Direct relevance of the 2014 Nobel Prize in Physiology and Medicine to Neuroscience and Architecture, and to the mission of ANFA

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Wayfinding is an important requirement of our everyday existence, an ability we often take for granted, particularly when we are young. We acquire a sense of place; we know where we are, and we can define a navigational strategy and the route we need to take in order to move accurately and effectively to a desired location. To do all of this, our brains must take in information about our environments through our sensory organs, principally our eyes and ears, and compare the new data with stored spatial information before a decision is made and a motor program implemented. How we accomplish this is of great interest to both neuroscientists, who want to understand how our brains work and why sometimes they don’t, and to architects and urban planners, who design the spaces we live in during the majority of our lives. Indeed, urban planner Kevin A. Lynch coined the term *wayfinding* in his 1960 book *The Image of the City*, defining it as "a consistent use and organization of definite sensory cues from the external environment."

In this context, the awarding of the 2014 Nobel Prize in Physiology and Medicine on September 12th to three neuroscientists, John O’Keefe, Professor at University College London, and May-Britt Moser and Edvard Moser, Professors at the Norwegian University of Science and Technology, is particularly relevant. The award recognizes their fundamental contributions to our understanding of how our brains create and store maps of our physical environments and retrieve spatial memories that allow us to know where we are and how to find our way to where we want to go; in other words, they have elucidated the brain mechanisms we use in *wayfinding*.

As stated in the Announcement by the Nobel Foundation:

This year’s Nobel Laureates have discovered a positioning system, an “inner GPS” in the brain that makes it possible to orient ourselves in space, demonstrating a cellular basis for higher cognitive function. In 1971, John O’Keefe discovered the first component of this positioning system. He found that a type of nerve cell in an area of the brain called the hippocampus that was always activated when a rat was at a certain place in a room. Other nerve cells were activated when the rat was at other places. O’Keefe concluded that these “place cells” formed a map of the room. More than three decades later, in 2005, May-Britt and Edvard Moser discovered another key component of the brain’s positioning system. They identified another type of nerve cell, which they called “grid cells”, which generate a coordinate system and allow for precise positioning...
and pathfinding. Their subsequent research showed how place and grid cells make it possible to determine position and to navigate. The discoveries of John O’Keefe, May-Britt Moser and Edvard Moser have solved a problem that has occupied philosophers and scientists for centuries – how does the brain create a map of the space surrounding us and how can we navigate our way through a complex environment?

Thus, “place cells” and “grid cells” store information about a location in a particular space defined by a set of cues that the animal perceives and remembers. More recent investigations indicate that humans have the same types of cells, as well as others, that allow us to orient and determine direction and distance, and that we use all of them to go to the grocery store and then find our way home, or to move about our living spaces without having to always consciously design a motor strategy. Here is where the architect and designer come in: designing spaces that are straightforward for the user to navigate, by considering geometry and the location of cues and landmarks that facilitate our ability to create and retrieve the maps we need to have a practical and useful “sense of place.”

Unfortunately, a lot of architectural designs turn out to be tough to navigate, particularly those of institutional facilities such as government buildings and hospitals, where people are often lost and inefficient in finding the desired office or clinic. Many urban configurations seem to be designed to befuddle us and to test our navigational abilities rather than to facilitate wayfinding. A wide range of different types of cues and landmarks are in use to help us walk or drive to the desired location, some more useful than others, but we do not know which are best suited to help the human user create spatial maps and route configurations. Moreover, as people get older, and demographic projections indicate an increasing percentage of older and very old people in our society, their spatial cognitive abilities decrease. Buildings and urban landscapes must be designed to take into account the needs and abilities of this older group.

The mission of ANFA, the Academy of Neuroscience for Architecture, is to bring together architects and neuroscientists in order to benefit the practice of designing living spaces with a better understanding of brain function and human cognitive abilities. ANFA’s initiatives address a broad range of interesting issues in the area of human-environment interactions; one that is a major thrust is wayfinding. At the recent biennial ANFA International Conference at the Salk Institute and UC San Diego (UCSD), a whole session was devoted to this topic. The first presentation of the session was by Prof. Jill Leutgeb, Ph.D., who spent several years as a post-doctoral researcher in the laboratory of May-Britt and Edvard Moser in Norway before joining the faculty at UCSD and establishing her own research group. She summarized the current status of our knowledge of space-encoding cells, and of how they perform their functions. She was followed by UCSD Prof. David Salmon, Ph.D., who described how different types of dementias, Alzheimer’s and Lewy-body, affect differently a person’s spatial cognitive abilities because distinct areas of the brain are affected earlier in the course of these neurodegenerative diseases. Particularly, in Alzheimer’s disease the hippocampus and associated structures, such as the entorhinal cortex, are the earliest to show a severe volume decrement, a characteristic that is used as a diagnostic for this ailment. It is therefore not surprising those who suffer this type of
dementia not only show memory deficits, but also a serious loss of their sense of place. The
session also included two shorter presentations, one by Colin Ellard and Vedran Dzebic
(University of Waterloo, Canada) on “The Psychology of Architectural and Urban Design:
Sensor-based Field Methods Based on Guided Walks,” and the second by Niamh Merriman, Jan
Ondřei, Eugenie Roudaia, Carol O’Sullivan and Fiona N. Newell (Dublin, Ireland) on the subject
of how “Familiar Environments Enhance Object and Spatial Memory in both Younger and Older
Adults”. These presentations were complemented by many others throughout the conference,
attesting to the strong interest in wayfinding in architecture by both neuroscientists and
architects. Many of these presentations are available for viewing at the ANFA website,

The 2014 Nobel Prizes in Physiology and Medicine could not be more relevant to the mission of
ANFA.

Biographies of the Nobel Prize Winners, from the Nobel Committee Announcement:

John O’Keefe was born in 1939 in New York City, USA, and holds both American and British
citizenships. He received his doctoral degree in physiological psychology from McGill
University, Canada in 1967. After that, he moved to England for postdoctoral training at
University College London. He has remained at University College and was appointed Professor
of Cognitive Neuroscience in 1987. John O’Keefe is currently Director of the Sainsbury
Wellcome Centre in Neural Circuits and Behaviour at University College London.

May-Britt Moser was born in Fosnavåg, Norway in 1963 and is a Norwegian citizen. She
studied psychology at the University of Oslo together with her future husband and co-Laureate
Edvard Moser. She received her Ph.D. in neurophysiology in 1995. She was a postdoctoral
fellow at the University of Edinburgh and subsequently a visiting scientist at University College
London before moving to the Norwegian University of Science and Technology in Trondheim in
1996. May-Britt Moser was appointed Professor of Neuroscience in 2000 and is currently
Director of the Centre for Neural Computation in Trondheim.

Edvard I. Moser was born in 1962 in Ålesund, Norway and has Norwegian citizenship. He
obtained his Ph.D. in neurophysiology from the University of Oslo in 1995. He was a
postdoctoral fellow together with his wife and co-Laureate May-Britt Moser, first at the
University of Edinburgh and later a visiting scientist in John O’Keefe’s laboratory in London. In
1996 they moved to the Norwegian University of Science and Technology in Trondheim, where
Edvard Moser became Professor in 1998. He is currently Director of the Kavli Institute for
Systems Neuroscience in Trondheim.