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Presentation Antonino Saggio, Introduction Paola Gregory

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TOWARDS A NEUROSCIENCE OF ARCHITECTURE

– Embodied Mind and Imagination

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"While the brain controls our behaviour and genes control the blueprint for the design and structure of the brain, the environment can modulate the function of genes and, ultimately, the structure of our brain, and therefore they change our behavior. In planning the environments in which we live, architectural design changes our brain and behavior"[1]
Fred Gage

ARCHITECTURE – AN IMPURE DISCIPLINE

Architecture is a hybrid and "impure" discipline. The practice of architecture contains and fuses ingredients from conflicting and irreconcilable categories, such as material technologies and mental intentions, construction and aesthetics, physical facts and cultural beliefs, knowledge and dreams, past and future, means and ends. Besides its traditional reliance on the tacit knowledge of timeless practices of construction, architecture relies largely on theories and findings of other areas of research and knowledge instead of possessing an independent theoretical foundation of its own. During the past decades, architecture has been viewed from various theoretical perspectives, provided by, for instance, psychology, psychoanalysis, structuralist linguistics, and anthropology as well as deconstructionist and phenomenological philosophies., just to name a few. It is evident that in the field of architecture, scientific criteria or

methods have mainly been applied in its technical, physical and material aspects, whereas the mental realm ihas been left to individual artistic intuition. On the other hand, the fast development of computerized digital technologies has provided an entirely new horizon for architectural production. In fact, the digital technologies seem to have developed beyond our complete grasp of what really is the essence in the interaction of digital technologies and the innate nature of our biologically grounded perception, experience and lived reality. At the face of the miracles brought about by technical innovations, we tend to underestimate, or entirely neglect, the miracles of life itself.

The complexity of our neural system is beyond comprehension: the human brain contains more than one hundred billion neurons, and each neuron has in average 7000 synaptic connections. That amounts to the staggering fact that each one of us has roughly 500 trillion synapses.[2] Along with the current discourse arising from ideas of human embodiment and the new emphasis on sensory experiential qualities, various findings and views emerging in the neurosciences are promising a deeper understanding of the mental implications and impacts of the art of building. In addition to its essence as an artifact, architecture now needs to be seen in its biological and ecological context. Recent findings in the complexities and plasticity of the human brain and neural systems emphasize the innately multi-sensory nature of our existential and architectural experiences. These views challenge the traditional and still prevailing visual understanding of architecture and suggest that the most significant architectural experiences arise from existential encounters rather than retinal percepts, intelligence and aesthetics of the new. In these encounters the world and the perceiver become merged, and the boundary between outer and inner mental worlds turn vague, as they merge. As Maurice Merleau-Ponty argues, “The world is wholly inside, and I am wholly outside myself”[3].

Most importantly, the recent discovery of mirror neurons begins to help us to understand the origins of empathy and emotion, and how we can experience emotion and feeling in material and spatial phenomena. How can a painting, consisting of paint on canvas, and a building made of dead matter, make us feel anguished or happy, bored or stimulated, rooted or alienated? Why does the stair hall of Michelangelo's Laurentian Library, built of mere pietra serena, make me weep?

Today, scientific experiments reveal the processes taking place in the human brain as well as their specific locations, dynamics and interactions. Yet, experiencing mental and poetic meaning through space, form, matter, and illumination is a phenomenon of different category and order than observations of electro-chemical activities in the brain. That is why combining the quickly advancing neurological knowledge to appropriate philosophical framing and analyses seems a particularly suitable methodology in approaching the mysteries of artistic meaning. This approach with a double focus has been appropriately called neurophenomenology.

THE MEASURABLE AND THE IMMEASURABLE

Instead of attempting to enter the ground of neuroscience, I wish to say something about the specific mental essence of architecture, that ought to be understood before any hasty conclusions are made about the relations of distinct brain activities and architectural qualities. Architecture is a realm that is deeply biologically, culturally and mentally grounded, but today frequently neglected in theoretic studies, education as well as professional practice. I hope that the biological sciences and neuroscience, which are opening exciting doors to the essence of brain, mental functions and consciousness , can valorize the interaction of architecture and the human mind, and reveal the hidden complexities that have escaped rational analyses and measurement. In our consumerist society, often dominated by

shallow and prejudiced rationality and a reliance on the empirical, measurable and demonstrable, the embodied, sensory and mental dimensions of human existence continue to be suppressed. “The genuineness of an expression cannot be proved; one has to feel it”, Ludwig Wittgenstein points out, and this applies to existential qualities as well[4]. Or, as Jean-Paul Sartre argues: “Essences and facts are incommensurable, and one who begins his inquiry with facts will never arrive at essences… understanding is not a quality coming to human reality from the outside; it is its characteristic way of existing.”[5]

I believe that neuroscience can give support to the mental objectives of design and arts, which are in danger of being disregarded because of their “uselessness” and apparent subjectivity. The new biological sciences can emancipate us from the limits of the “naïve realism” of our culture. Architecture has its utilitarian qualities in the realm of rationality and measurability, but its mental values are most often concealed in embodied metaphors and ineffable unconscious interactions; it can only be encountered, experienced and lived.

Instead of attempting to suggest the new insights of the neuroscience, that may be applicable in architecture, I have chosen to focus on the mental dimensions of buildings , the essences that could be valorized by new scientific research. I believe that neuroscience can reveal and reinforce the fundamentally mental, sensory, embodied, and biological essence of architecture against today’s tendencies towards ever increasing materialism, intellectualization, and commodification.

THE TASK OF ARCHITECTURE

The purpose of our buildings is still too often seen narrowly in terms of functional performance, physical comfort, economy, symbolic representation, or aesthetic values. However, the task of architecture

extends beyond its material, functional, and measurable dimensions, and even beyond aesthetics, into the mental and existential sphere of life. Besides, architecture has practically always a collective impact and meaning. Buildings do not merely provide physical shelter or facilitate distinct activities. In addition to housing our fragile bodies and actions, they also need to house our minds, memories, desires, and dreams. Our buildings are crucial extentions of ourselves, both individually and collectively. Buildings mediate between the world and our consciousness through internalizing the world and externalizing the mind.

Landscapes, built settings, houses and rooms are integral parts of our mental landscape and consciousness. Through structuring and articulating lived existential space and situations of life, architecture constitutes our most important system of externalized order, hierarchy and memory. We know and remember who we are as historical beings by means of our constructed settings. Architecture also concretizes "human institutions" – to use a notion of Louis Kahn – the accumulation and structuring of culture, as well as the layering of time. It is not generally acknowledged that our constructed world also domesticates and scales time for human understanding. It is usually accepted, that architecture gives limitless and meaningless space its human measures and meanings, but it also scales endless time down to the limits of human experience. As Karsten Harries, the philosopher, suggests, architecture is "a defense against the terror of time"[6]. Architecture slows down, halts, reverses, or speeds up experiential time, and we can appropriately speak of slow and fast architectures; it is evident that in our era of speed and acceleration architecture becomes ever faster. As Paul Virilio has remarked, speed is the most important product of the contemporary culture[7].

The human essence of architecture cannot be grasped at all unless we acknowledge its metaphoric, mental, and expressive nature. "Architecture is

constructed mental space", my colleague Professor Keijo Petäjä used to say. [8] In the Finnish language this sentence projects simultaneously two meanings: architecture is a materialized expression of mental space, and our mental space itself is structured by architecture. This idea of a dialectical relationship, or inter-penetration, echoes Maurice Merleau-Ponty's phenomenological notion of "the chiasmatic bind"[9] between the world and physical space, on the one hand, and the self and mental space, on the other. In the philosopher's view, this relationship is a continuum, not a polarity. The best visualization of this boundless mergin, that I can think of, is the mysterious Moebius strip, a three dimensional twisted loop, which has two side ,but only a single surface. It is exactly this chiasmatic merging and mirroring of the material and the mental that has made the artistic and architectural phenomena unattainable for an empirical scientific approach; the artistic meaning exists fundamentally in the experience, and that is always unique, situational and individual. Scientific thinking needs to accept the first person perspective in phenomena which do not have another projection. Artistic meaning exists only on the poetical level in our encounter with the work, and it is existential rather than ideational. Merleau-Ponty also introduced the suggestive notion of "the flesh of the world", which we are bound to share with our bodies as well as with our architecture. In fact, we can think of architecture as specific articulations of this very existential and experiential flesh; through architecture we mold our domicile and ourselves. In accordance with the motto of my essay, settings alter our brain, and our brain (or neural entity) changes our behavior and the world. It is now known that the architecture of each person's brain is unique, and its uniqueness stems partly from the places he/she has experienced .[10]

BOUNDARIES OF SELF

"What else could a poet or painter express than his encounter with the world", Merleau-Ponty asks.[11] An architect is bound to articulate this very

same personal encounter, regardless of the basic utility and rationality of his task. This might sound like a self-centered position for the designer, but in fact, it emphasizes and concretizes the subtlety of the designer's human task. In the essay written in memory of Herbert Read, Salman Rushdie suggests: "In the creative act the boundary between the world and the artist softens and permits the world to flow into the artist and the artist to flow into the world."[12] Profound pieces of architecture also sensitize the boundary between the world and ourselves, and they sensitize us to our domicile. The architectural context gives human experience its unique structure and meaning by means of projecting specific frames and horizons for the perception and understanding of our own existential situation.

Merleau-Ponty formulates the idea of the world as the primary subject matter of art (and architecture, we may again add) followingly: "We come to see not the work, but the world according to the work."[13] We are invited inside a unique ambience, an artistically structured world of embodied experiences, which addresses our sense of being, and temporal duration in a way that bypasses rationality and logic. As Alvar Aalto wrote: "In every case (of creative work) one must achieve the simultaneous solution of opposites. Nearly every design task involves tens, often hundreds, sometimes thousands of contradictory elements, which are forced into a functional harmony only by man's will. This harmony cannot be achieved by any other means than those of art."[14]

THE SECRET CODE

The content and meaning of an architectural experience is not a given set of facts or elements, as it is a unique imaginative re-interpretation and re-creation of a situation by each individual. The experienced meanings of architecture are not primarily rational, ideational or verbalized meanings, as they arise through one's sense of existence by means of embodied and unconscious projections, identifications and empathy.

We are mentally and emotionally affected by works of architecture and art before we understand them, or, in fact, we usually do not "understand" them at all. I would even argue that the greater the artistic work is, the less we understand it intellectually. A distinct mental short circuiting between a lived emotional encounter and intellectual understanding is a constitutive characteristic of the artistic image. I wish to suggest that art is unconsciously more concerned with our past than the future; art desires to save or revitalize our mental connections with the biological and animistic world. A poetic understanding takes place through unconscious identification, simulation, and internalization. While rational understanding calls for a critical distance and separation from the subject, poetic "understanding" requires nearness and empathy. In fact, art is not about understanding at all, as an artistic image is an existential encounter which momentarily re-orients our entire sense of being. Great works possess a timeless freshness, and they project their enigmas always anew, as if we were each time experiencing the work for the first time. I like to revisit architectural and artistic masterpieces around the world in order to repeatedly encounter their magical sense of newness and freshness. I remember many of these masterworks by heart, yet they always appear enigmatic and unexpected as they embrace me in their unique ambience. The greater the work is, the stronger is its resistance to time. As Paul Valéry, the poet, suggests: "An artist is worth a thousand centuries."[15] The oldest rock paintings of Africa and Australia give evidence of experiential artistic values that have already survived four hundred centuries.

The interaction of newness and the primordial in the human mind is yet another aspect of the artistic and architectural image that can be understood through neurological research, I believe. We humans are essentially creatures that are suspended between the past and the future more poignantly than other forms of life, we are unnoticeably viewing the

future through our collective bio-cultural past. The common view that art is interested in and a harbinger of future is certainly a hasty assumption – the main concern of art is to maintain our biological and historical integrity.

IDENTIFICATION AND EMPATHY

As neurological research has recently revealed, we have a surprising capacity to mirror the behavior of others, and even to unconsciously animate and mimic inanimate material constructions and objects through our imagination. "Be like me", is the call of a great poem according to Joseph Brodsky.[16] A building certainly makes a similar invitation; a profound piece of architecture invites and guides us to be better and more sensitive human beings. The world of art and architecture is fundamentally an animistic world awakened to life by the projection of our own intuitions and feelings. In this very sense, the artistic intention is in -conflict with the scientific view.

We have an amazing capacity to grasp complex environmental entities through simultaneous multi-sensory sensing of atmospheres, feelings, and moods. This capacity to instantaneously grasp existential essences of vast entities, such as spaces, places, landscapes and entire cities, suggests that we intuit entities before we identify their parts and details. "The quality of the whole permeates, affects and controls every detail"[17], as John Dewey, the visionary philosopher, pointed out eighty years ago. This view of the dominance of unified entities over "elements" has been strongly suggested by neuroscience, and it casts a serious doubt on the prevailing elementarist theories and methods of education. The attempt to teach a complete experiential entity gradually through its "elements" is doomed to failure- we learn to swim only by experiencing water through our body, not by intellectually knowing its chemical constitution.

HUMAN BIOLOGICAL HISTORICITY

We need to accept the essential historical and embodied essence of human existence, experience, cognition, and memory. In our bodies we can still identify the remains of the tail from our arboreal life, the plica semilunaris in our eye corners as the remains of our horizontally moving eye-lids from the Saurian age, and even the remains of gills in our lungs deriving from our fish life hundreds of millions of years ago. We certainly have similar remains in our mental constitution from our biological and cultural historicity; one aspect of such deeply concealed memory was pointed out by Sigmund Freud and Carl G Jung, namely the archetype.[18] I want to add here that Jung defined archetypes dynamically as certain tendencies of distinct images to evoke certain types of associations and feelings. So, even archetypes are not concrete or given "building blocks" in artistic creation, as Post-Modernism seemed to believe- they are dynamic tendencies with a life of their own. Architecture, also, has its roots and mental resonances in our biological historicity. Why do we all sense profound pleasure when sitting by an open fire if not because fire has offered our predecessors safety, pleasure and a heightened sense of togetherness for some seven hundred thousand years. Vitruvius, in fact, dates the beginning of architecture in the domestication of fire. The taming of fire actually gave rise to unexpected changes in the human species and its behavior: "Control over fire changed human anatomy and physiology and became encoded in our evolving genome", Stephen Pyre suggestes.[19] Some linguistic scholars have suggested that also language originates in the primordial act of gathering around the fire. Such bio-psychological heritage, especially the spatial polarity of "refuge" and "prospect", has been shown to be significant in Frank Lloyd Wright's houses by Grant Hildebrandt.[20]. The proxemic studies of the American anthropologist Edward T Hall in the 1960s revealed unbelievably precise unconscious mechanisms in the use of space and its culture specific parameters and even meaningful chemical communication between our endoctrine glands , which have been considered to be closed

from the outside world and thus only have an internal metabolic function[21.] Such studies are surely only a beginning in re-rooting modern man, the Homo Faber, back in his biological roots, and neuroscience can be expected to valorize the internal workings of these genetic and instinctual behaviors and reactions. Neurological studies can also be expected to reveal the neural ground for our fundamental spatial and environmental pleasures and displeasures, as well as feelings of safety and fear. Neurological research has suggested that all reactions of biological life can be deduced back to the pleasure principle, and undoubtedly even today's technologized and "intelligent" buildings need to identify these primal human needs.

UNDERSTANDING ARCHITECTURE

Merleau-Ponty makes the significant remark, "The painter takes his body with him… Indeed, we cannot imagine how a mind could paint".[22] The same must certainly be said about architects, as our craft is unavoidably constituted in an embodied manner of existence, and architecture articulates that very mode of being. This argument turns more complex when we acknowledge that the notion of the "body" is not self-evident – we have at least four bodies: physical body, emotional body, mental body, and social body. In my way of thinking, architecture is more an art of the body and existential sense than of the eye, and more of emotive and unconscious feelings than rational deduction. This is where the logocentric and over-intellectualized theorizing of architecture, so popular in the recent past, has gone decisively wrong. But, again, neuroscience can valorize these hierarchies and priorities. I believe that neurological research will confirm that our experiences of architecture are grounded in the deep and unconscious layers of the human mental life.

What I have said so far probably suggests an opposition between the scientific and artistic approaches. I wish to reiterate that they are two fundamentally different modes of knowledge~~;~~: methodically formalized

knowledge, on the one hand, and existential and lived knowledge on the other, but I wish to suggest an attitude of mediation, particularly in my own field of architecture.

I am not speaking against attempts to grasp the structure or logic of experiential phenomena; I am merely concerned of a reductivist or biased understanding of architectural phenomena. The study of artistic phenomena also calls for appropriate methods of study. In the mid-1930s, Alvar Aalto wrote about "an extended Rationalism", and urged architects to expand rational methods even to the psychological and mental areas. Aalto states: "We might say that one way to produce a more humane built environment is to extend our definition of Rationalism. We must analyse more of the qualities associated with an object than we have done so far."[23] Aalto continues: "It is not the rationalization itself that was wrong in the first and now past period of modern architecture. The wrongness lies in the fact that the rationalization has not gone deep enough. Instead of fighting rational mentality, the newest phase of Modern architecture tries to project rational methods from the technical field out to human and psychological fields… Technical Functionalism is correct only if enlarged to cover even the psychophysical field. That is the only way to humanise architecture."[24]

Aalto expresses a desire to expand the rational method to include phenomena explored in the fields of "neurophysiology and psychology". He writes, "My aim was to show that real Rationalism means dealing with all questions related to the object concerned, and to take a rational attitude also to demands that are often dismissed as vague issues of individual taste, but which are shown by more detailed analysis to be derived partly from neurophysiology and partly from psychology. Salvation can be achieved only or primarily via an extended concept of Rationalism"[25]·Eight years later, Aalto takes this concept one step further: "I would like to add

my personal, emotional view, that architecture and its details are in some way all part of biology."[26] This is a suggestion I wish to support.

INTUITIVE "NEUROLOGISTS"

Semir Zeki, neurologist who has studied the neural ground of artistic image and effect, regards a high degree of ambiguity, such as the unfinished imagery of Michelangelo's slaves, or the ambivalent human narratives of Johannes Vermeer's paintings, as essential contributors to the greatness of these works.[27] In reference to the great capacity of profound artists to evoke, manipulate and direct emotions, he makes the surprising argument: "Most painters are also neurologists… they are those who have experimented with and, without ever realizing it, understood something about the organization of the visual brain, though with the techniques that are unique to them."[28] This statement echoes interestingly an argument of the Dutch phenomenologist-therapist J.H. Van den Berg: "All painters and poets are born phenomenologist."[29] Artists and architects are phenomenologists in the sense of being capable of "pure looking", an unbiased and naive manner of encountering things. The recent book, Proust was a Neuroscientists, by Jonah Lehrer popularizes this topic arguing that certain masterful artists, such as Walt Whitman, Marcel Proust, Paul Cézanne, Igor Stravinsky, and Gertrude Stein, anticipated certain neurological findings of today in their art often more than a century ago.[30] In his significant books The Architect's Brain: Neuroscience, Creativity and Architecture, and Architecture and Embodiment: The Implications of the new Sciences and Humanities for Design, Harry F. Mallgrave has connected the findings in neuroscience with the field of architecture directly in accordance with the objective of our seminar.[31]

In Inner Vision: An Exploration of Art and the Brain, Semir Zeki suggests the possibility of "a theory of aesthetics that is biologically based".[32] Having studied animal building behavior and the emergence of aesthetically

motivated choice in the animal world for forty years, I personally have no doubt about this. What else could beauty be than Nature's powerful instrument of selection in the process of evolution? Joseph Brodsky assures us of this with the conviction of a poet: "The purpose of evolution, believe it or not, is beauty"[33] . In his study on the neurological ground of art, Zeki argues that "art is an extension of the functions of the visual brain in its search for essentials"[34]. I see no reason to limit this idea of extension, or externalization to the visual field only. I believe that art provides momentary extensions of the functions of our perceptual and neural systems, consciousness, memory, emotions, and existential "understanding". The great human quality of art is that it permits ordinary mortals to experience something through the perceptual and emotive sensibility of the greatest individuals of human history. We can feel through the neural subtlety of Brunelleschi, Mozart, and Rilke, for instance. And again, we can undoubtedly make the same assumption of meaningful architecture; we can sense our own existence amplified and sensitized by the works of great architects of history from Ictinus and Callicrates to Frank Lloyd Wright and Louis Kahn. Great architecture elevates our experience of ourselves and it emanates unspoken but contagious existential wisdom.

THE GIFT OF IMAGINATION

It is arguable that the most human of our capacities is that of imagination. Imagination is often thought of as a kind of daydreaming, and sometimes even as something suspect. Yet, even perceiving and memorizing places, situations and events, engage our imaginative capacities. The acts of experiencing and memorizing are embodied acts, which evoke imaginative realities with specific meanings. The existence of our ethical sensibility alone calls for imaginative skills. Recent studies have revealed that the acts of perceiving and imagining take place in the same areas of the brain, and consequently, these acts are closely related.[35] Even perceptions call for

imagination, as percepts are not automatic products of the sensory mechanism; they are essentially creations and products of intentionality and imagination. We could not even see light without our "inner light" and formative visual imagination, Arthur Zajonc, the physicist, argues.[36] To conclude, "Reality is a product of the most august imagination", Wallace Stevens, the poet, suggests.[37]

We do not judge environments merely by our senses, we also test and evaluate them through our imagination. Comforting and inviting settings inspire our unconscious imagery, daydreams and fantasies. Sensuous settings sensitize and eroticize our relationship with the world. As Gaston Bachelard argues: "(T)he chief benefit of the house (is that) the house shelters daydreaming, the house protects the dreamer, the house allows one to dream in peace… (T)he house is one of the greatest powers of integration for the thoughts, memories and dreams of mankind".[38]

COLLABORATIVE UNDERSTANDING OF THE MIND

The widening interest in the neuroscience of architecture has already led to the establishment of the Academy of Neuroscience for Architecture (ANFA) in San Diego, California. In addition to its research projects, the Academy hosts annual conferences on various aspects of the neuroscience of architecture. In November 2012 the Frank Lloyd Wright School of Architecture and the Academy organized a symposium entitled "Minding Design: Neuroscience, Design Education and the Imagination" at Taliesin West, Arizona, which brought together scientists and architects. Today there are two schools of architecture which include neuroscience in their programs, the New School of Architecture + Design (NSAD) in SanDiego , California, and the University of Arizona (UofA) in Tucson, Arizona.

The interaction of neurosciences and architecture offers vast potential to enhance the quality of our settings. Any scientific proof of mental

phenomena and their consequences concerning the characteristics of the environments of our lives will certainly help to make claims for better architectural qualities better acceptable in our surreally materialist culture. This conversation is in its beginning, and so far it has been largely directed by neuroscientists. It is obvious that the neuroscientific investigation of architectural experiences and meanings has to be based on a deep dialogue between scientists and the makers of architecture.

Juhani Pallasmaa

Sources, notes

1 Fred Gage, “Neuroscience and Architecture”, as quoted in Melissa Farling, “From intuition to Evidence”, manuscript for MindingDesign: Neuroscience, Design education and the Imagination, Sarah Robinson, Juhani Pallasmaa, editors, Frank Lloyd Wright School of Architecture, Scottsdale, Arizona (in progress 2013), p.3.

2 Sarah Robinson, “Nested Bodies”, manuscript for MindingDesign, op.cit., p.15.

3 Maurice Merleau-Ponty, The Phenomenology of Perception, trans. Colin Smith, London: Routledge and Kegan Paul, 1962, p. 407.

4 Ludwig Wittgenstein, Philosophical Investigations, Oxford, 1999, as quoted in Bernhard Leitner, The Wittgenstein House, Princeton Architectural Press, New York, 2000, p.188.

5 Jean-Paul Sartre, The Emotions: An Outline of a Theory, Carol Publishing Co., New York, 1993, p. 9.

6 Karsten Harries, ‘Building and the Terror of Time’, Perspecta: The Yale Architecture Journal, issue 19. The MIT Press, Cambridge, Mass., 1982.

7 Paul Virilio, Katoamisen estetiikka (The aesthetics of Disappearance), Gaudeamus, Tampere, 1994, the page number unidentified.

8 Keijo Petäjä, architect and professor (1919–1988), one of the founders of the Finnish journal Le Carré Bleu specialized in architectural theory. In Finnish the sentence reads: “Arkkitehtuuri on rakennettua mielentilaa.”

9 Maurice Merleau-Ponty, ‘The Intertwining–The Chiasm’, The Visible and the Invisible, Claude Lefort, editor, Northwestern University Press, Evanston, 1969.

10 Michael Arbib, lecture at “MindingDesign: Neuroscience, Design Education and the Imagination” Symposium, Nov 9, 2012, Frank Lloyd Wright School of Architecture, Scottsdale, Arizona.

11 Maurice Merleau-Ponty, Signs, Nortwestern University Press, Evanston, Ill., 1982, p. 56.

12 Salman Rushdie, ‘Eikö mikään ole pyhää?’ (Isn’t anything sacred?), Parnasso, Helsinki 1.1996, p. 8.

13 Maurice Merleau-Ponty, as quoted in Iain McGilchrist, The Master and His Emissary: The Divided Brain and the Making of the Western World, Yale University Press, New Haven and London, 2010, p. 409.

14 Alvar Aalto, ‘Taide ja tekniikka’ (Art and Technology), lecture, Academy of Finland, October 3, 1955, in: Göran Schildt, Alvar Aalto Luonnoksia, Otava Publishers, Helsinki, 1972, pp. 87–88.

15 Paul Valéry, Dialogues, Pantheon Books, New York, 1956, p. XIII.

16 Joseph Brodsky, ‘An immodest Proposal’, On Grief and Reason, Farrar, Straus and Giroux, New York, 1997, p. 206.

17 John Dewey, Art As Experience, 1934 (1987), as quoted in Mark Johnson, The Meaning of the Body: Aesthetics of Human Understanding, The University of Chicago Press, Chicago and London, 2007, p. 73.

18 See Carl G. Jung et al. (editors), Man and His Symbols, Doubleday, New York, 1968, p. 57.

19 Stephen J. Pyre, Fire: Nature and Culture, Reaction Books Ltd, London, 2012, p. 47.

20 Grant Hildebrandt, The Wright Space: Pattern and Meaning in Frank Lloyd Wright’s Houses, University of Washington Press, Seattle, 1992.

21 Edward T. Hall, The Hidden Dimension, Anchor Books, New York · London · Toronto · Sydney · Auckland, 1990, pp. 33–34. The writer refers to endocrinological research by A.S.Parkes and H.M.Bruce. The researchers even launched a term “exocrinoloy” to supplement the notion of endocrinology.

22 Maurice Merleau-Ponty, The Primacy of Perception, Northwestern University Press, Evanston, Ill., 1964, p. 162.

23 Alvar Aalto, ‘Rationalism and Man’, 1935, in Göran Schildt, ed., Alvar Aalto in His Own Words, Rizzoli, New York, 1997, p. 91.

24 Ibid., p. 102.

25 Op.cit., p. 92.

26 Alvar Aalto, ‘The Trout and the Stream’, Domus/Arkkitehti, 1948. Republished in Schildt, ed., Alvar Aalto in His Own Words, p. 108.

27 Semir Zeki, Inner Vision: An Exploration of Art and the Brain, Oxford University Press, Oxford, 1999, pp. 22–36.

28 Ibid., p. 2.

29 J.H. Van den Berg, as quoted in Bachelard, The Poetics of Space, op.cit., p. XXIV.

30 Jonah Lehrer, Proust was a Neuroscientist, Houghton Mifflin Company, Boston–New York, 2008.

31 Harry Francis Mallgrave, The Architects’s Brain: Neuroscience, Creativity, and Architecture, Wiley-Blackwell, Chichester, 2010, and Architecture and Embodiment: The Implications of the New Sciences and Humanities for Design, Routledge, Abingdon, 2013.

32 Semir Zeki, op.cit., p. 1.

33 Joseph Brodsky, “An Immodest Proposal”, in On Grief and Reason, Farrar,Straus and Giroux, New York, 1995, p.208.

34 Semir Zeki, op.cit., p. 1.

35 Ilpo Kojo, ‘Mielikuvat ovat aivoille todellisia (Images are real for the brain), Helsingin Sanomat, Helsinki, 26.3.1996. The article refers to

research at Harvard University under the supervision of Dr. Stephen Rosslyn in the mid-1990s.

36 Arthur Zajonc, Catching the Light: The Entwined History of Light and Mind, Oxford University Press, Oxford, 1995, p.5.

37 Quoted in Jonah Lehrer, op.cit., p. VI.

38 Gaston Bachelard, The Poetics of Space, op.cit., p. 6.

39 Melissa Farling, “From Intuition to Evidence”, manuscript for MindingDesign, op.cit., p.8.

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