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

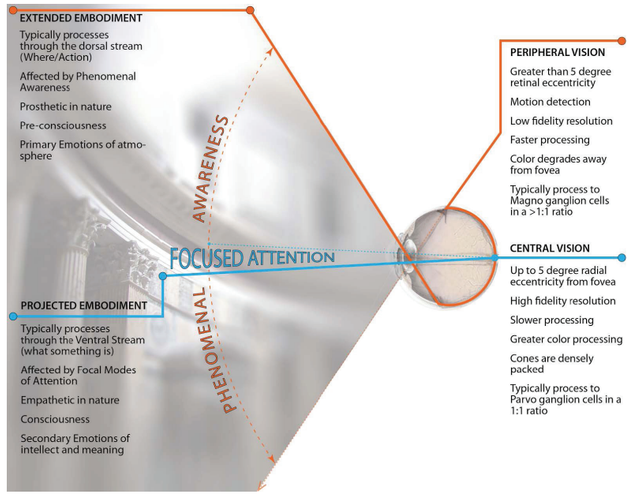

Figure 1 is a schematic of our contentions for architecture and the eye. I realize that these are vast generalizations in the complex biology of the eye \ brain. For instance the ventral and dorsal streams overlap and share in the parahippocampal area, however, dividing into two emotive and cognitive 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.

2. REFERENCES

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[2] Pallasmaa, Juhani. "An Architecture of the Seven Senses," in Steven Holl, Juhani Pallasmaa, and Alberto Pérez Gómez. Questions of Perception: Phenomenology of Architecture. New York, William Stout: 2006: 26-37.

[3] Several article play in this perspective: in particular David Freedberg, and Vittorio Gallese. "Abstract art and cortical motor activation: an EEG study." Frontiers in Human Neuroscience 6, 2012. Freedberg, David, and Vittorio Gallese. "Motion, emotion and empathy in esthetic experience." Trends in Cognitive Sciences 11, no. 5, 2007: 197-203. Umilta, M. Alessandra, Cristina Berchio, Mariateresa Sestito,

[4] Cinzia, Di Dio, and Gallese Vittorio. "Neuroaesthetics: a review." Current Opinion in Neurobiology 19.6 (2009): 682-687.

[5] Among many papers see particularly Mallgrave, Harry Francis. Architecture and Embodiment: The Implications of the New Sciences and Humanities for Design. Routledge, Taylor & Francis Group, New York, 2013.

[6] Arbib, Michael. "Towards a Neuroscience of the Design Process," pg.75-98 in Mind in Architecture. Compare with: Michael Arbib, "[Why] Should Architects Care About Neuroscience," in Architecture and Neuroscience, Tidwell, Phillip, Ed. Published by the Tapio Wirkkala-Rut Bryk Foundation: 2013: 43-72.

[7] Much of this work is based on the work of Dr. Kevin Rooney, see: Kevin K. Rooney, Robert J. Condia, Lester C. Loschky. "Focal and Ambient Processing of Built Environments: Object-based and atmospheric experiences of architecture." Frontiers in Psychology, in final peer review.

[8] For a background on vision and the arts see Livingstone, Margaret, and David H. Hubel. Vision and art: The biology of seeing. Vol. 2. New York: Harry N. Abrams, 2002.

[9] Rigoulot, Simon, et al. "Peripherally presented emotional scenes: a spatiotemporal analysis of early ERP responses." Brain Topography 20.4 (2008): 216-223.

[10] Several papers come to mind here: Manuel G. Calvo , Lauri Nummenmaa & Jukka Hyönä (2007) Emotional and neutral scenes in competition: Orienting, efficiency, and identification, The Quarterly Journal of Experimental Psychology, 60:12, 1585-1593. Calvo, M. G., Nummenmaa, L., & Hyönä, J. (2008). Emotional scenes in peripheral vision: Selective orienting and gist processing, but not content identification. Emotion, 8(1), 68. Calvo, Manuel G. "Processing of emotional visual scenes outside the focus of spatial attention: The role of eccentricity." Visual Cognition 13.6 (2006): 666-676. Calvo, Manuel G., and Peter J. Lang. "Parafoveal semantic processing of emotional visual scenes." Journal of Experimental Psychology: Human Perception and Performance 31.3 (2005): 502. De Cesarei, Andrea, Maurizio Codispoti, and Harald T. Schupp. "Peripheral vision and preferential emotion processing." Neuroreport 20.16 (2009): 1439-1443.

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.