

new technologies to enrich
your mind

Expanding
consciousness with
Brain-machine
interfaces

Consciousness is...

experiencing brain processes



Consciousness is...

experiencing brain processes
different processes cause different qualia



color

Consciousness is...

experiencing brain processes
different processes cause different qualia



color

sound

Consciousness is...

experiencing brain processes
different processes cause different qualia



color

sound

taste

Consciousness is...

experiencing brain processes
different processes cause different qualia



color



sound



taste



smell

Consciousness is...

experiencing brain processes
different processes cause different qualia



color

sound

taste

smell

pain

Consciousness is...

experiencing brain processes
different processes cause different qualia



color sound taste smell pain

let's enrich this experience with new

Expanding experience

brain
qualia

synthetic
qualia



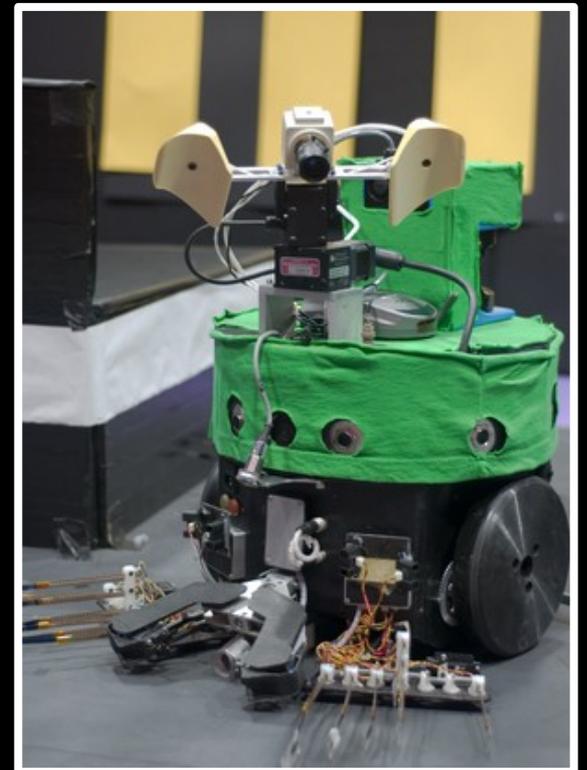
similarly to
neurons, brain
implant represents
itself in
consciousness

Synthetic qualia?

but is it possible for artificial device
to create consciousness?

artificial neural network models
have been already developed
which demonstrate
rudimentary consciousness or some
aspects of consciousness

Edelman brain-based devices →
neural networks simulations by
Dehaene, Gamez



Putting them together

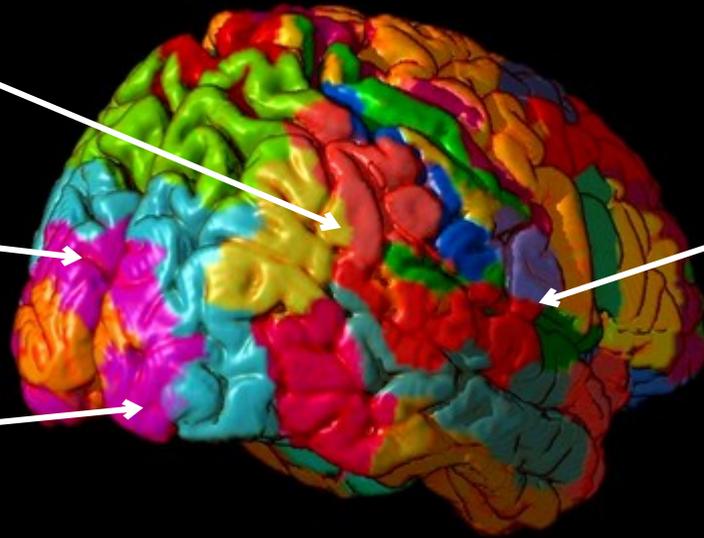
how to integrate synthetic qualia
with those produced by brain?

learn from nature!

motion

shape

color



sounds

so how does brain bring them all together?

The miracle of broadcast

what makes the system conscious?

Information Integration Theory

Tononi & Edelman

differentiation consist of many
specialized modules

integration each module
profoundly affects activity of
others

consciousness can be **measured
mathematically**

Global Neuronal Workspace Theory

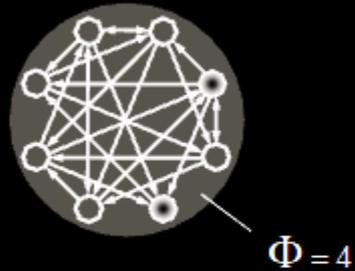
Dehaene

many specialized modules

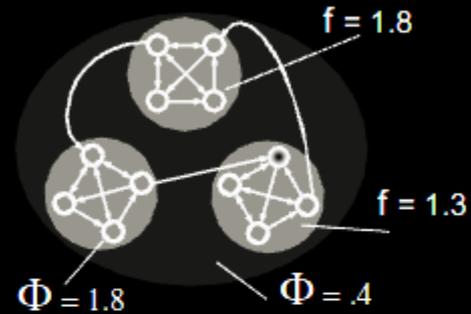
integration/broadcasting via
subset of special **workspace
neurons**

INTEGRATED INFORMATION & NEUROANATOMY

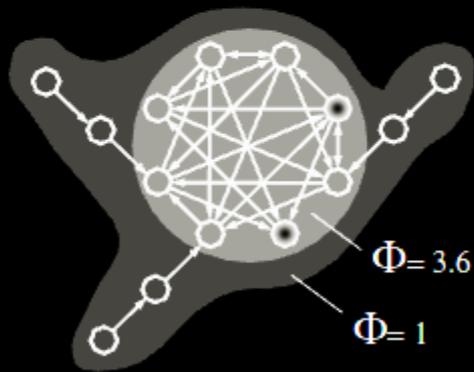
A CORTICOTHALAMIC SYSTEM



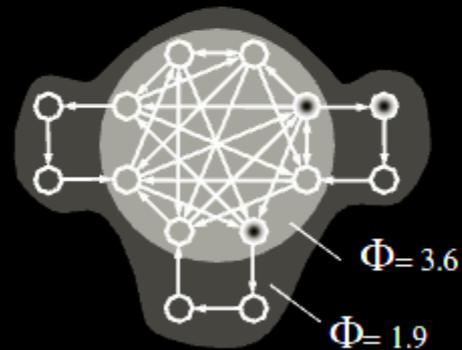
B CEREBELLAR SYSTEM



C AFFERENT PATHWAYS



D CORTICAL-SUBCORTICAL LOOPS



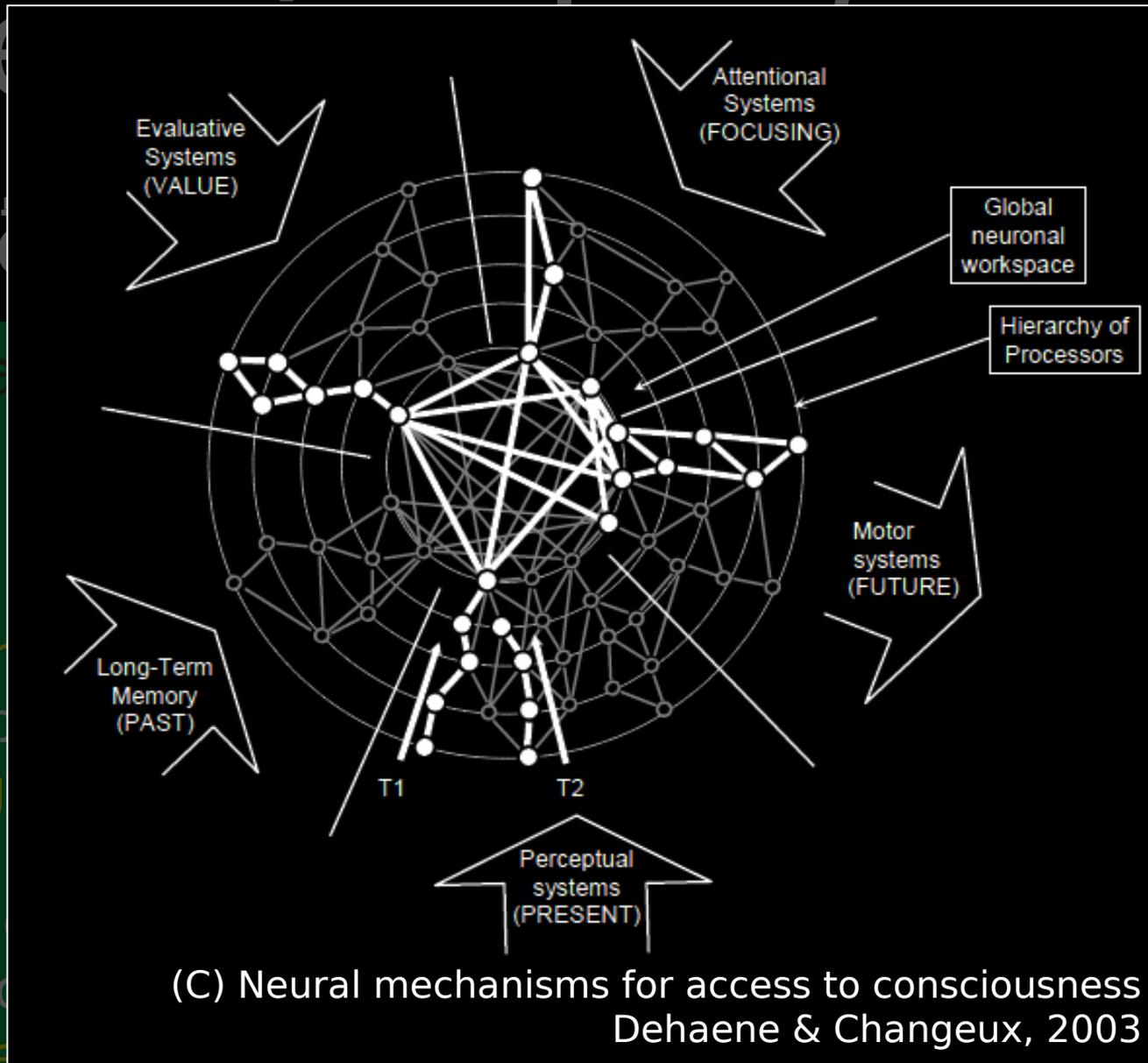
(C) Consciousness as Integrated Information: a provisional manifesto
Tononi, 2008

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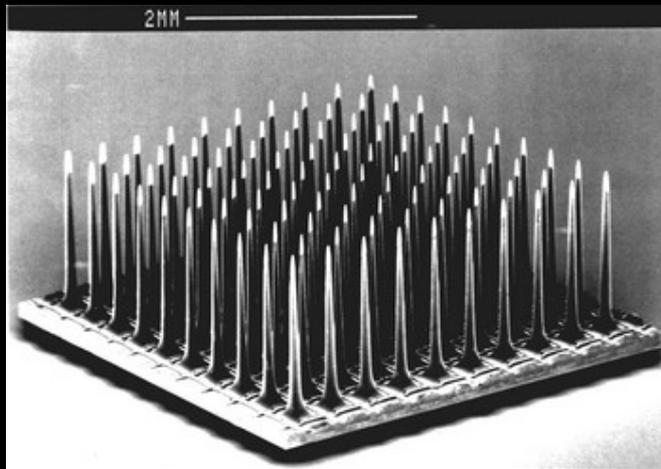
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subset of
neurons

The hardware

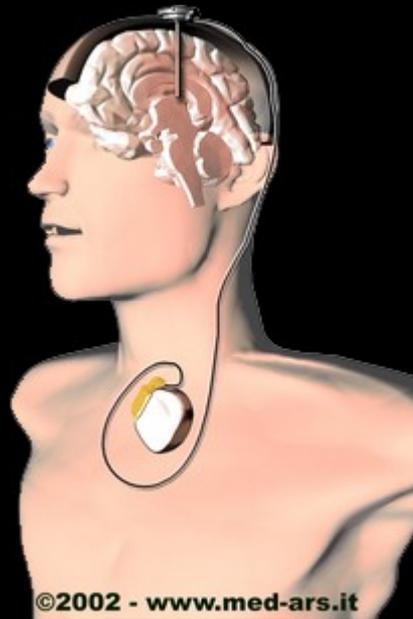
how to make the implant broadcast?

today's brain-machine interfaces



electrode grid

X only those neurons
close to the surface



DBS electrode

X many
connections are
not possible:
• can damage
everything
• procedure
too cumbersome

The hardware

a new hopes

“sprouting” brain-machine interfaces



Harnessing the blood supply network (R. Llinas)



Growing up your own network of neuroagents

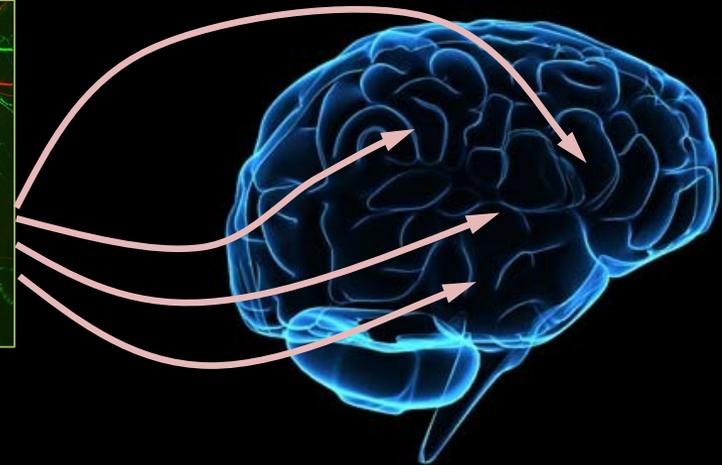
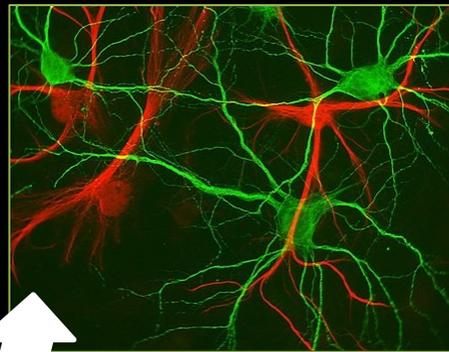
The hardware

interfacing in a brain-friendly way

neurons are
grown on a chip



their axons grow
through the brain



intermediate
layer between
brain and
electronics

communication channel
is natural for the brain

Applications

artificial bodies



tactile and
proprioceptive
feedback
for
neuroprostheses

Applications

approach to “cracking neural code”

conscious neural implants provide a fresh approach to the problem of transferring information into the brain

1. transfer happens when brain-implant system becomes conscious
2. a mathematical tools for analyzing conscious systems are being developed
3. these tools finally allow to calculate optimal design for the implant enabling consciousness = information transfer

Going further

exploring the minds of Others

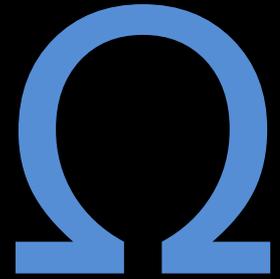


would it be possible
to join conscious
experience of another
being with yours?

the major difficulty is
provided by functional
aspects of
consciousness

Going further

the Consciousness Singularity



all consciousness on
the planet, living and
artificial, merged to a
single one

the “functional
problem” disappears
at the global level

The end?

nope, just the beginning!

Thank you!

