# NEUROSCIENCE AND ARCHITECTURE

## A talk given by Ian Ritchie to the Professors of Psychiatry (POP) at the Athenaeum, London

## 29th October 2015

**Hamlet – Tennant © RSC**

## INTRODUCTION

Inviting an architect to give a talk is to invite a degree of risk, especially one who has been a professor at the Royal Academy's of Art post-graduate school, as well as a former director of a firm of engineers and a professor at Leeds University engineering faculty.

I often make this comparison between engineers and architects: given a target the engineer will pull the string of his bow and fire the arrow directly into the bulls-eye. The architect will pull the string of his bow and fire into the sky and see where it lands!

So the target is the brain which, according to Woody Allen (in Sleeper) *is his second favourite organ.*

### ***Lascaux*** *animation film Deer & Bulls*

*https://www.**youtube**.com/watch?v=UM7gRh41pBA*

Artists at Lascaux used fire and torches to see inside caves, and the glow and flicker of flames may also have been integral suggesting movement in the stories the paintings told. We had to wait until 1878 to reproduce the effect through Muybridge's horse.

### ***Muybridge*** *film of the horse*

https://www.youtube.com/watch?v=IEqccPhsqgA

***Hamlet*** *– Tennant ©RSC* ***Robot*** *+ Kevin Warwick*

Some of you may look at this skull and think – there was a brain in there once, a consciousness, a person, someone whose behaviour and thoughts we could analyse.

But for Hamlet, the skull is a physical reminder of the finality of death. After all his brooding and philosophical contemplation of mortality, Hamlet literally looks death directly in the face. As you probably know it's a turning point for Hamlet. He thinks about the inevitability of death and the vanity of life.

This vanity of life – nothing matters under the sun. Perhaps the desire to resist the inevitable is what fuels the symbiotic relationship between the media and people with huge egos? The collective noun of architects is ‘a jealousy’. Funny if it were not true.

However, I believe that the primary role of the architect is to serve, as it is for a psychiatrist - to try to make things better. The world is never seems to be functioning quite the way we would like it, hence the need to strive for change and the idea of progress.

Psychiatrists engage with the intangible workings of the inner mind and body.

As an architect I appear to design for the outside – the physical body alone - to make physical spaces both practical and uplifting.

Twenty years ago I delivered a talk entitled: Touching Architecture. Then, as now, the challenge of talking about our senses and architecture is related to the fact that architecture is very much a visual art, related to the enjoyment of seeing rather than any other sense. OK, we are primarily ocular animals. When I was at university studying to become an architect vision and audition were important, but the other haptic qualities of buildings – tactility, warmth, smell, taste – were completely

absent. Although I studied colour theory, this has since been dropped from most UK schools of architecture.

In the research I did for the talk on ‘touch’, I discovered that touch is far more accurate than any other sense, and perhaps because it has no specific organ that we can identify, like an ear, nose or eye, is probably the reason why architects have seldom tried to understand and exploit touch in architecture. The normal Cartesian way of analytical thinking makes us always want to create a rubric through which we can break down ideas and information in order to understand it better, has left touch out on the edge as something we cannot fathom.

***Ice Watch 2014*** *©Olafur Eliasson*

***touch the skin*** = ***smooth, cold, auditory, ….?***

In today's world, as an architect, we are so remote from the feeling of physically building ourselves - like an Eskimo constructing an igloo or building bamboo architecture in Indonesia. People throughout the ages have always used their hands and their bodies to make and to touch the materials which they use in construction. An architect is remote from the materials he uses, and in today's world of technology we are so far removed during the design process that we don't actually feel materials in the same sense whatsoever.

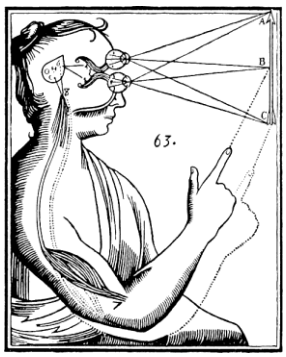
***2001*** *©Kubric*

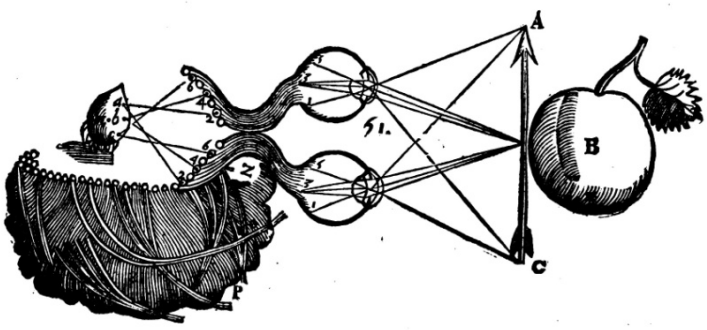
However, since embarking in 2009 on the design of the Sainsbury Wellcome Centre for Neural Circuits and Behaviour at UCL I have become more and more interested in *neurodesign* – to design with a deeper understanding of the impact of what we create upon the mental welfare of the user - and to do so we need to draw on the emerging knowledge from neuroscientists.  I believe that will result in my practice designing better spaces and better environments. Whether these will considered by prize-givers as better architecture is another subject.

Richard Axel said that one of the temptations of having a mind is to try to use it to solve the mystery of its own nature. Look at this illustration by Vesalius.

***Vesalius****- de humani corpus*

He, the skeleton, is contemplating a second skull, a brain. Can thinking alone uncover the nature of man?



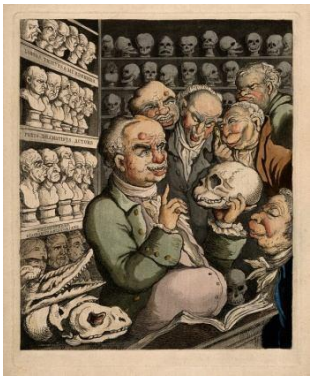


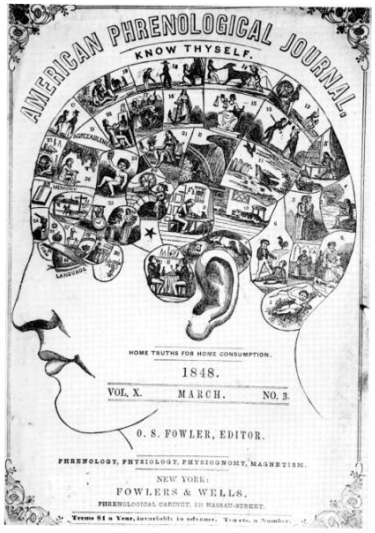

***Descartes*** *– separating mind from matter, man from nature?*

So far, however closely we examine the constituents of the brain's matter, we have yet to discover when these molecules become conscious: when brain becomes mind.

From earliest times philosophers have attempted to define consciousness. Then they were joined by psychologists.

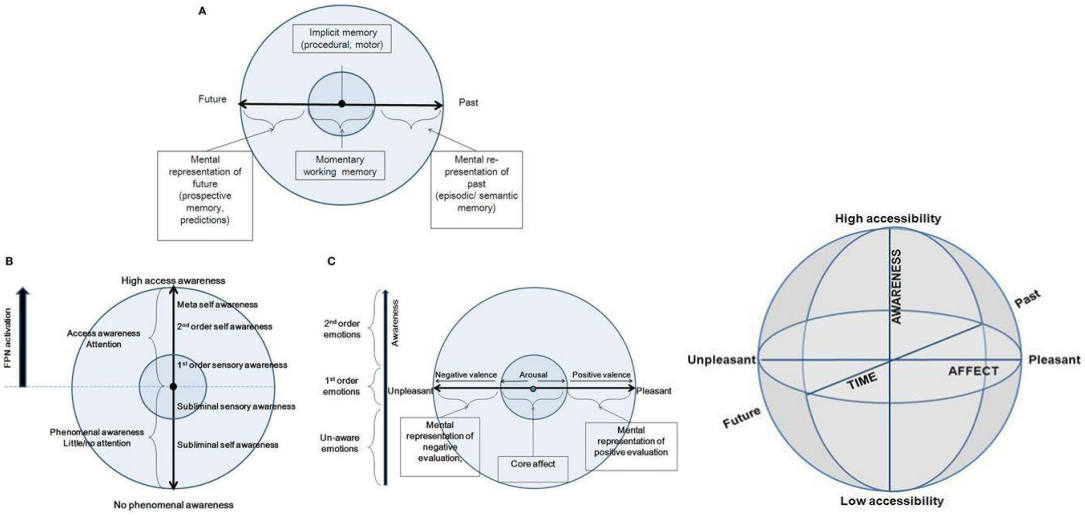
Neither have had much success.






## *Gall and phrenology*

Gall's version of Organology states that the mind is a collection of independent entities housed within the brain.




A more recent theory has been presented by *Aviva Berkovich-Ohana / Joseph Glicksohn* **– the theory of the** consciousness state space or CSS.

[*Frontiers in Psychology – perception science 29 April 2014 : Department of Neurobiology, Weizmann Institute of Science, Rehovot, Israel/ Department of Criminology, Bar-Ilan University, Ramat Gan, Israel / The Leslie and Susan Gonda (Goldschmied) Multidisciplinary Brain Research Center, Bar-Ilan University, Ramat Gan, Israel*

I quote the essence of their research. Every experience, those we are aware of and those we are not, is embedded in a subjective timeline, is tinged with emotion, and inevitably evokes a certain sense of self. Here, Berkovich-Ohana and Glicksohn present a phenomenological model for consciousness and selfhood which relates time, awareness, and emotion within one framework.

[The consciousness state space (CSS) model is a theoretical one. Briefly, it is suggested that all phenomenological states fall into two categories of consciousness: core and extended. Core Consciousness supports minimal selfhood its scope being the here and now. Extended Consciousness supports narrative selfhood, which involves personal identity and continuity across time, as well as memory, imagination and conceptual thought. The CSS is a phenomenological space, created by three dimensions: time, awareness and emotion.]

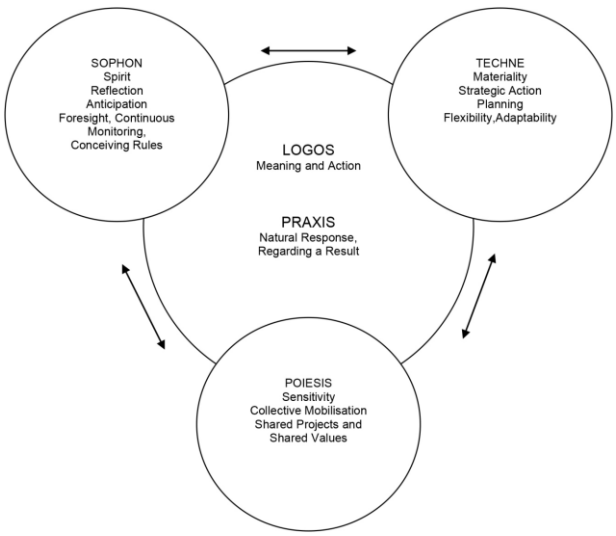
When I asked Richard Axel what's all this neuroscience research about, his esoteric answer was "How and why did we get a pre-frontal lobe?" He subsequently said that ignoring the brain's biology has a long history. Probably because it has been so difficult to access.

[For example, there was much excitement when the June issue of Nature reported that previously unknown lymphatic vessels existed in the outer layers of the brain apparently linking the brain and spinal cord with the rest of the body's immune system. (University of Virginia). The research suggests the discovery may require a reassessment of current assumptions about the brain's role in diseases involving brain inflammation or degeneration.]

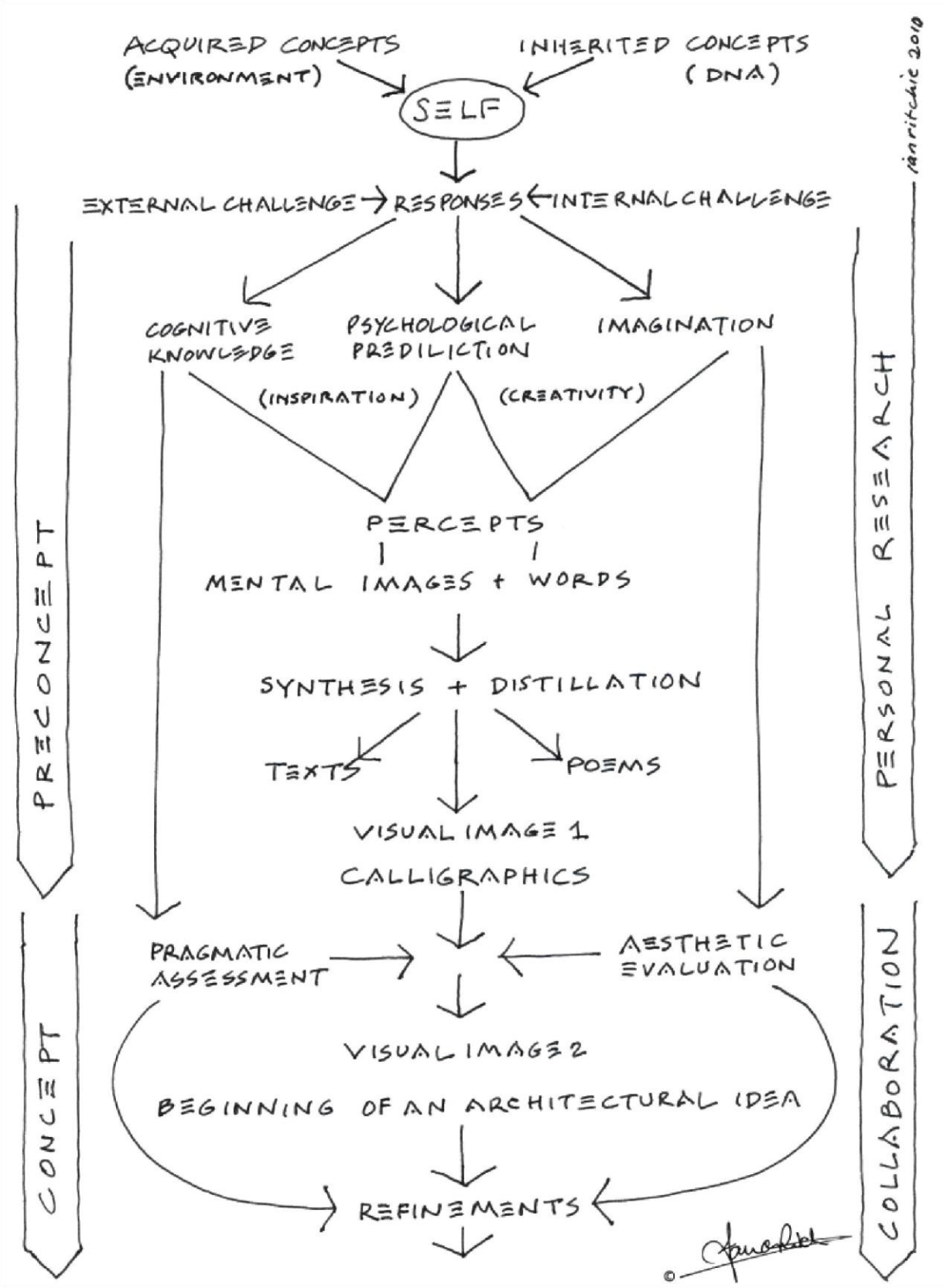
Recently, psychologists and philosophers were joined by theoretical neuroscientists and then, even more recently, by experimental neuroscientists. Experimental biology of the brain has become a focus of research.

Bringing theory and experimentation together will result in more profound insights into perception, cognition and behaviour. This is the underlying philosophy of the SWC research centre.

## THE WAY I THINK DESIGN




***Sophon Techne Logos Praxis Poiesis © Equipe Poïesis 1987***




***Preconcept to Concept*** *©Ian Ritchie*

## *Poem: Dreaming of a Project*

**Dreaming of a Project**

As the banks crashed
the fishing began.
We watched fish fly,
new born lambs jump
and architects worry
about the next job.

Are architects magicians?
Bankers manipulated
and spirited away
immense substance,
but above all,
loyalty and trust.

What do magicians do?
The science of magic?
As neuroscientists
research the mind
magicians play with it.
How?
Do they misdirect us?
Divert our attention,
blind us temporarily?
Do they fill in the gaps?
Fill in the margins between
the frames of a film?
Our eyes see, but not the film.
We see wheels go backwards
because we snap the world.
We imagine, we fill in.
And then there is memory.
Under which cup is the ball?

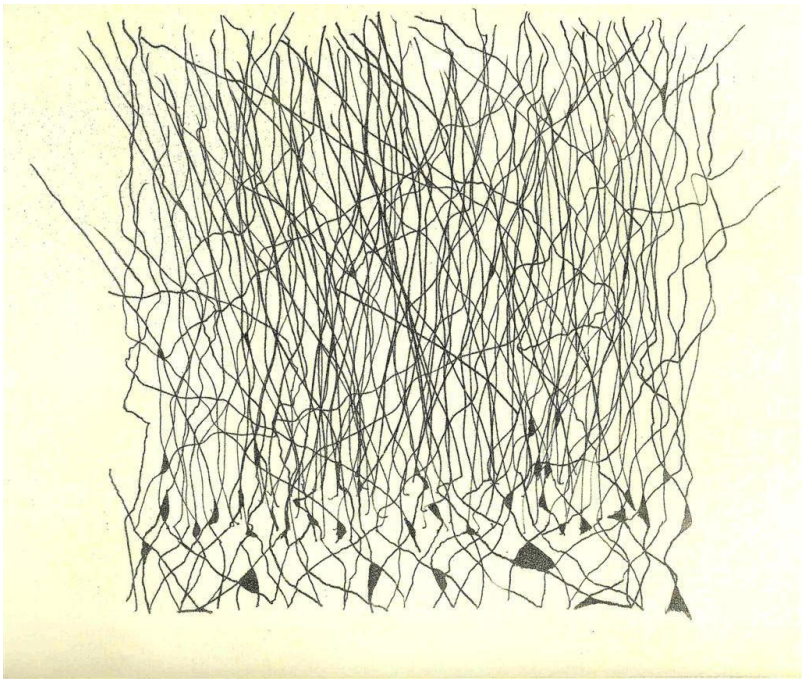
What card did I pick?
Ah, the magician has secrets!
The illusion of free will,
And as now with the bankers
we trust not the magician?

Architects are not magicians.
They are dreamers.
My architecture starts
in the spaces I create in my mind.
Space is in here and out there, it is a continuum between inside and outside, mental and physical.

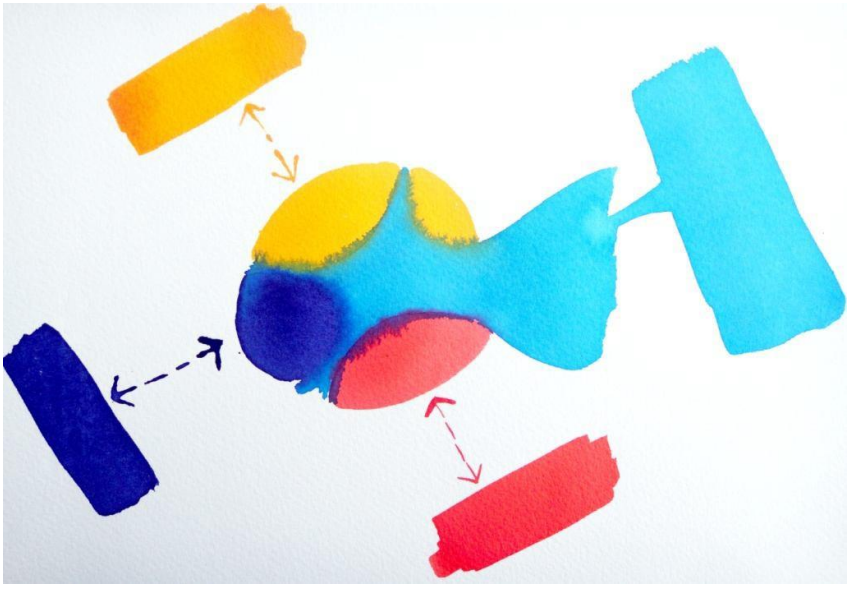
Architecture has two distinct phases:
the mental dream and reality's nightmare.
Being an optimist I know
that the dream is always there,
like the sunshine behind the darkest cloud
and the snowflake in the rain.

We can imagine two futures,
the one we dream of
and the one left to fate.
Or we can imagine one future,
the one we dream of
and the one we left to fate.

To be able to read our reality
requires a reference – our dreams –
and some of our dreams question reality's reality.
Now I am designing with the mind in mind.
Dreams? I try to build mine
avoiding the nightmares.

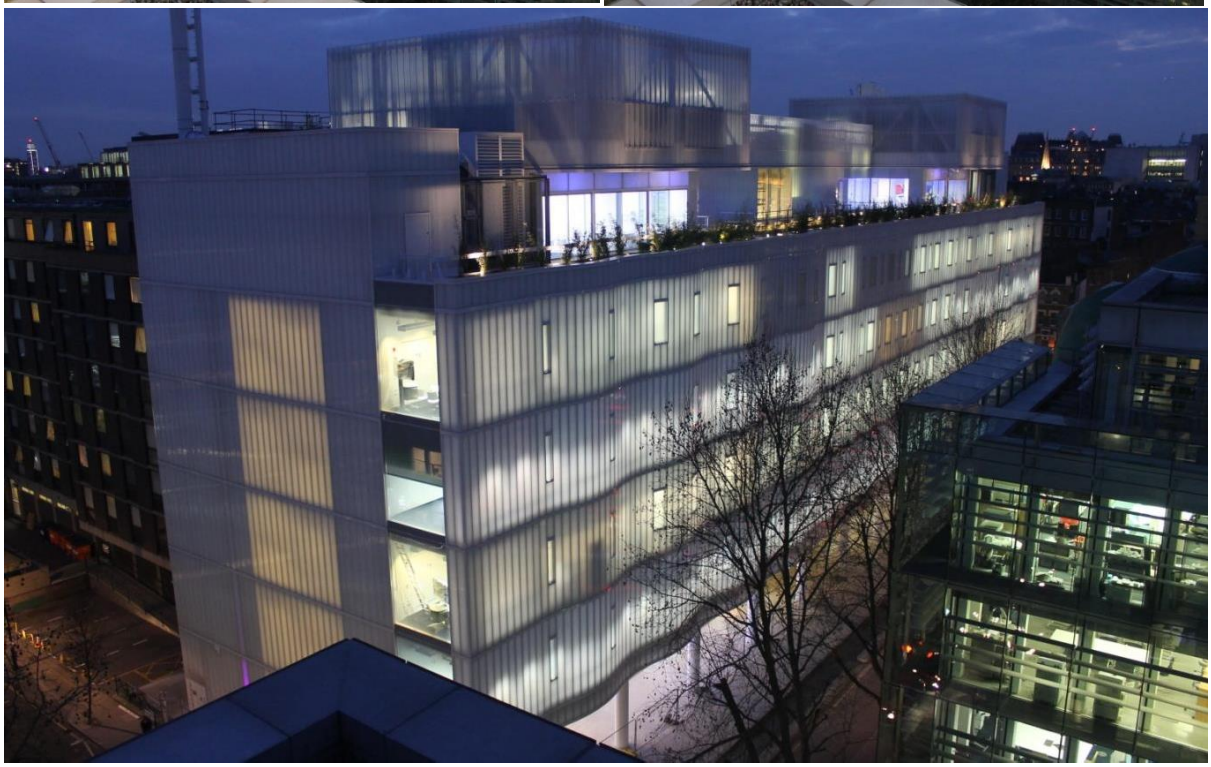


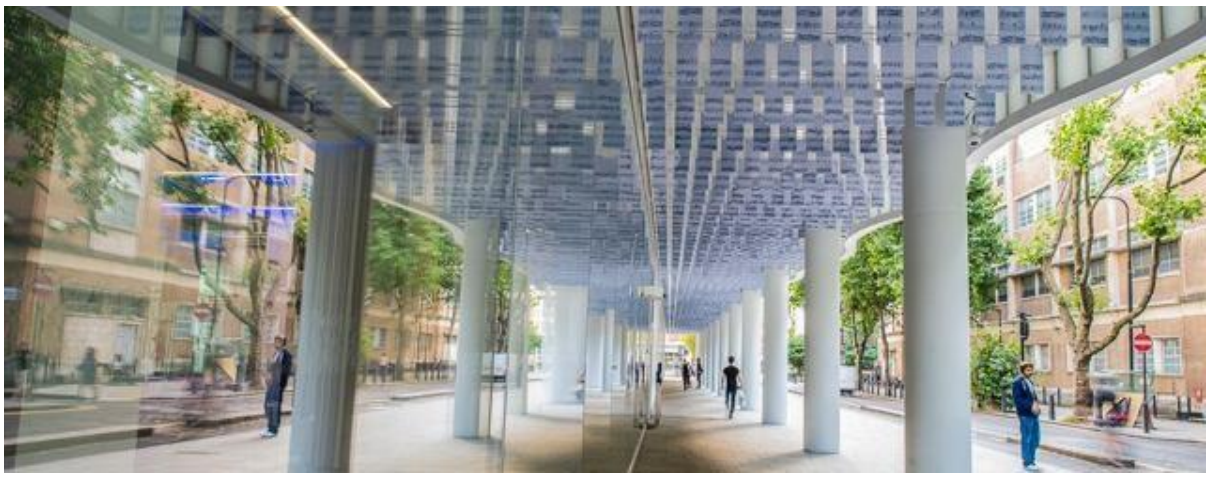
***etching: Dreaming of a Project*** *© Ian Ritchie*

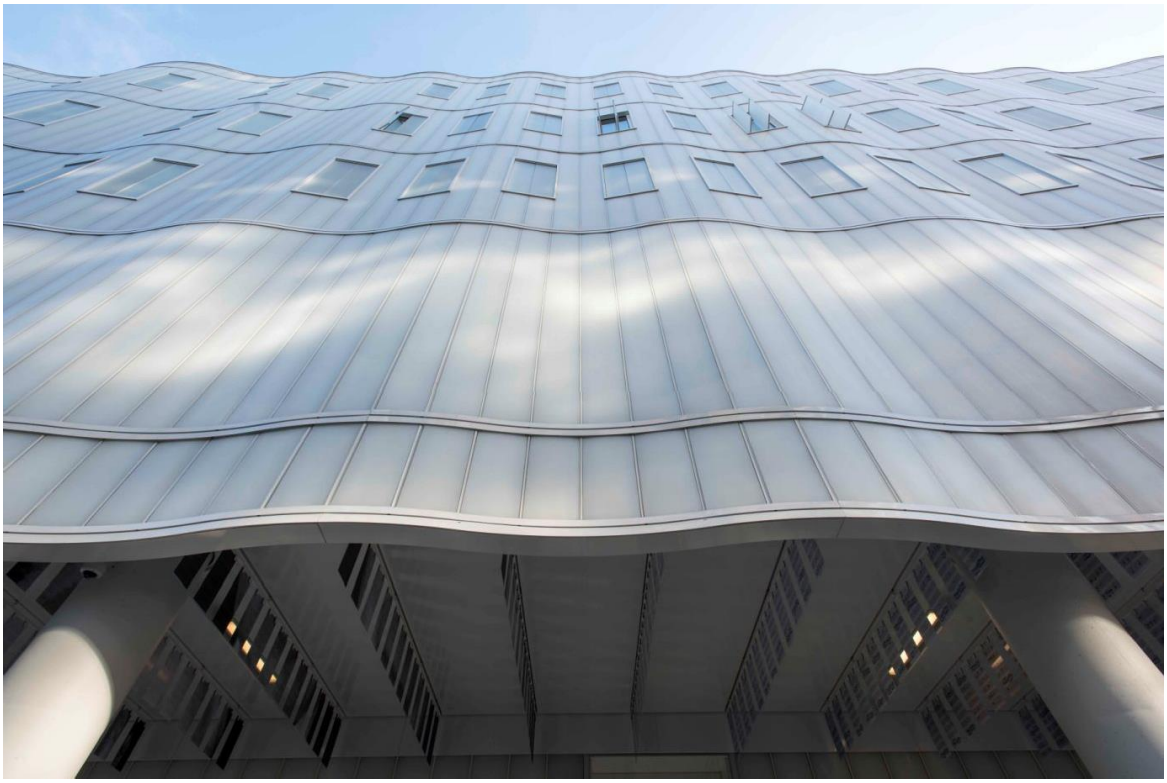


***SWC Inking plan*** *© Ian Ritchie*

## THE SAINSBURY WELLCOME CENTRE FOR NEURAL CIRCUITS AND BEHAVIOUR AT UCL







Architects for centuries have depended on intuition and experience to create environments that generate desired reactions in the people who use the space:

feelings of awe in cathedrals,

feelings of powerlessness in totalitarian architecture,

feelings of calm and contemplative intimacy with nature in a Japanese teahouse.

But neuroscience is changing that.

The ability to design environments to elicit specific emotional and neurological responses is slowly becoming a science as much as an art.

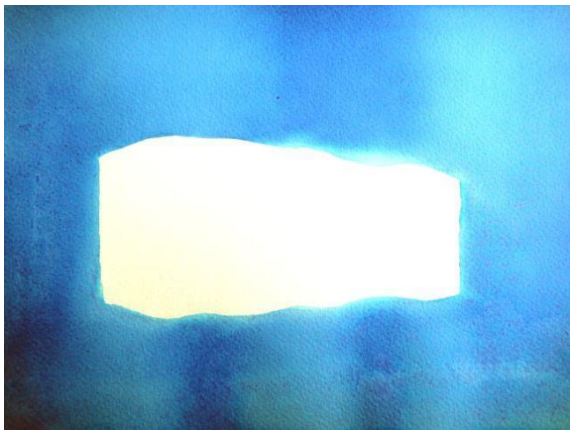
John O'Keefe, Nobel laureate 2014, is the new director of the SWC. He, and Peter Dayan, who heads the Gatsby Computational Theoretical Unit, were our key scientific advisors as we designed the building from the inside to outside.

John's work has been on Place Cells within the brain– navigation. Architects design spaces and places. What better partner for this project?! We had to learn his language, and he ours.

Space: what does it mean? To an architect, buildings have boundaries made manifest through light. These boundaries can dissolve through reflections. Perhaps this explains their predilection to use glass over the past 40 years.

To Descartes, Newton and Einstein – space was imaginable but boundless? For Kant it was pure *a priori* from our intuition. Poincaré was open enough to say that although limited mathematically, Euclidean geometry defines space, is easier to understand and works well enough. This is the space of architects, although we should be interested in its temporal qualities too.

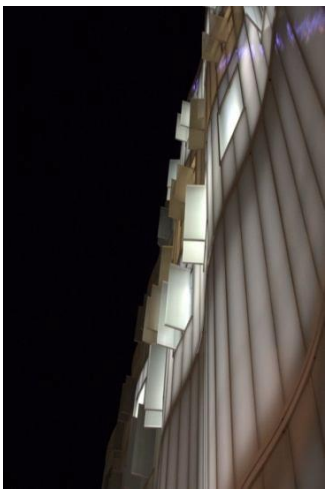
**Neuroscience building and how it was designed.**

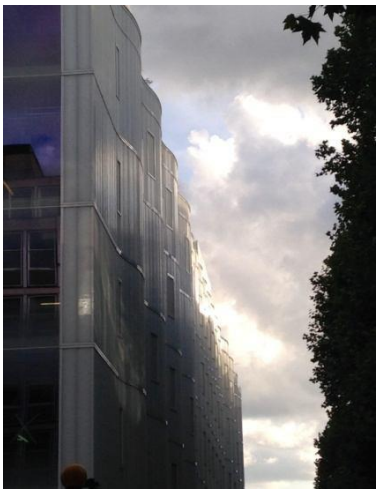


**What examples are there linking the brain and architecture?**

There is physicality/materiality to the building that is a metaphor for climate change – the context of the project – humanity's well-being.

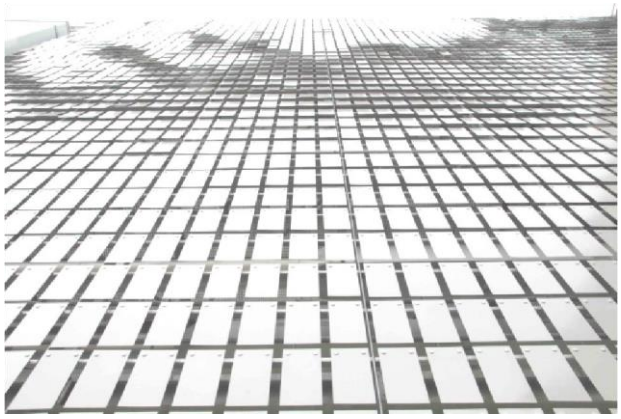
The whiteness of its mass refers to an iceberg, and it is melting at the corners. As the wavy façade turns the corner the glass becomes more immaterial, like water flowing.





***looking up north facade***

The curvy façade also reflects my sense of humour. Meeting different neuroscientists across the world I became acutely aware of their pan-disciplinary skills - physics, biology, electronics, chemistry, electro-mechanical engineering etc. The wavy façade suggests that the experimentalists have a significant brain wavelength, while the theoretical computational neuroscientists are on another wavelength altogether – hence the increase infrequency where they are housed over three floors in the middle – they wanted to be on the roof with the garden – but that would have privileged them and isolated them – so there was some coercion.

## *Animated south side*

On the south side the building the surface is fractured, as in an ice flow, and moves with the wind.


## *Blue 480nm*

Russell Foster, Professor of Circadian Neuroscience at Oxford, is a member of the SWC Governing Council (along with Richard Axel, Richard Morris, Marc Tessier-Lavigne, President of Rockefeller University, and Professor Sir John Tooke President of the Academy of Medical Sciences and Vice Provost (Health) and Head of the Medical School at UCL). His work on lighting is a perfect example of neuroscience research giving the architecture added value.

Scientific research has discovered ganglion receptors in the back of the retina that aren't used for vision. They integrate changes in light levels throughout the day and feed these directly into receptors in the brain's circadian clock - the response of the brain to the changing time of day.

What the architect needs to understand is how circadian disruption can affect many aspects of mental function, mental health and physical functions and health.

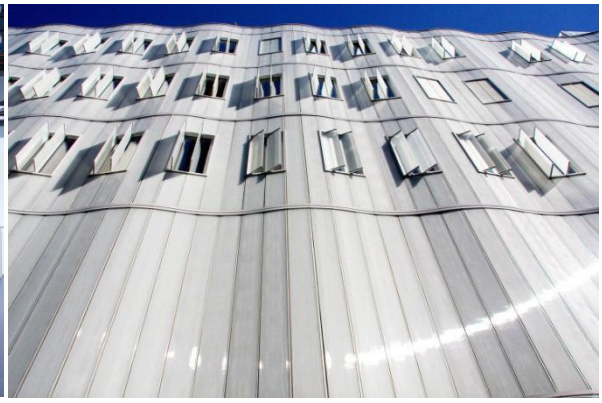
Does our architecture allow appropriate and natural cycles of light into buildings, particularly for people who spend a lot of time inside?
One entire wall of the SWC is of translucent glass, which not only allows soft daylight to filter into the building while reducing the need for artificial lighting but also allows the soft change of day to night to register on the wall.

***Admin offices & blue lighting***

According to Russell the colour blue – or more precisely 480 nanometres is the wavelength that makes us feel most alert.

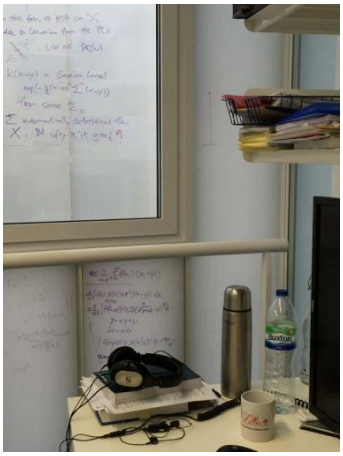
**A lot of new design seems to focus on creating a calming environment. Does neuroscience support this trend?**

Stress responses and hormonal changes in response to the environment are being studied at a neurological level. Calming effects relate to elements like light levels, noise levels and types of sound – for example the sounds of water are soothing.



***Windows in the laboratory glass wall***

Sightlines, views of and access to outdoor spaces seem to be correlated with mental and physical health in terms of heart rate and stress levels as well as healing. The translucent wall has integrated windows to allow fresh air – and louvres to provide privacy and also to reflect sunlight.



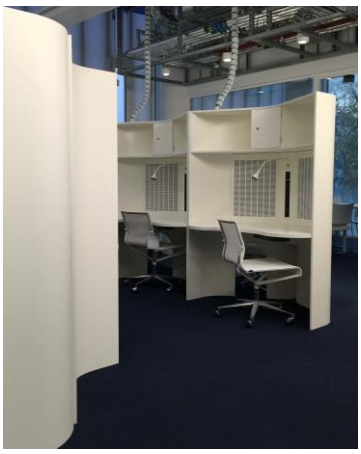
***Windows in PI office***

Definitive empirical studies need to be done, but indications are that building design has a real biological and neurological impact. This is not unexpected.

***Roof Garden***

In the SWC the roof garden, seminar-cafeteria and administration at the same level, are designed to encourage feelings of contact and interaction with the natural world - greenery and weather.

**Isolation or togetherness** can encourage contentedness or depression. Offices, classrooms and hospitals are particular building typologies in which these factors are particularly relevant, as is the issue of the control of one's personal environment.

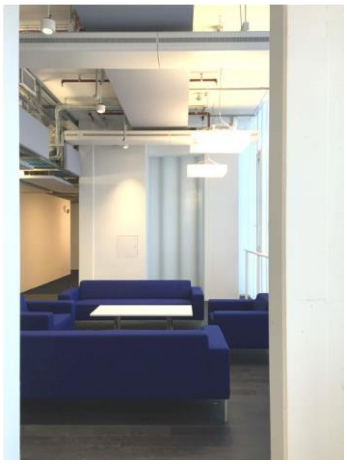


***Write up and office space***

In the SWC the adaptable nature of the spaces allows for both private and write-up desk spaces and their lighting to be intimate within communality. It accommodates ease of interaction and privacy if desired. The write up edges are for the most part curved providing an extra sense of privacy and reflecting the wave of the building.

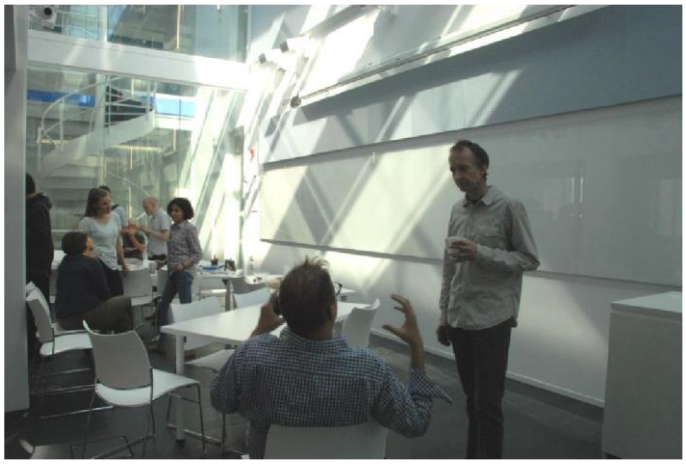
***Accidental interaction spaces -***

Principal floor circulation routes are designed with sightlines through the entire building with spaces. Along them are meeting places to encourage chance encounters to become discussions where information is shared.



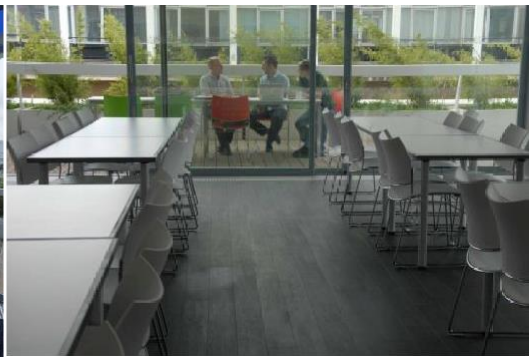
***Interaction space - intentional***

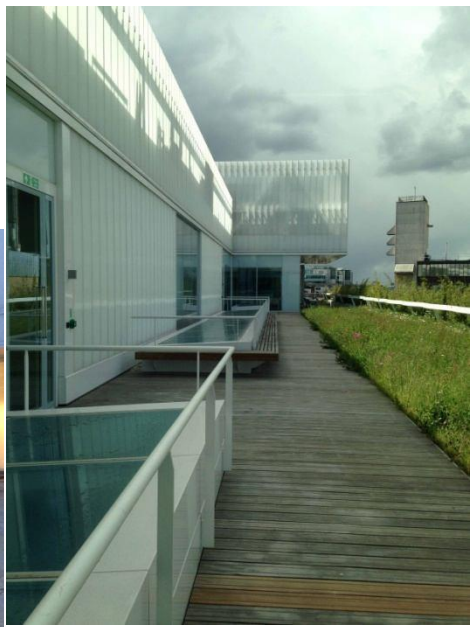
There are many spaces for chance encounters –soft and hard areas – intended and accidental.

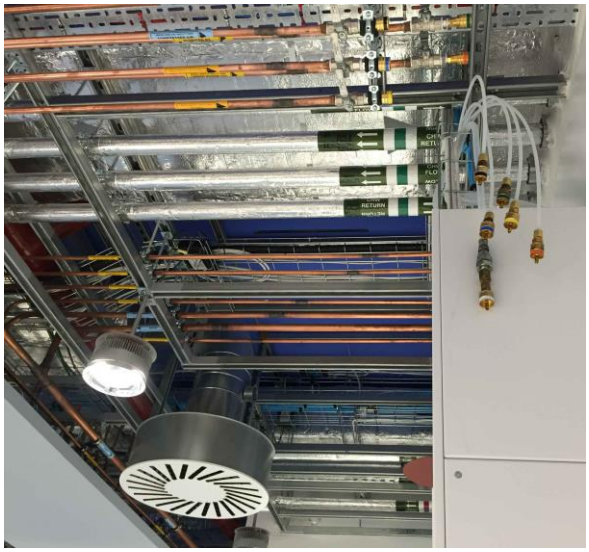


***Interaction space – roof & GCNU lecture + tea atrium***

And of course the roof has many spaces, some covered.





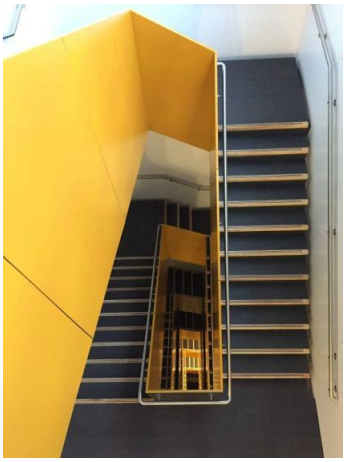


***Double height lab*** ***'plug and play' services***

The most difficult is vertical separation – people on separate floors without visual contact.

This is the primary reason why we designed the labs as two-storey open houses – offering visual connection between floors of activity, as well as the potential for large vertical spatial experiments.

Crucially, the labs from the very beginning have been designed to be adaptable – to provide a plug & play environment. Change will occur following demand and/or the desire of the scientists - whether it's the services or the space.



***Main stairs – Ariadne's ribbon and Fire escape***

Even the staircases have landings which are more generous.

In an environment where a lot of creative work is being done by individuals, the opportunity for natural cross-communication between disciplines to happen is especially important. It is impossible to predict whether these will happen over a cup of coffee, down the pub, on the staircase. It is not important – the fact that there are multiple happenchance spaces and visual connections is what we believe to be important on the basis that interaction is a vital aspect of research.

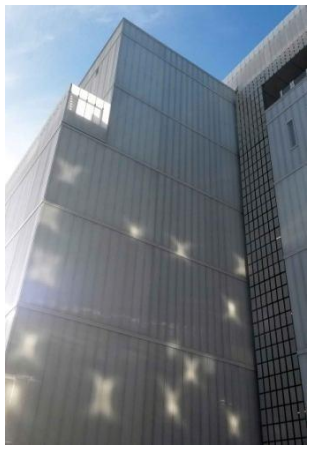
***undulating north wall and the moving south wall***

I have hardly touched on beauty in design, or neuro-aesthetics – inherited (DNA) and acquired (environmental) information through which we apparently assess aesthetics and about which Semir Zeki at UCL has written a lot.***:***

For me, beauty is non-linear. This is captured in the pixellated south wall's movements in the wind, and the way light behaves on the ribbed cast. It is the unpredictable which I find amazing beautiful although this may suggest that it is scary. The ability to accept uncertainty as one of life's certainties is my own panacea for remaining calm. Architecture is a dream when one starts to design, but the reality of constructing that dream can turn into a nightmare!

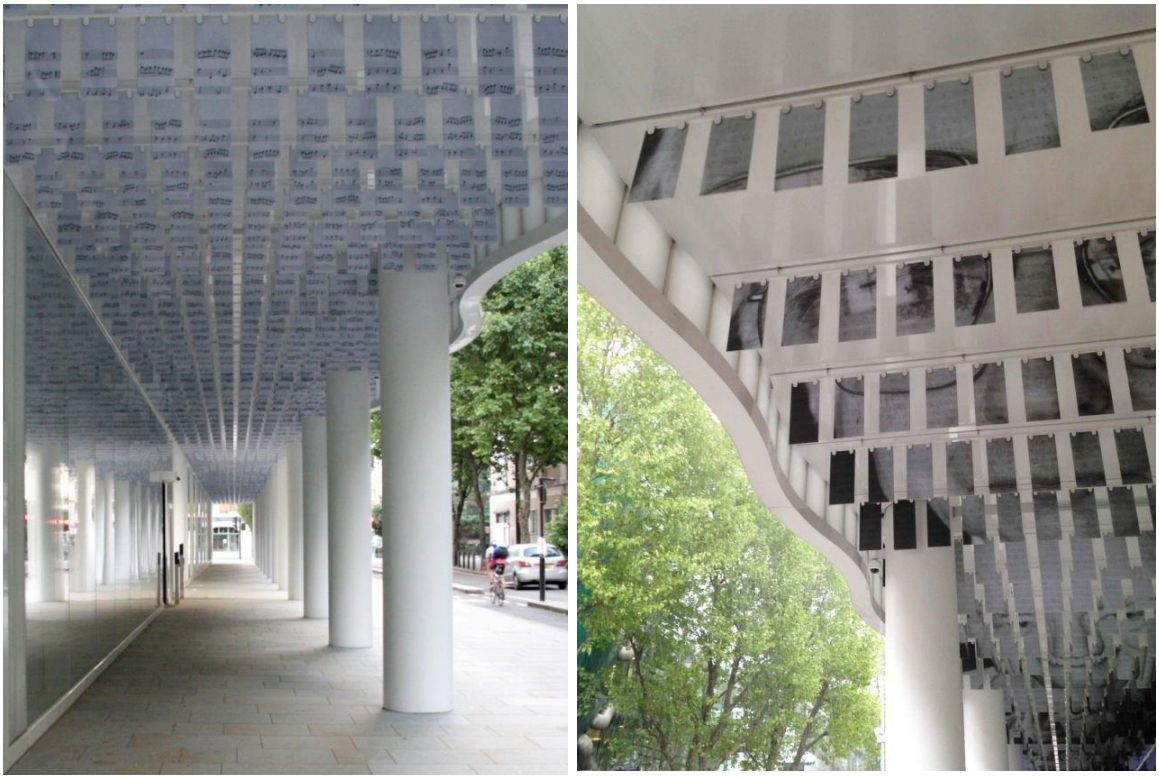
***light on the north wall***

The aesthetics of the Sainsbury Wellcome Centre has a fugitive, even ethereal quality which comes from the idea of how to compose with and use glass in ways which have not been done before, to exploit reflections through the micro profile of the glass surface, to allow the façade to play akin to a piano.



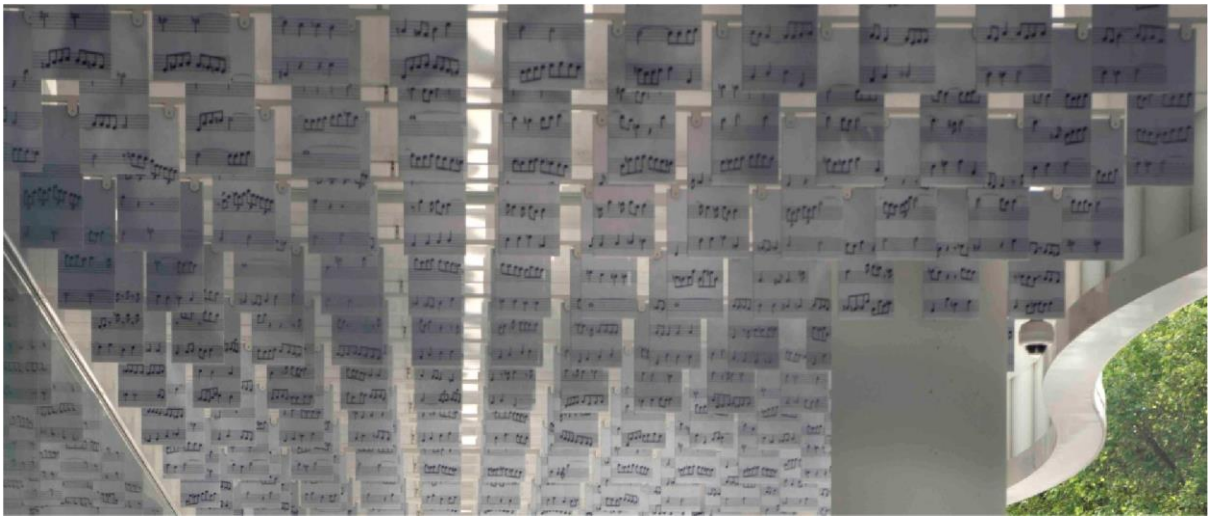
***Light on the south wall & shadows in the colonnade***

There is applied art to the building – as a way of communicating the inside activities to the outside making the building less anonymous.



***Pixels - colonnade of Bach music & UCL Nobel laureats***

The colonnade has a thousand suspended pixels. One side contains J.S. Bach: Musical Offering (1747): Ricercar a 3 – recommended by the Principal of the Royal Academy of Music as one of the mind's greatest ever compositions and described him as:



***Bach music pixels close up***

"*The distillation of three perfectly interweaving lines, of shared melody in perfect form and harmony, reflects the ultimate in unveiling the mysteries of the musical mind.*

*Bach's famous visit to Potsdam to visit Frederick the Great on May 7th in 1747 inspired a theme in his 'Musical Offering' which conflates the Renaissance knotty-ness of the old Ricercar with the staged luminosity of the fashionable Enlightenment. As artists so often do, the return to first principles at the end of a creative life leads to works where not a note, a word or a figure could be removed without reigning incoherence. Bach's raw scientific data absorbed and lost into the realms of the ear, heart and mind is just the start of a 40-minute work which hurls the 16th-century towards the late-19th in a single arc of creative genius*."

On the other side are eleven Nobel Laureates in Physiology or Medicine who have stepped into UCL at some point in their careers. One bay of pixels was left blank for the next one to come out of the Centre. It turned out to be John O'Keefe!

These images are recognised at 'sweet' points as one walks along – a little play on perception.

## *Vitrines*

There are also five 'vitrines' towards one end of the colonnade which explain some visual phenomena and the way the brain can confuse us: - distortion, deception, inversion, illusion and perception.

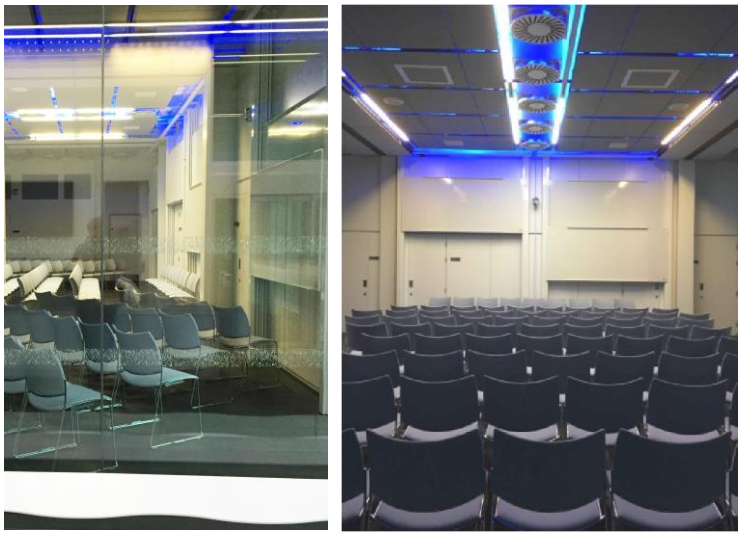
***Image of neuron***

Neuroscience images can be projected onto the west end wall.

## NEURODESIGN IN THE FUTURE & WHAT WE SHOULD BE DOING

Architects should be keen to understand how best to provide spaces that work best for the occupants.

The challenge is that our needs change throughout the day, across time, according to our state of health, or the tasks we're being asked to engage in.



***SWC adaptable lecture theatre***

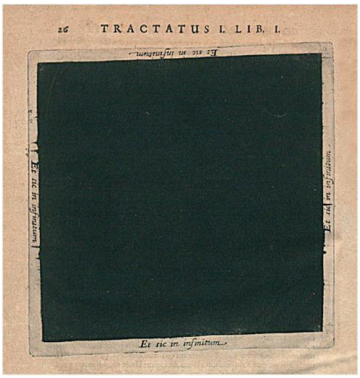
How can architects design for adaptability and flexibility? For us they are different aspects. Adaptability is physical organisation and dimensions of space changing. Flexibility is softer, flexible light, flexible quiet, flexible temperature, smell and colour. As designers if we begin to react to these dynamic needs we can move architecture in the right direction.

There is a vast amount of neuroscience literature covering aspects of how environmental variables influence behaviour in animals. This knowledge is surely pertinent to architects. Perhaps architects can start to define some of the experiments which will give us answers to specific design issues.

What would a completely adaptive architecture look like? It is certainly not one that would appear radical internally, nor do I suspect, externally. We have already made a start with the Sainsbury Wellcome Centre.

**CONCLUSION**

What scientists deal with, including the field that fascinates me neuroscience, is the ‘actual’ physical world. For them it is stable and unchanging. But the way artists work out answers is not always acceptable to the scientist. Has this been true of psychiatrists too.




***Fludd: et sic in infinitum 1617  Malevich black square c.1923***

Fludd was an English Paracelsian physician, Malevich a painter and art theoretician. Both these works expression of emptiness, the void, eternity and death. Hamlet returns.

What we see through these images is confirmation that the piece of paper is never completely blank. What is evident is that the mind of the artist is dealing with three phenomena:

*The external world* which we sense - and these *sensations* form the context in which our knowledge is embedded and is expressed.

*The internal world* – and I'm not sure it is just from the brain – we have a body (recall Woody Allen and the other organ) – The *Emotions*, which come from within and are usually 'mixed' by the brain with sensation and knowledge.

*The artist's cultural context* - We recognise that there are many representations of the world. In engineering, as in architecture, there are many solutions to a given problem or challenge. And there is no single right answer. There is always *a context* and it is the interpretation of the context combined with knowledge and the fluidity of the imagination at the time which will deliver the concepts and answers. All answers are true. Some more powerfully expressed than others and it is the power of these truths that can capture the imagination of the viewer.

Without a context information is meaningless.

**Madonnas**

If we look at ***one subject*** through the work of artists we see how imagination is not free, but is informed by the specific culture of the time

***Cimabue's Madonna C13***

***Botticelli's Madonna 1480-81***

***Cimabue***'s Madonna is full of symbolism which is opaque to many now that the iconography which gave meaning to the images is no longer understood by the greater public.

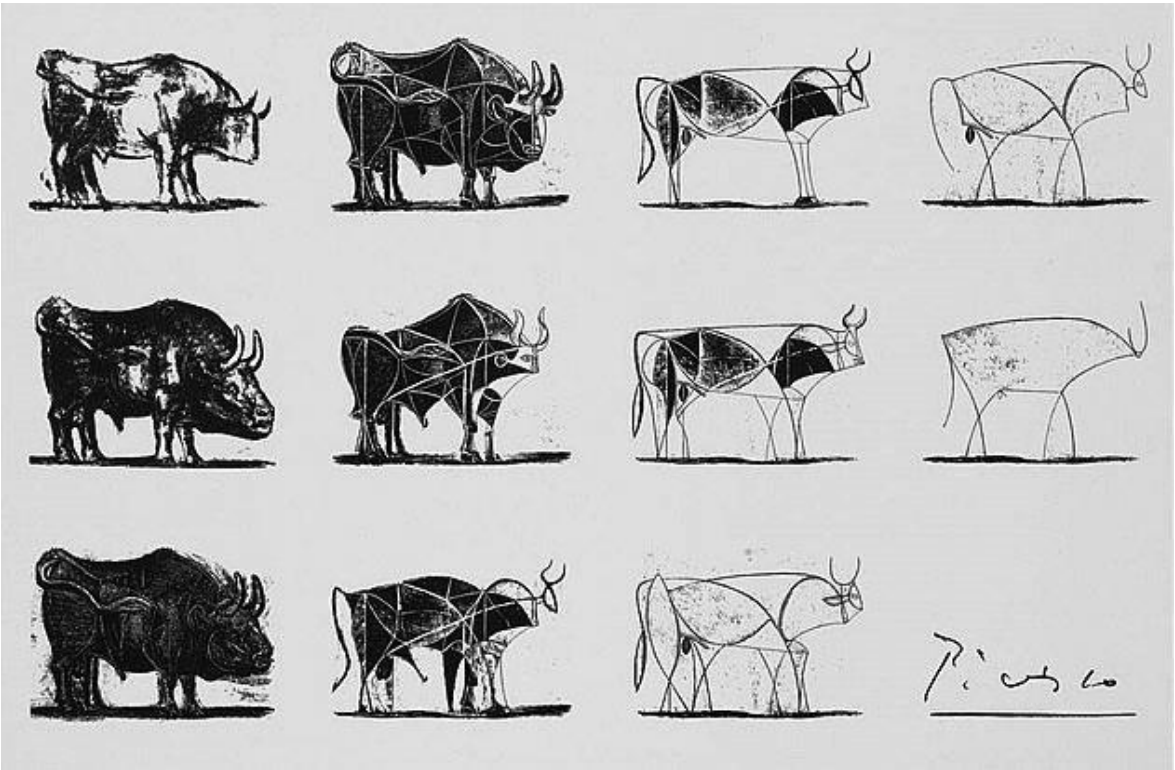
***Botticelli***'s Madonna is simpler, less symbolic, golden and graceful,

***Titian 1530*** ***Ritchie 2014***

***Titian*** presents a more natural Madonna, and languid goddesses.

***Ritchie*** Madonna and child is reduced to two flowing lines.

Relativism is perhaps the nearest style to describe my art and architecture. Relativism is an art movement in sculpture and painting that began in the 1950s and emphasized extreme simplification of form and colour.



***Picasso bull etchings 1945***

Presents an evolution to an abstracted or reductive form, but how they remind us of those early cave paintings.

Science is concerned with reality at any given time in history – a speculative reality one might argue - and not with subjective notions. There has to be an empirical result, a proof.

I'm interested in the bridge between them. I would like new information and facts from behavioural neuroscience to help me imagine new forms of space. I'm hopeful that designers will benefit from the exploration of quantative and qualitative aspects between architectural, philosophical, and aesthetic concepts of space.

Where are psychiatrists in all this? Does it interest them? Is it of interest?

I understand that the original vision of psychiatry was as a medicine – or physic of the mind. In May this year at the Royal Society of Medicine the day was dedicated to: Psychiatry and society: Will neuroscience change psychiatrists' understandings and practices?

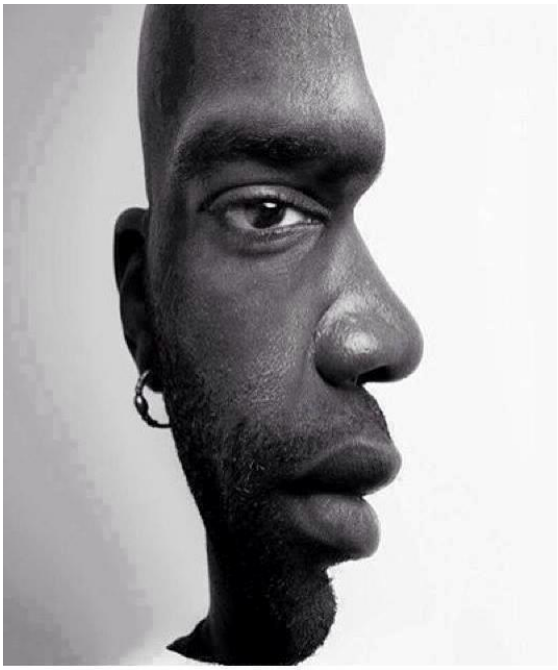
Surely, if psychiatry wants to be an up-to-date-medicine of the mind then it must engage with the biological and behavioural world of neuroscience.

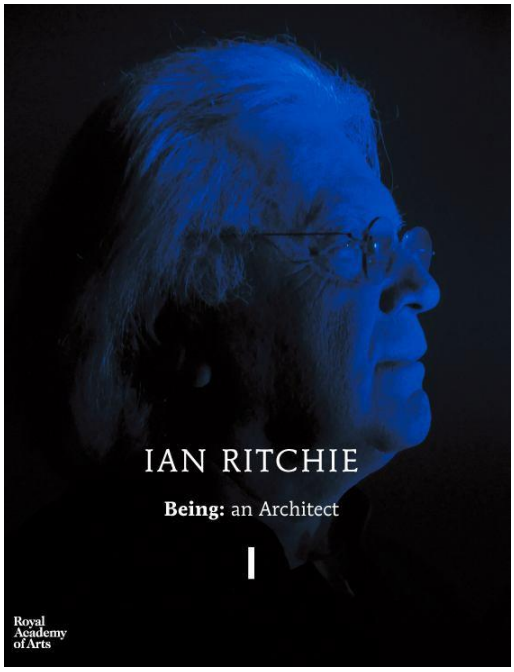
I am keen to extract value from their work.

After all, you are here to advance a better treatment for the mind. It may not be the right thing to say, but advertising gurus have been out there for a while exploiting this emerging 'knowledge' – and they have a name for it: neuromarketing.

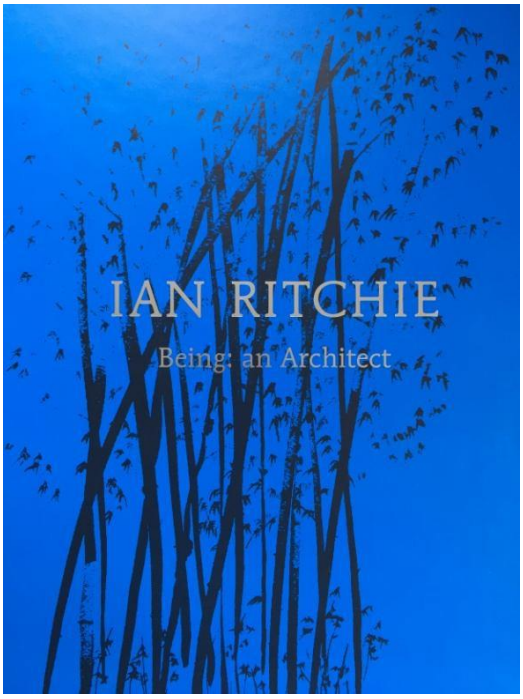
I recall Sir Martin Rees writing that one human brain was more complex than the universe. Maybe, but surely understanding the biology of the brain, however mind-bogglingly complex, and the interpretation of behaviour, equally mindboggling, are essential to the evolution of man as a just social animal and not fundamentally a biological killing machine. Have we come far from Lascaux?

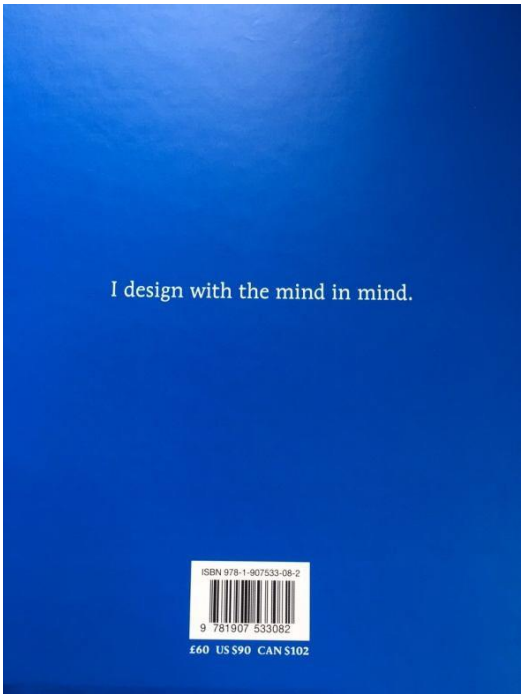
Michel Foucault stated that: if a tendency toward self-harm is taken as an elementary symptom of mental illness, then humans, *as a species*, are arguably insane in that they have tended throughout recorded history to destroy their own environments, to make war with one another, etc. *Foucault, Michel (1988). Madness and Civilization: a History of Insanity in the Age of Reason. New York: Vintage Books.*






Earth is 45 million centuries old, but this century is special. It's the first when one species – ours – can determine the biosphere's fate. What a tragedy if we do not understand anything important about ourselves before we ruin the Earth. Is that what a black hole really means?




***END***