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PRESENTER ABSTRACTS

ACADEMY OF NEUROSCIENCE FOR ARCHITECTURE

The Challenge of Adapting Neuroscience to the Needs of Architecture

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

1. EXTENDED ABSTRACT

1.1. The Many Levels of Neuroscience

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

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

1.2. Three Forms of Neuroscience for Architecture

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

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

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

1.3. Case Study 1: The Hippocampus, Wayfinding and the Seattle Public Library

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

1.4. Case Study 2: The Thinking Hand

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

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

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3. AUTHOR BIO

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

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

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