primeira Pessoa exhibition, held by Itaú Cultural. In 2003, this very same research was granted an honorable mention from Rumos Itaú Pesquisa. She was a finalist for the Rumos Dance 2003 - Videodance award, granted by Itaú Cultural. She received the APCA award in 2000, granted by Sao Paulo Association of Art Critics. In 1999, she was a VITAE fellow in two residency programs at the American Dance Festival.

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