

Department of Psychological and Behavioural Science public lecture

A Day in the Life of the Brain: the neuroscience of consciousness from dawn 'til dusk

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EVENTS

Hashtag for Twitter users: #LSEbrain

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THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■

The background of the slide is a photograph of a landscape at dawn or dusk. In the foreground, there is a grassy field with some low-lying vegetation and a single, leafless tree standing prominently. The middle ground shows a body of water, possibly a lake or a wide river, reflecting the light from the horizon. The sky is a deep blue, and a string of small, bright lights is strung across it, forming a gentle arc. Two larger, brighter lights are positioned at the ends of this arc, resembling stars or distant galaxies. The overall mood is serene and contemplative.

A DAY IN THE LIFE OF THE BRAIN

THE NEUROSCIENCE OF CONSCIOUSNESS

from Dawn

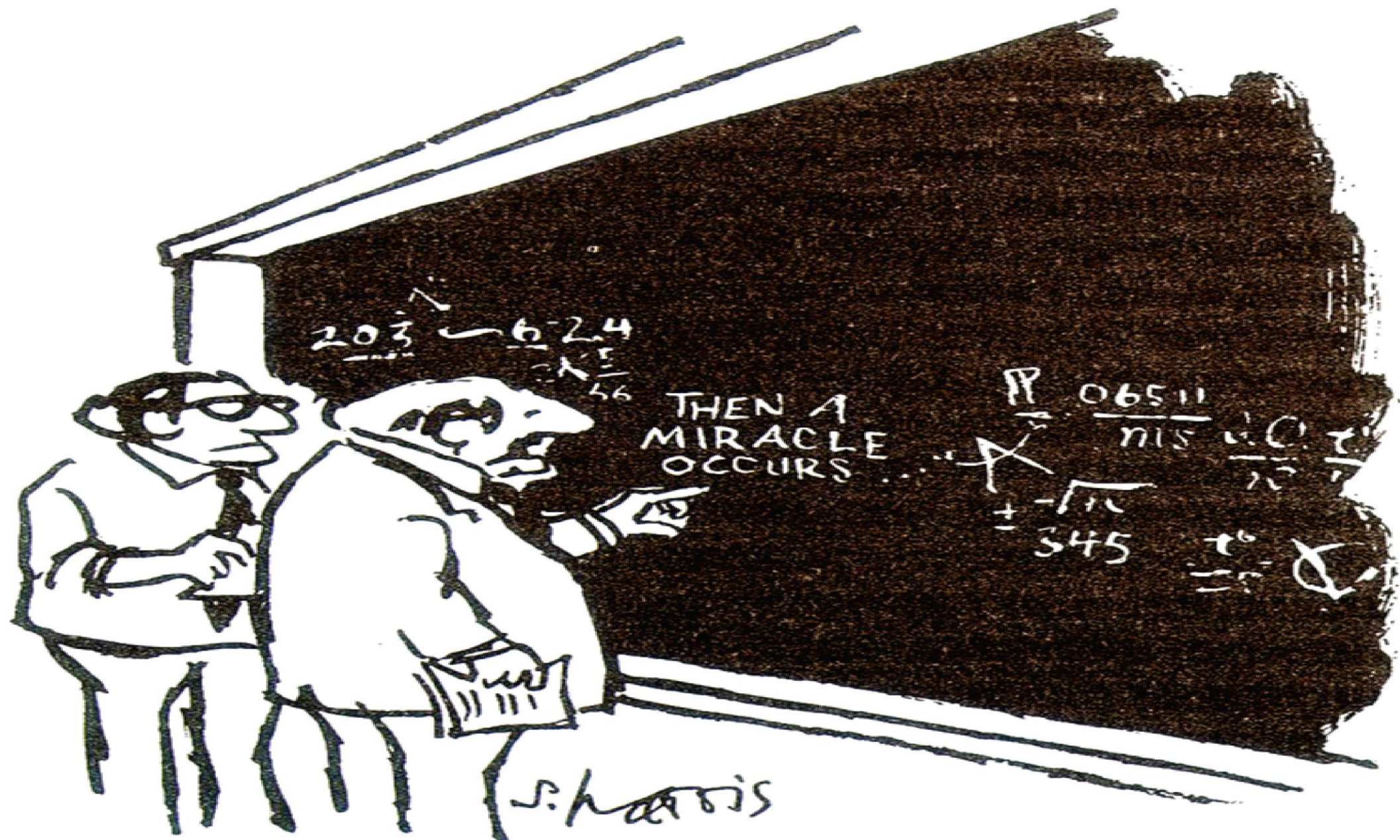
'til Dusk

A black and white photograph of a man with a beard, resting his head on his hands in a contemplative pose. The image is grainy and has a vintage feel. The man's face is the central focus, with his hands framing it from above. The lighting is dramatic, with strong shadows.

WHAT *IS* A SUBJECTIVE EXPERIENCE?



IN THE DARK...



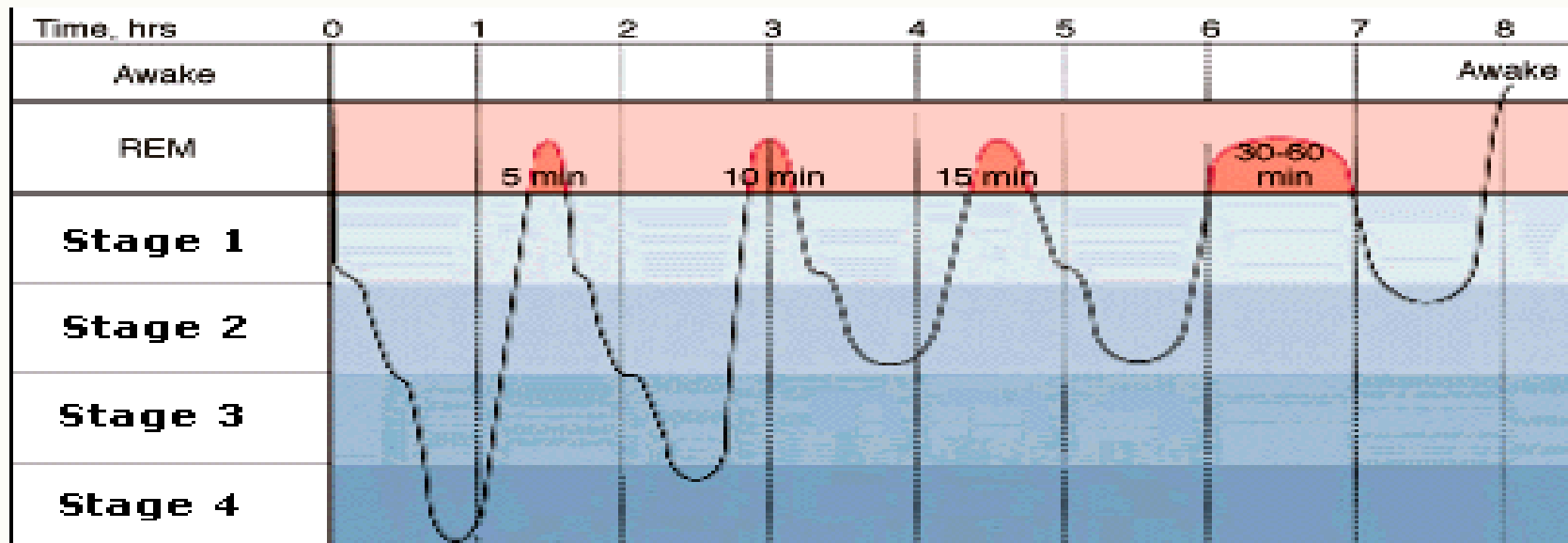
'I think you should be more explicit here in step two.'



WAKING UP



UNCONSCIOUSNESS IS VARIABLE...



IN SEARCH OF A PROCESS...



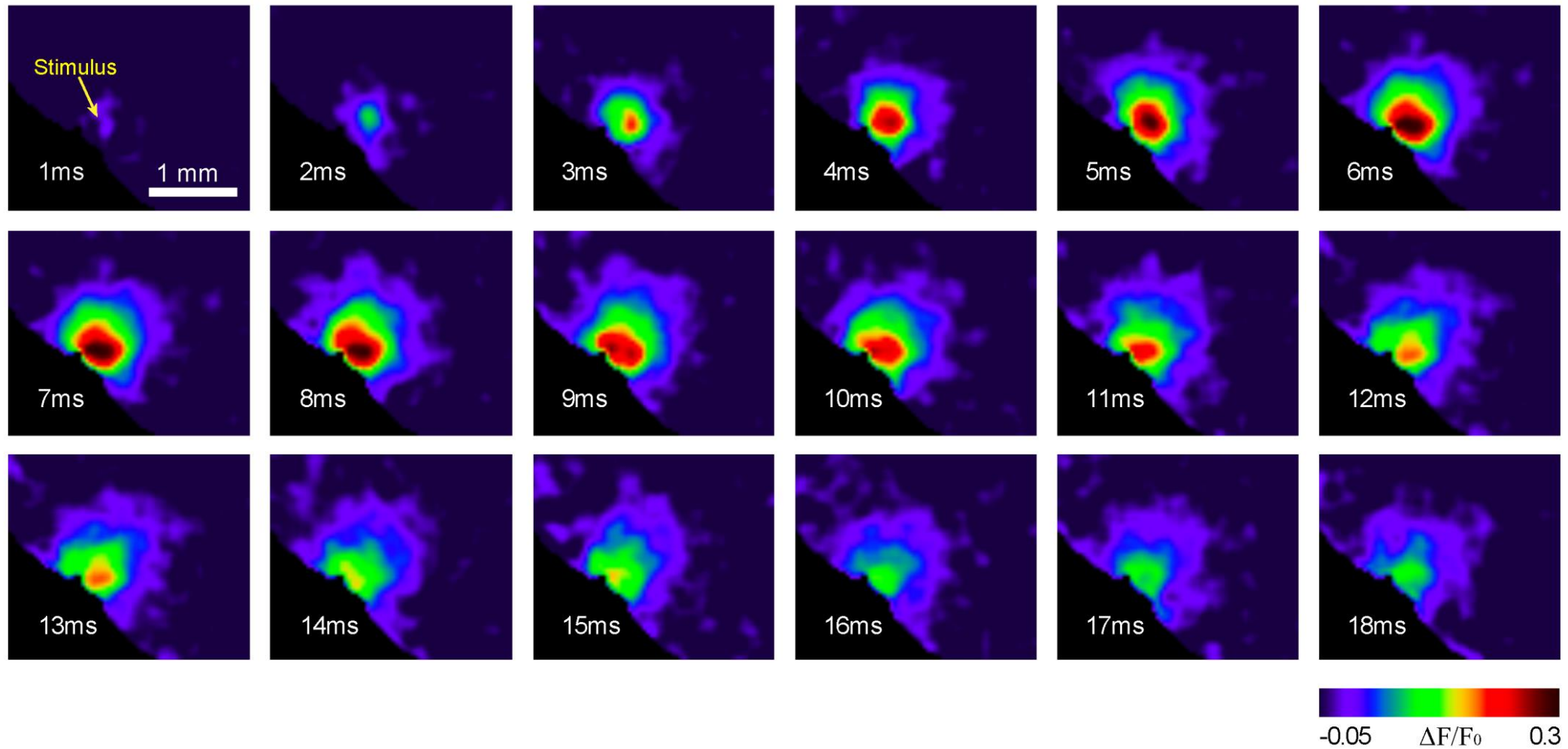
...Where Consciousness is Continuously Variable

CONSCIOUSNESS TOO IS VARIABLE
...LIKE RIPPLES



‘RIPPLES’ IN THE BRAIN:

Neuronal Assemblies

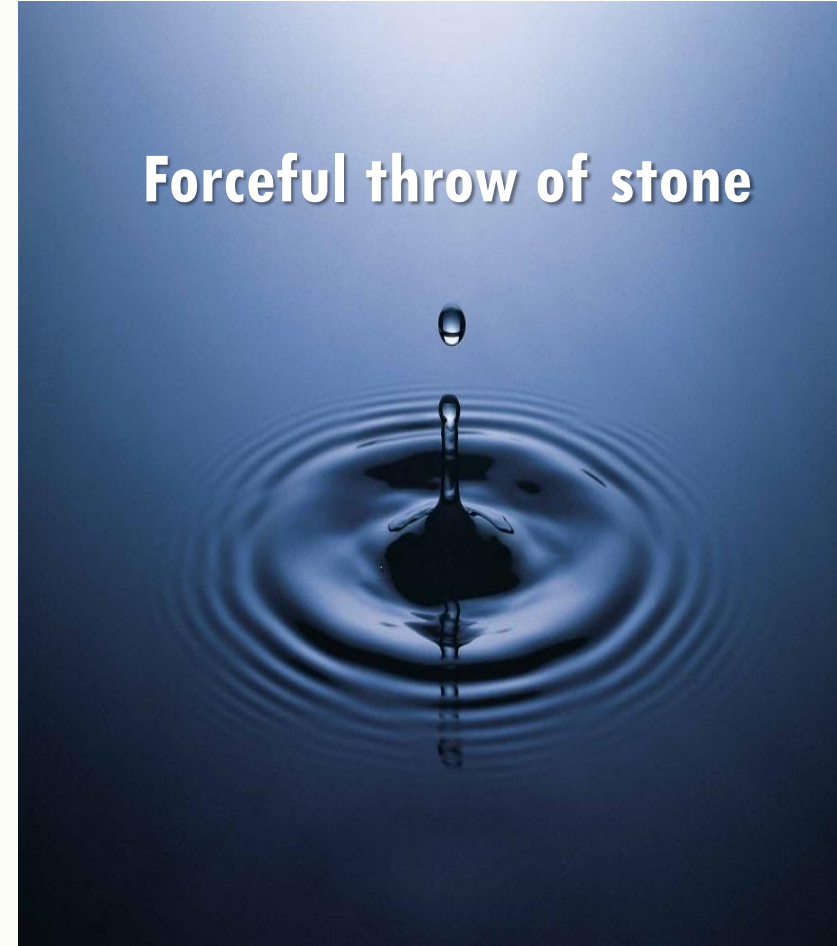


NEURONAL ASSEMBLIES

Variable, transient (subsecond), macro-scale groups of neurons (>10 million) not confined to/defined by anatomical brain regions/systems.



(1) WHY DOES AN ALARM CLOCK WAKE YOU UP?

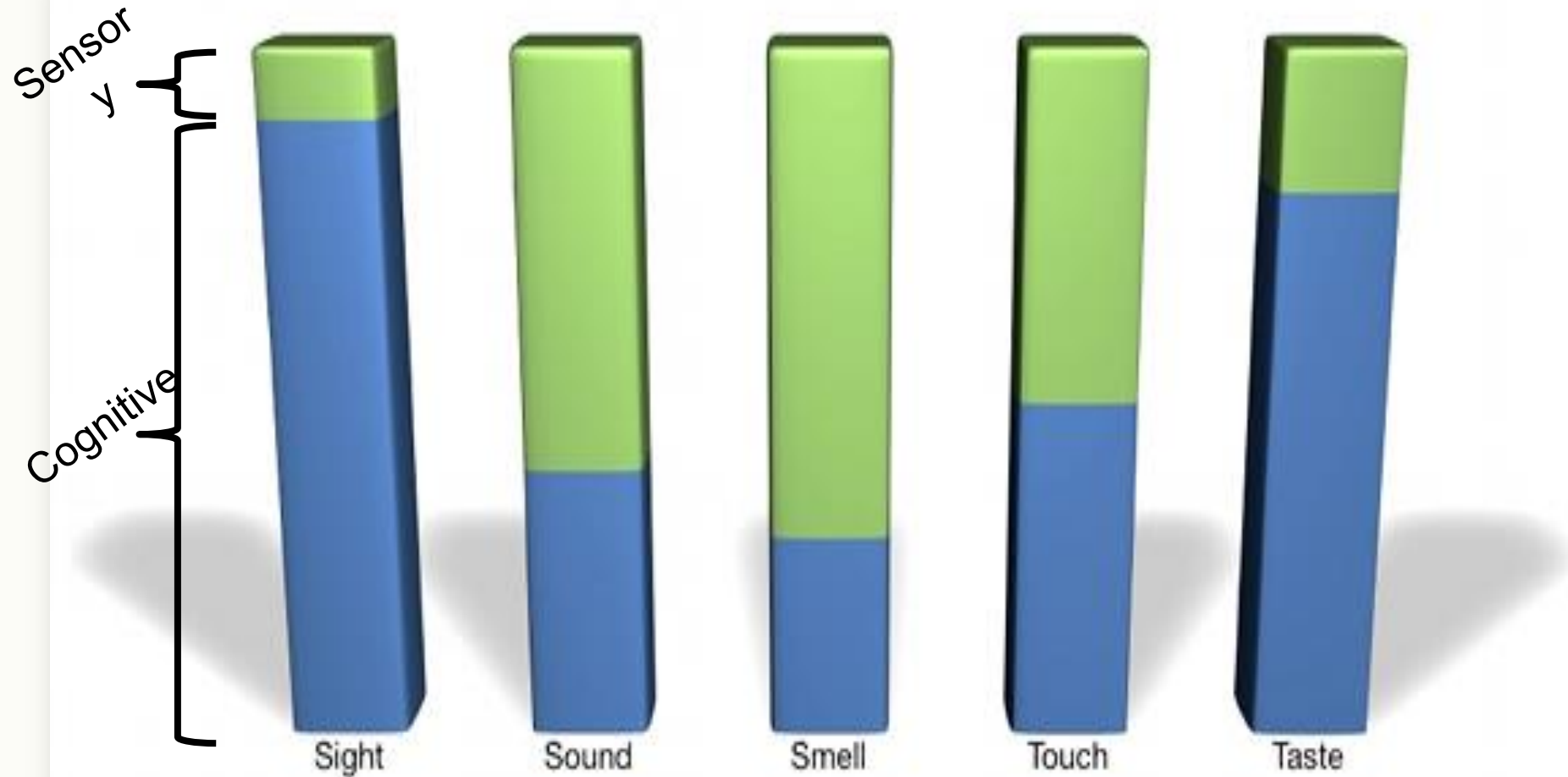


BREAKFAST



DIFFERENT SENSES:

A Sensory-Cognitive Continuum



DIFFERENT SENSES:

A Sensory-Cognitive Continuum

1. VISION



DIFFERENT SENSES:

A Sensory-Cognitive Continuum

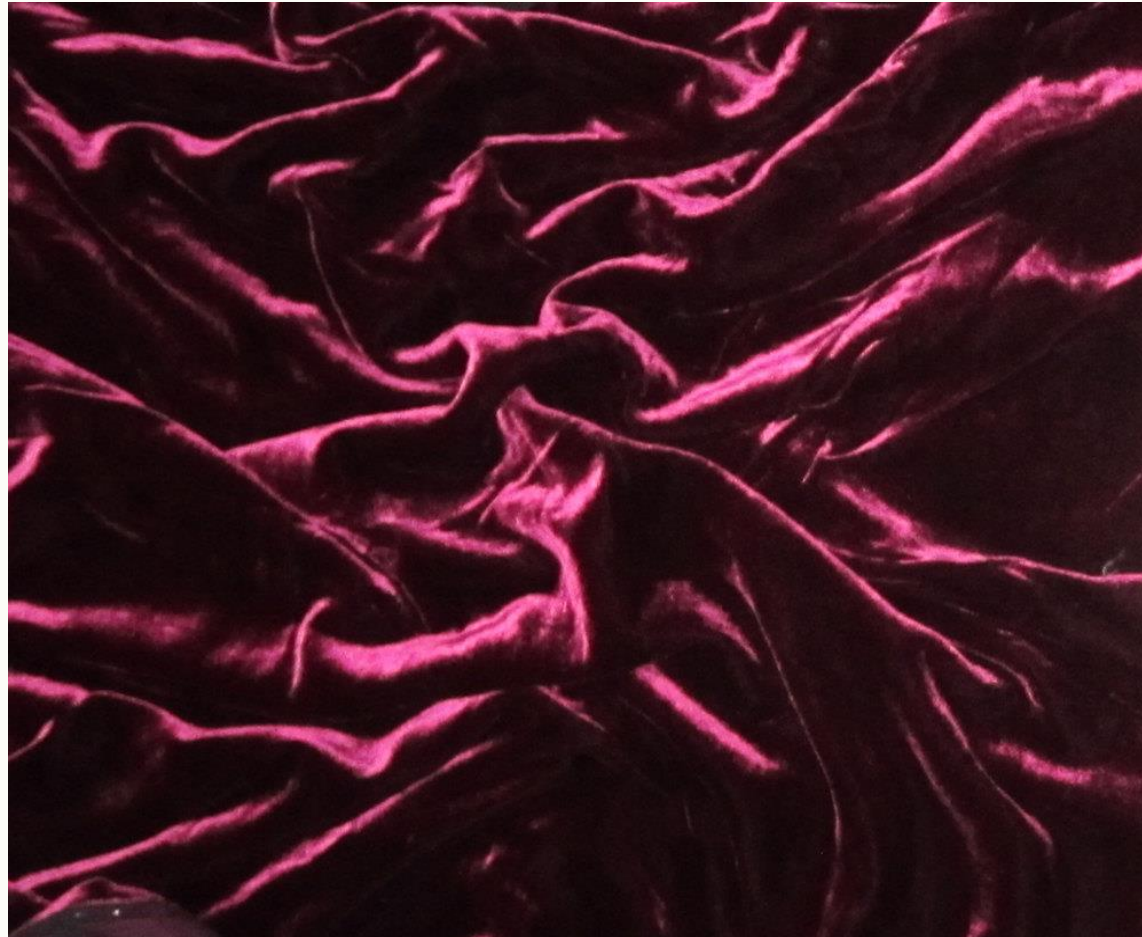
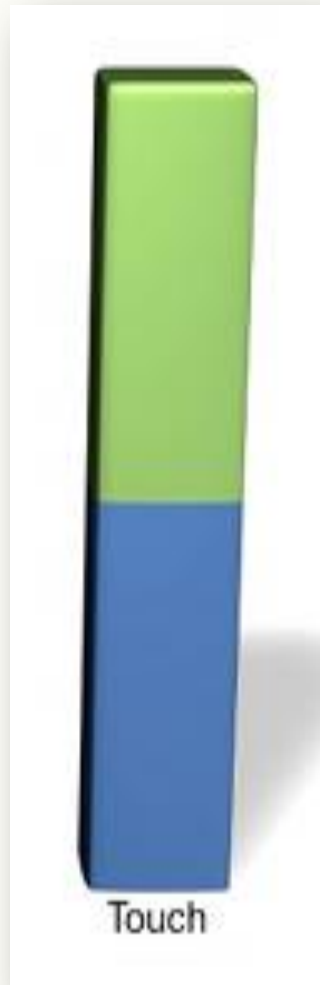
2. TASTE



DIFFERENT SENSES:

A Sensory-Cognitive Continuum

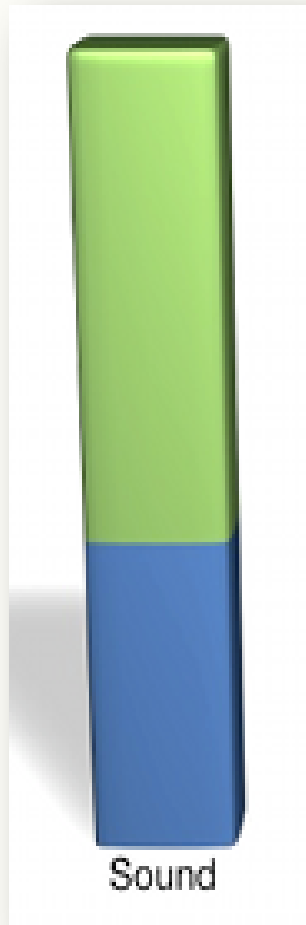
3. TOUCH



DIFFERENT SENSES:

A Sensory-Cognitive Continuum

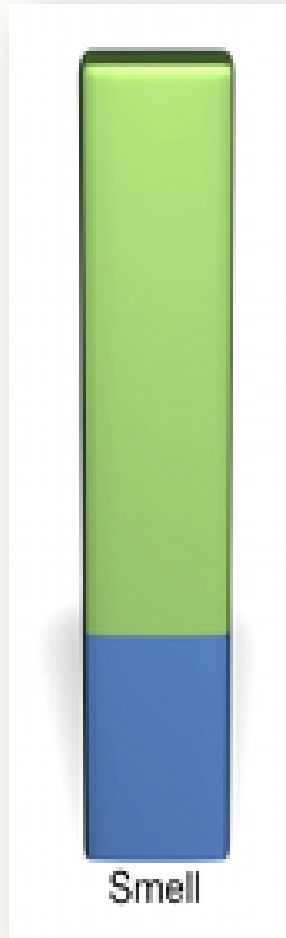
4. SOUND



DIFFERENT SENSES:

A Sensory-Cognitive Continuum

5. SMELL



TASTE & VISION



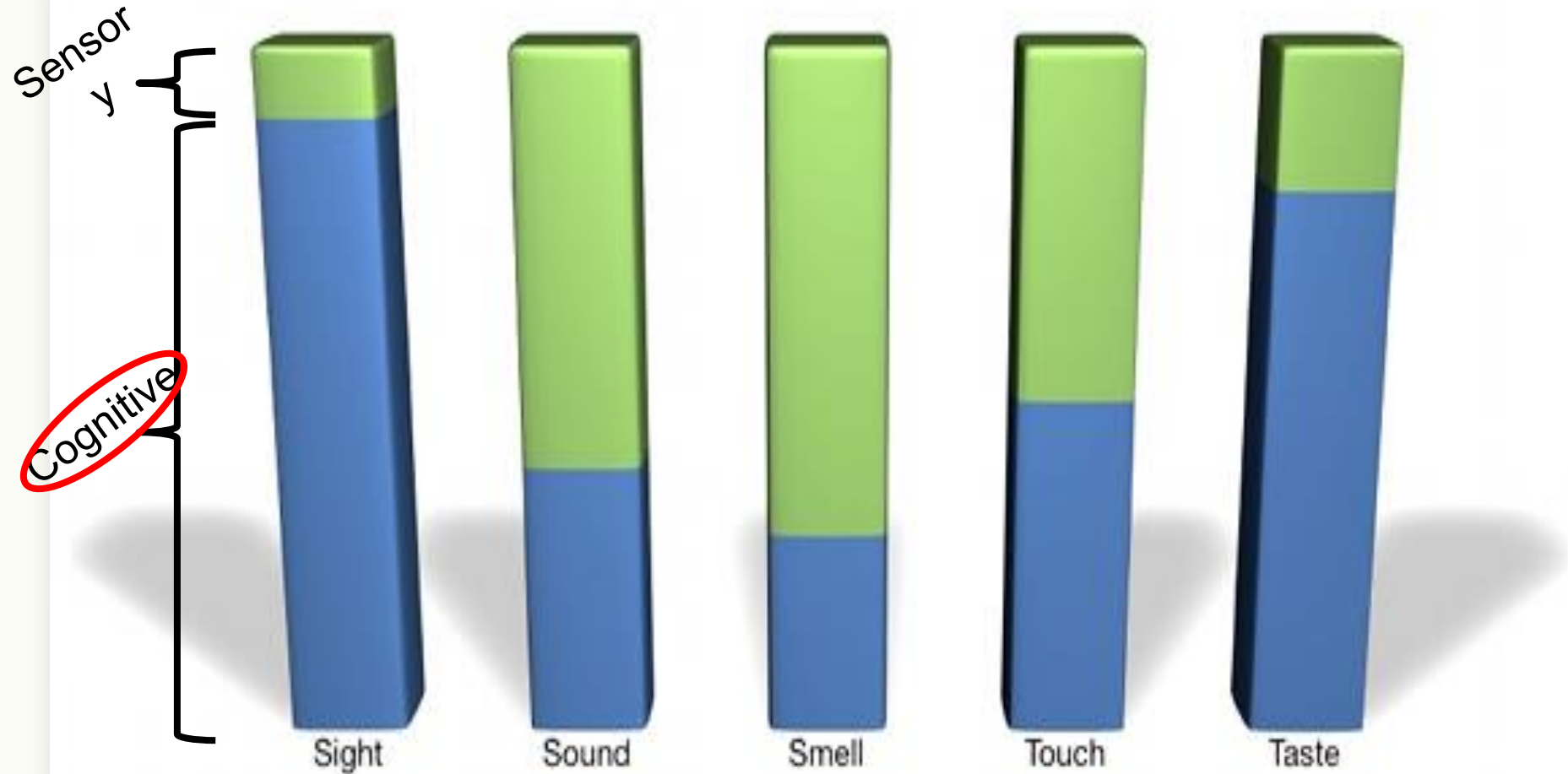
SMELL & HEARING



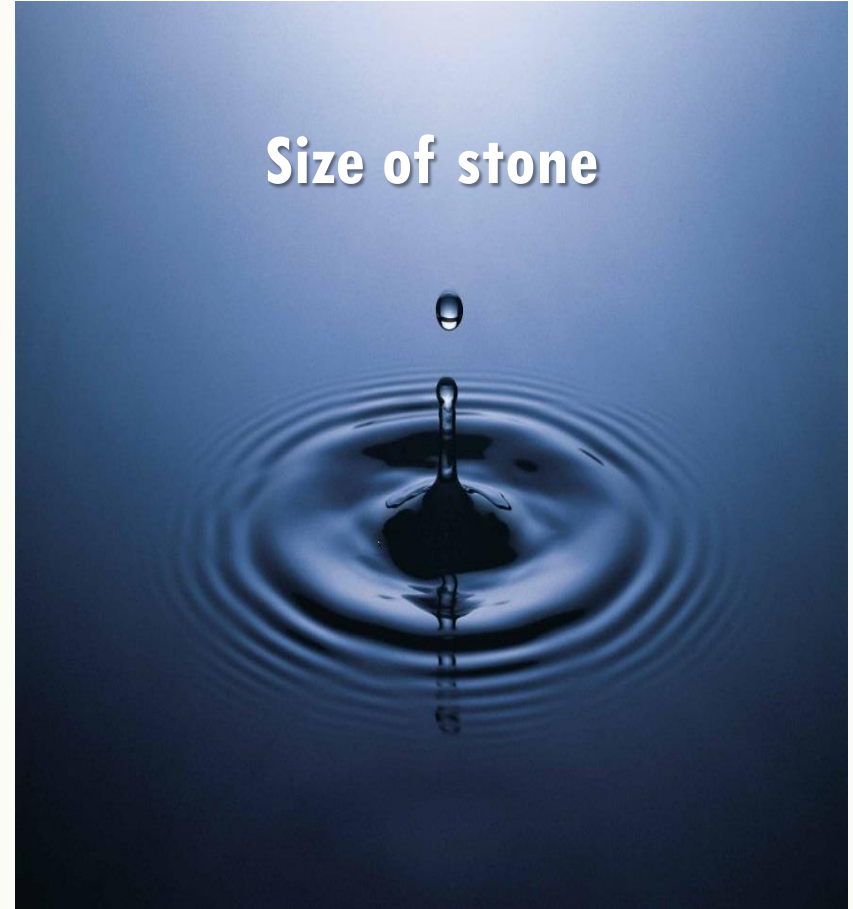


DIFFERENT SENSES:

A Sensory-Cognitive Continuum

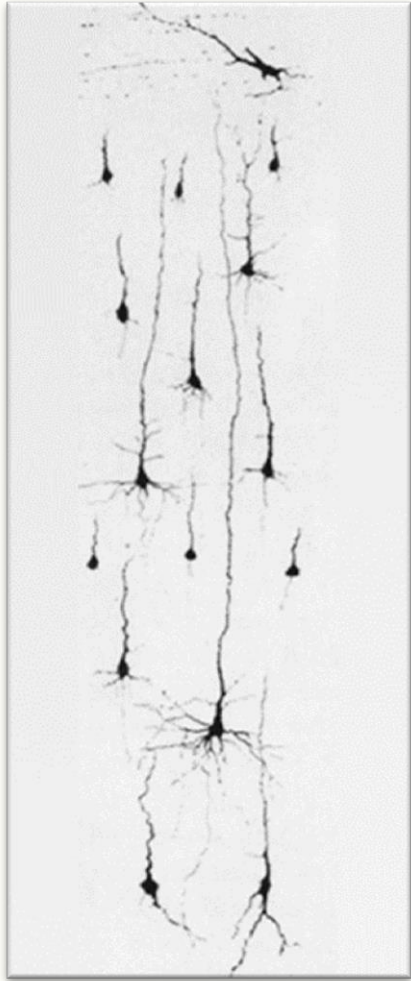


(2) HOW CAN PERSONAL EXPERIENCE AFFECT CONSCIOUSNESS?

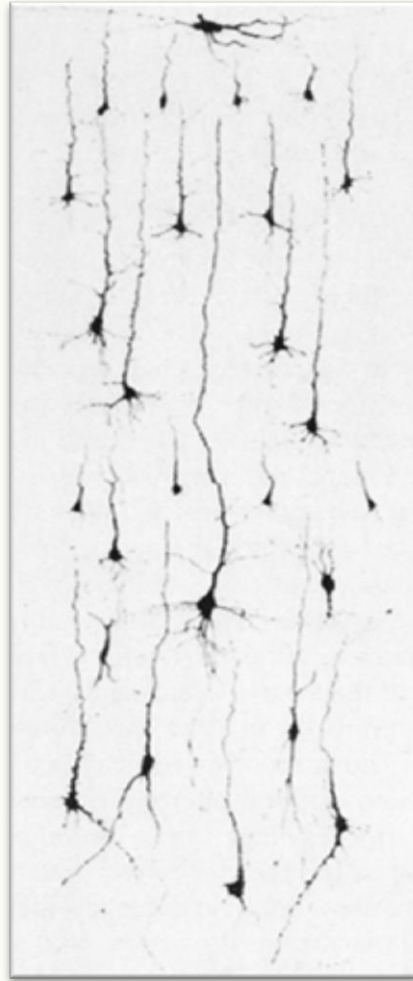




DEVELOPING A MIND...



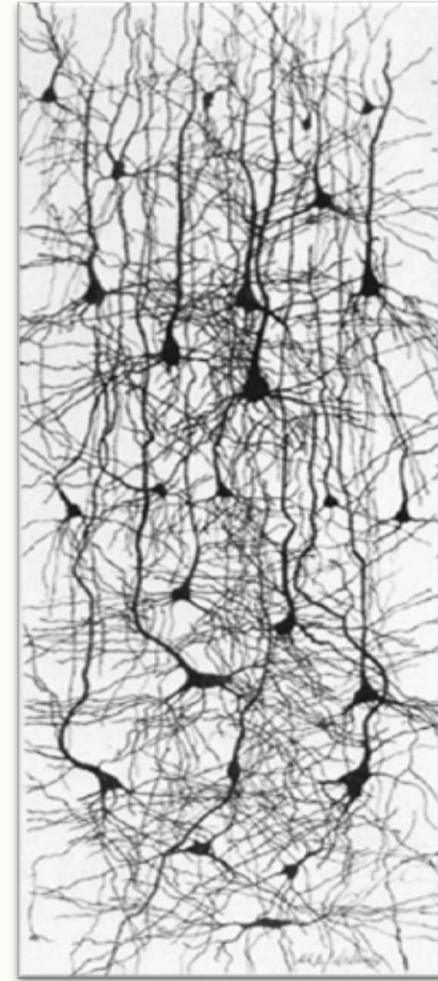
Newborn



3 Months



15 Months



2 Years

CONNECTIONS GIVE EVER DEEPER MEANING OVER TIME...





**THE BIOLOGICAL BASIS OF THE MIND IS THE PERSONALISATION OF
THE BRAIN THROUGH UNIQUE DYNAMIC CONFIGURATIONS OF
NEURONAL CONNECTIONS,
DRIVEN BY UNIQUE EXPERIENCES**

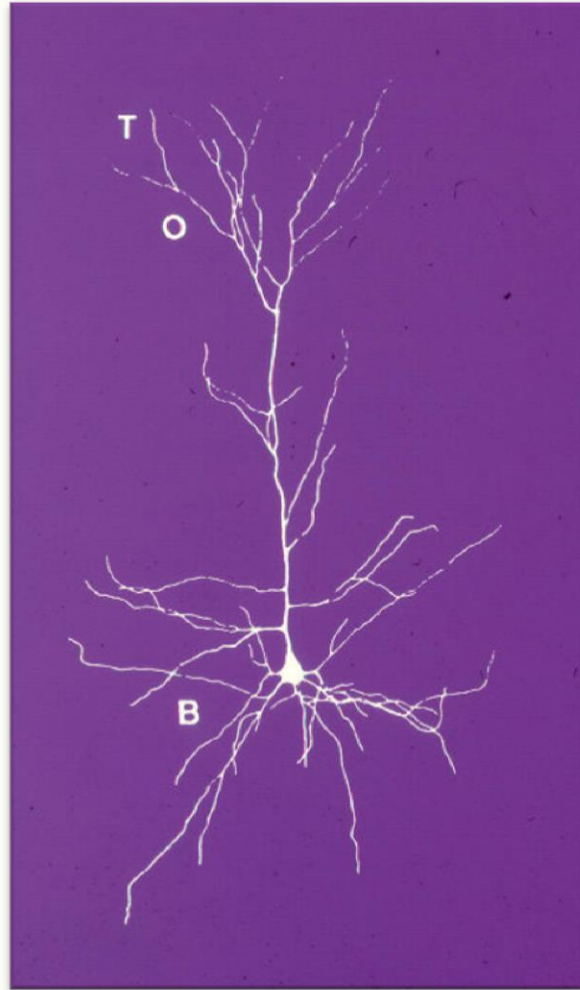
AT THE OFFICE



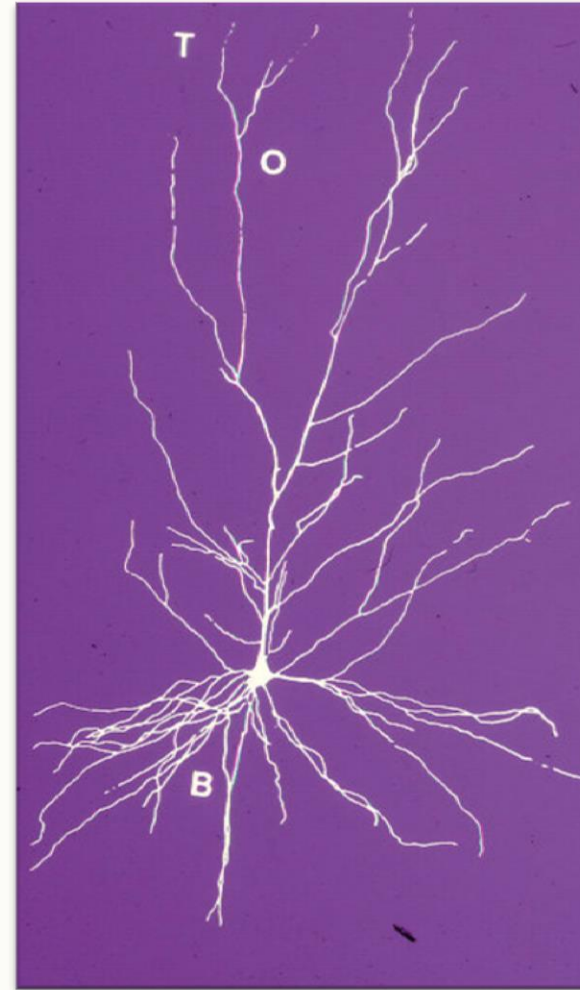
AN 'ENRICHED' ENVIRONMENT...



EFFECTS OF AN 'ENRICHED' ENVIRONMENT

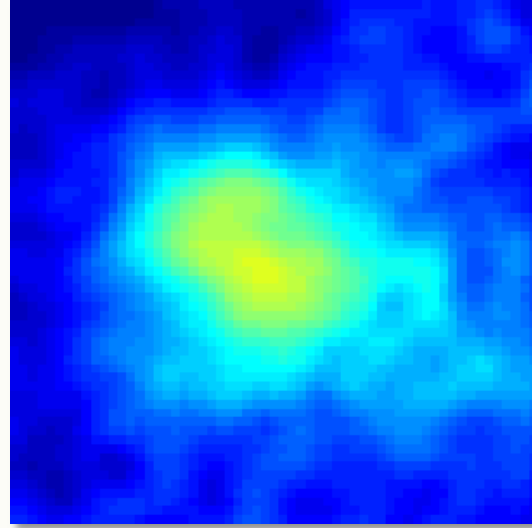


Standard

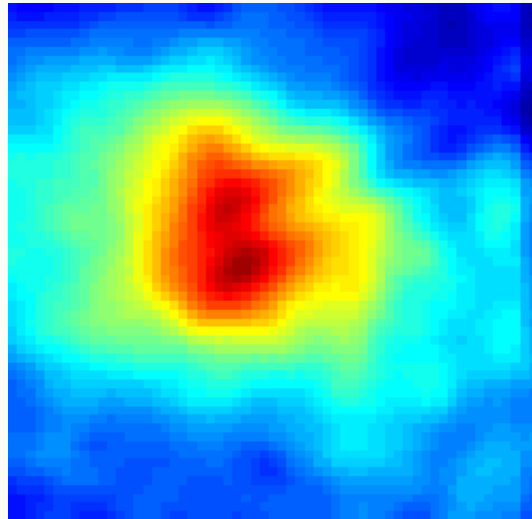


'Enriched'

EFFECTS OF AN ENRICHED ENVIRONMENT ON NEURONAL ASSEMBLIES



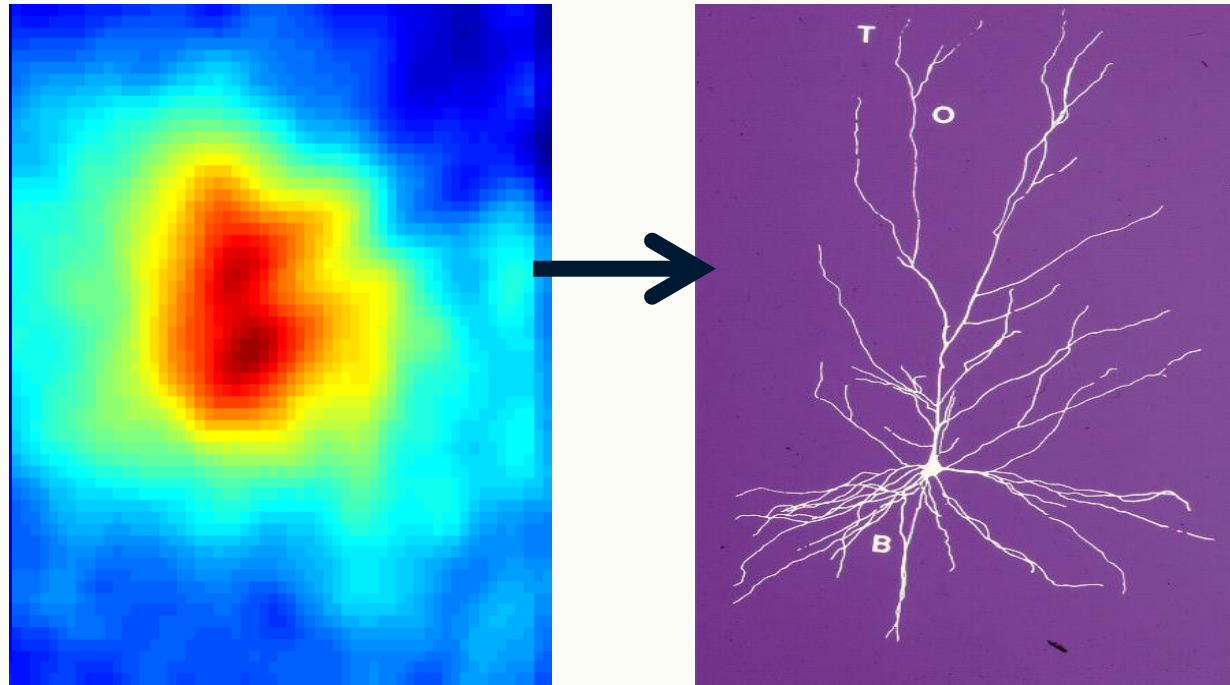
Control



Enriched

(Devonshire et al., 2010)

IF ENRICHMENT-ENHANCED PLASTICITY INCREASES ASSEMBLY SIZE, COULD ASSEMBLY GENERATION ENHANCE PLASTICITY?



THE EVOLUTIONARY FUNCTION OF NEURONAL ASSEMBLIES?



To facilitate **CO-ORDINATED, GLOBAL** adaptation to the environment.

EXPERIENCES LEAVE THEIR MARK ON THE BRAIN...



‘THINKING IS...

MOVEMENT CONFINED TO THE BRAIN’

Control

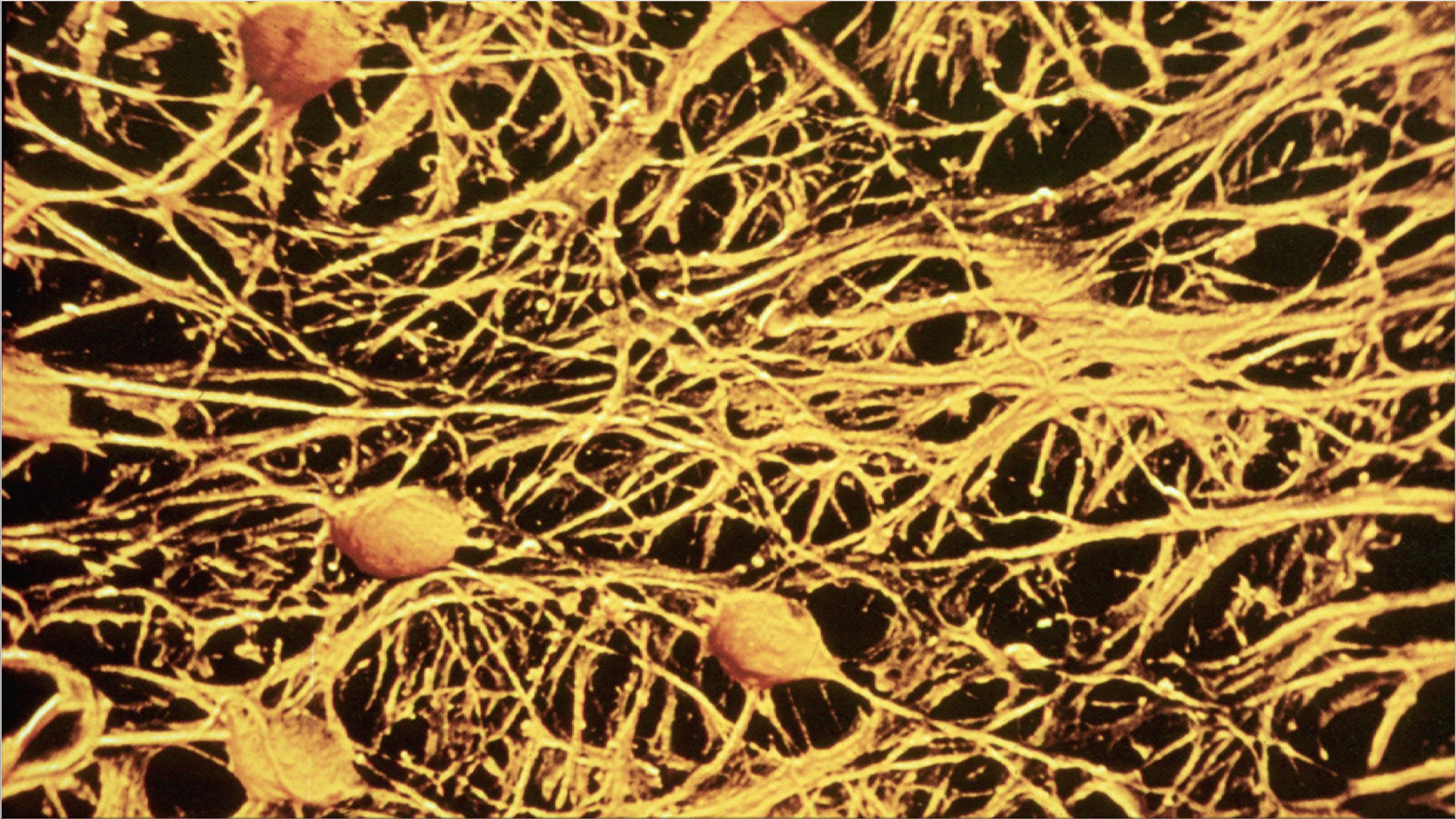


Physical Practice



Mental Practice







THE COGNITIVE BENEFITS OF INTERACTING WITH NATURE



Marc G. Berman, John Jonides, and Stephen Kaplan Psychological Science, 2008. 19 1207-12.

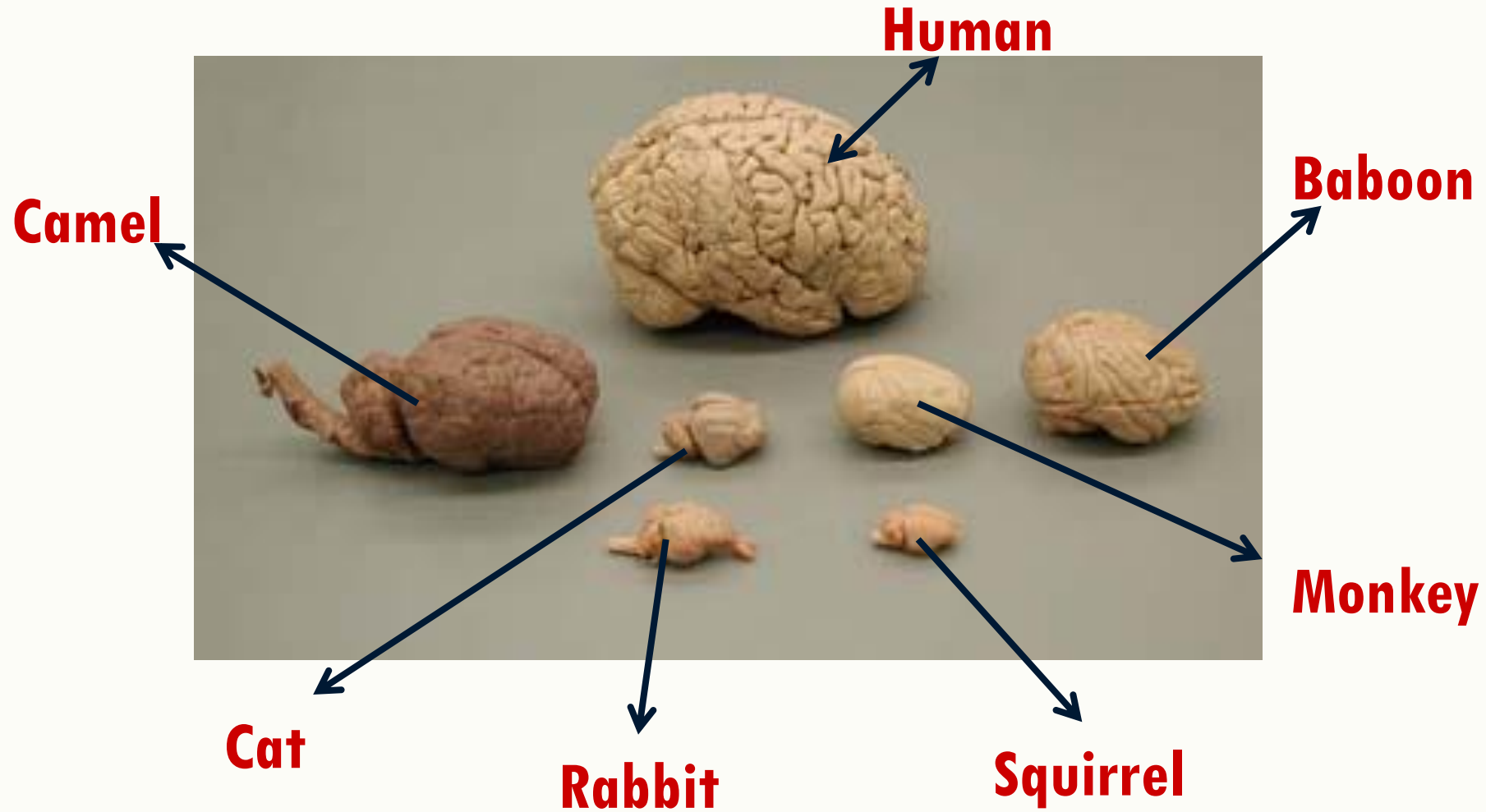
WALKING THE DOG



(3) WHAT IS ANIMAL CONSCIOUSNESS?



WHERE IS THE DIFFERENCE?



WHERE IS THE DIFFERENCE?

ELEDONE CIRRHOSA



No legislation

OCTOPUS VULGARIS



Government protection

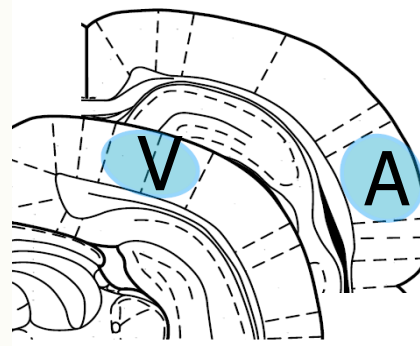
WHEN DOES CONSCIOUSNESS BEGIN?



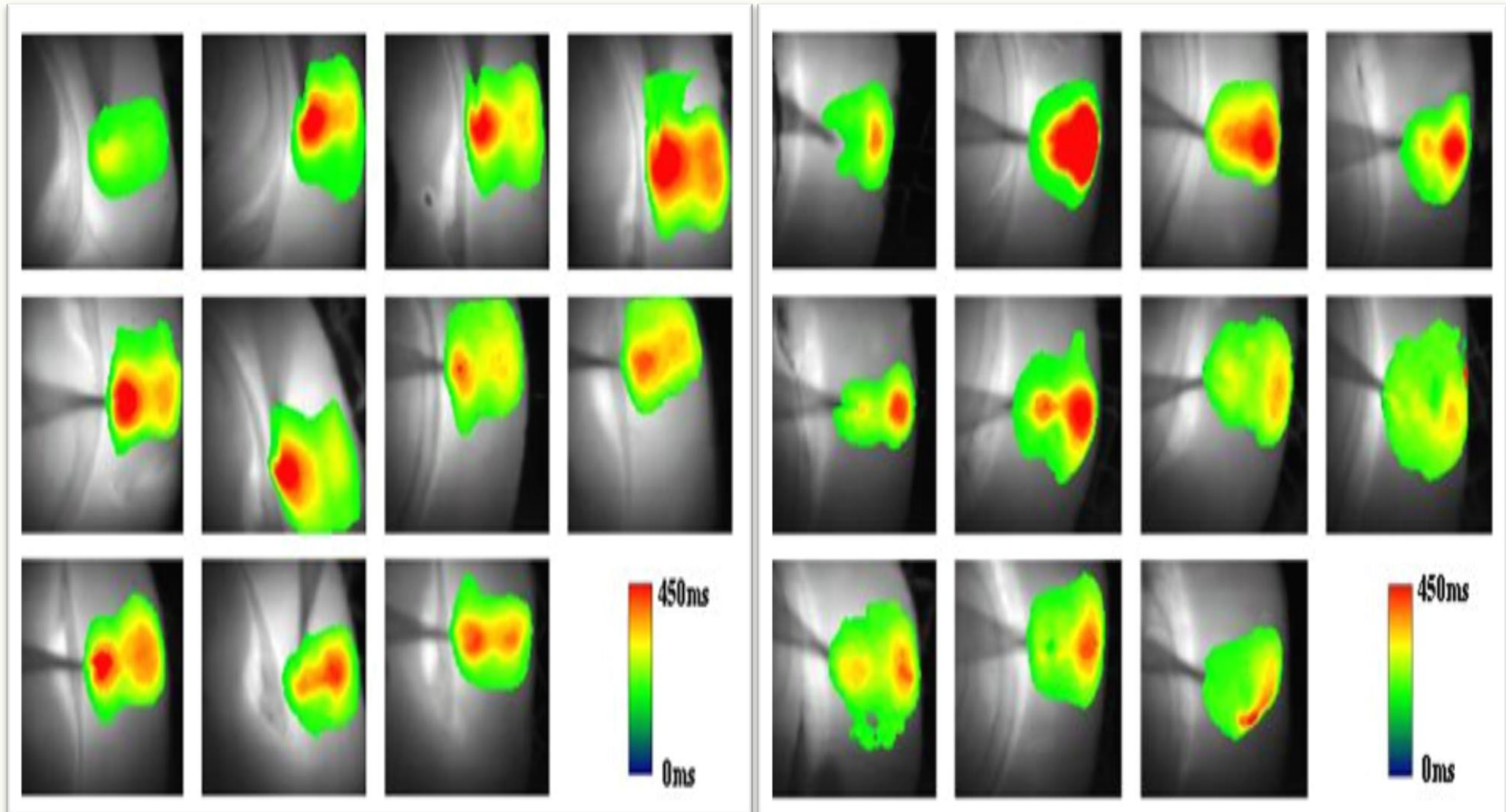
(4) HOW DO WE EXPLAIN THE DIFFERENCE IN SUBJECTIVITY OF HEARING AND SEEING?



VISUAL SYSTEM



AUDITORY SYSTEM



Research Article

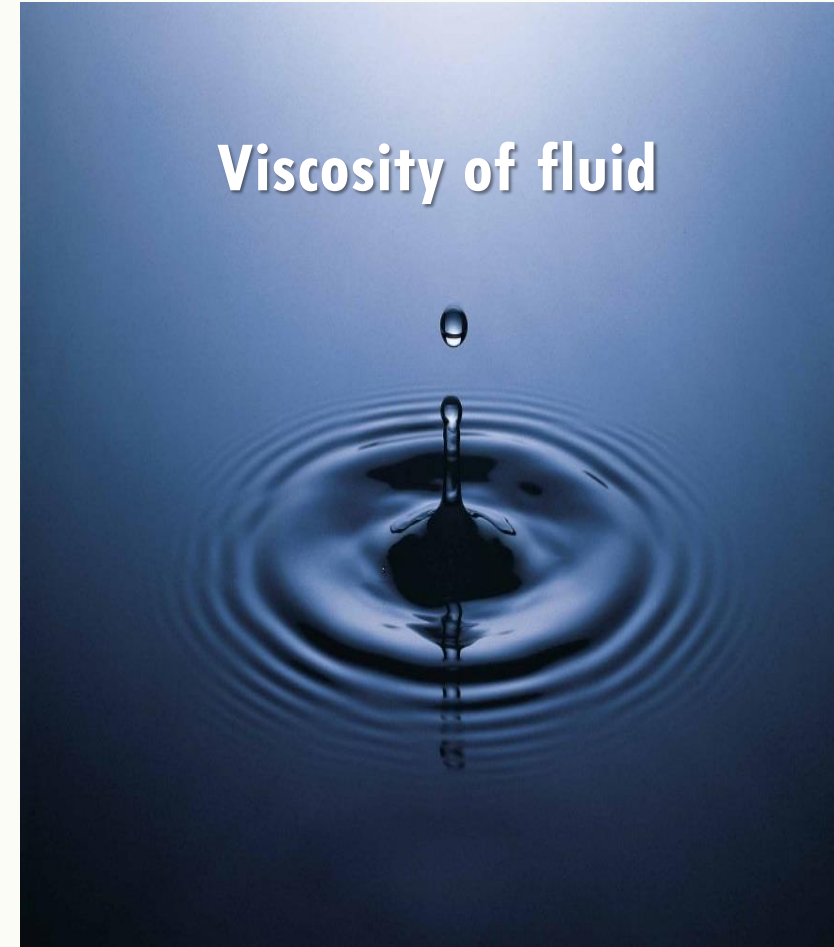
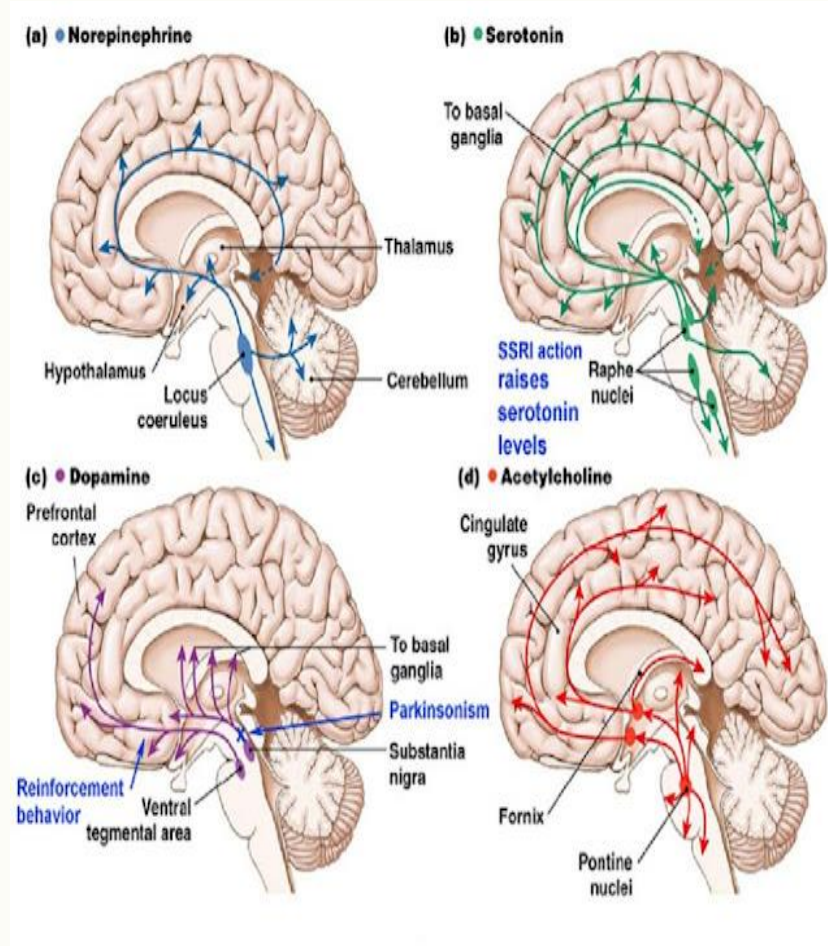
Differential dynamics of transient neuronal assemblies in visual compared to auditory cortex

Chakraborty S1, Sandberg A, Greenfield SA.

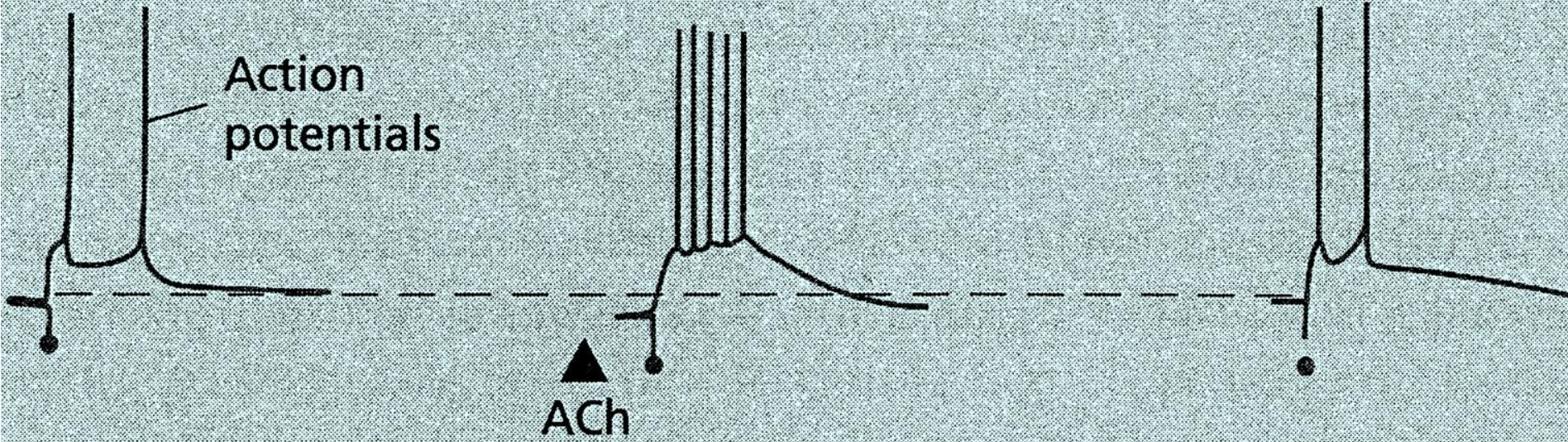
How to cite: Chakraborty S, Sandberg A, Greenfield SA. Differential dynamics of transient neuronal assemblies in visual compared to auditory cortex. Exp Brain Res. 2007 Oct;182(4):491-8. Epub 2007 Aug 3. PubMed PMID: 17673993.

**HEARING AND VISION ONLY DIFFERENTIATED
AT 250MSEC:
THE SAME TIME WINDOW AS CONSCIOUSNESS!**

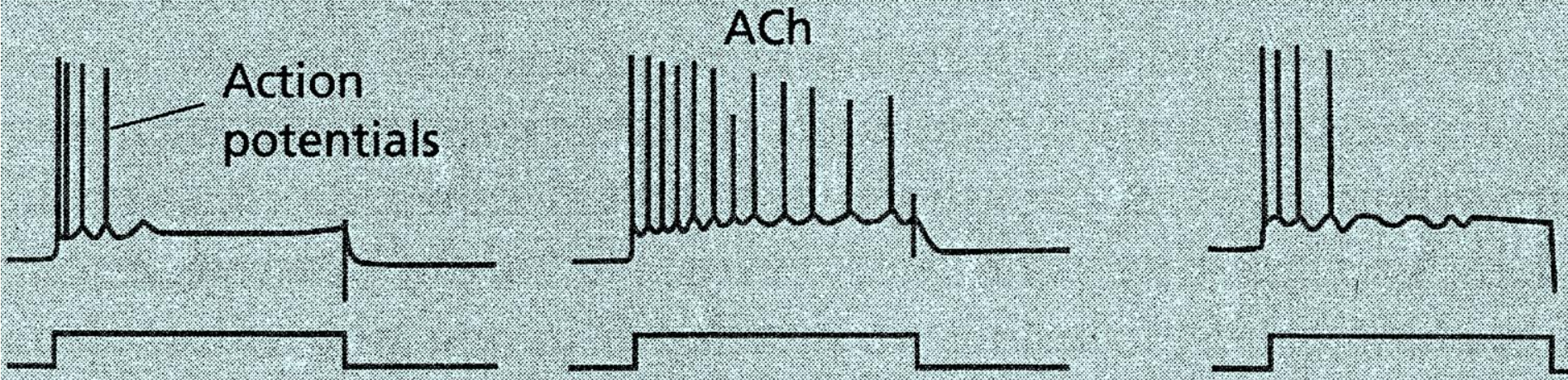
(5) HOW DOES AROUSAL AFFECT CONSCIOUSNESS?



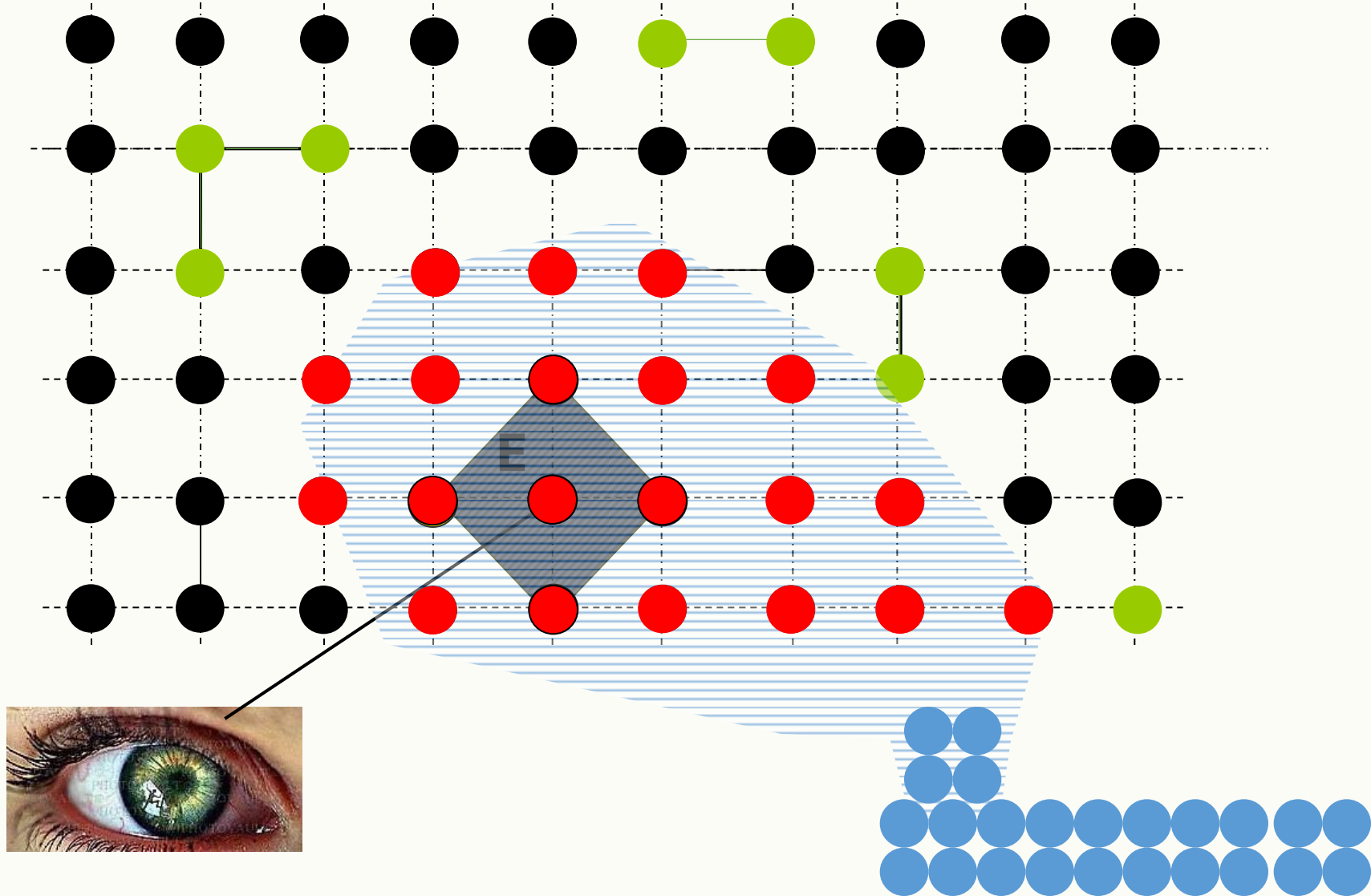
Thalamus: ACh opens K^+ channels and thus predisposes a particular type of cell to generate Ca^{2+} conductance, which facilitates generation of action potentials.



Hippocampus: ACh closes K^+ channels, which normally stops generation of action potentials.



FORMATION OF NEURONAL ASSEMBLIES: THE RIPPLES





Arousal



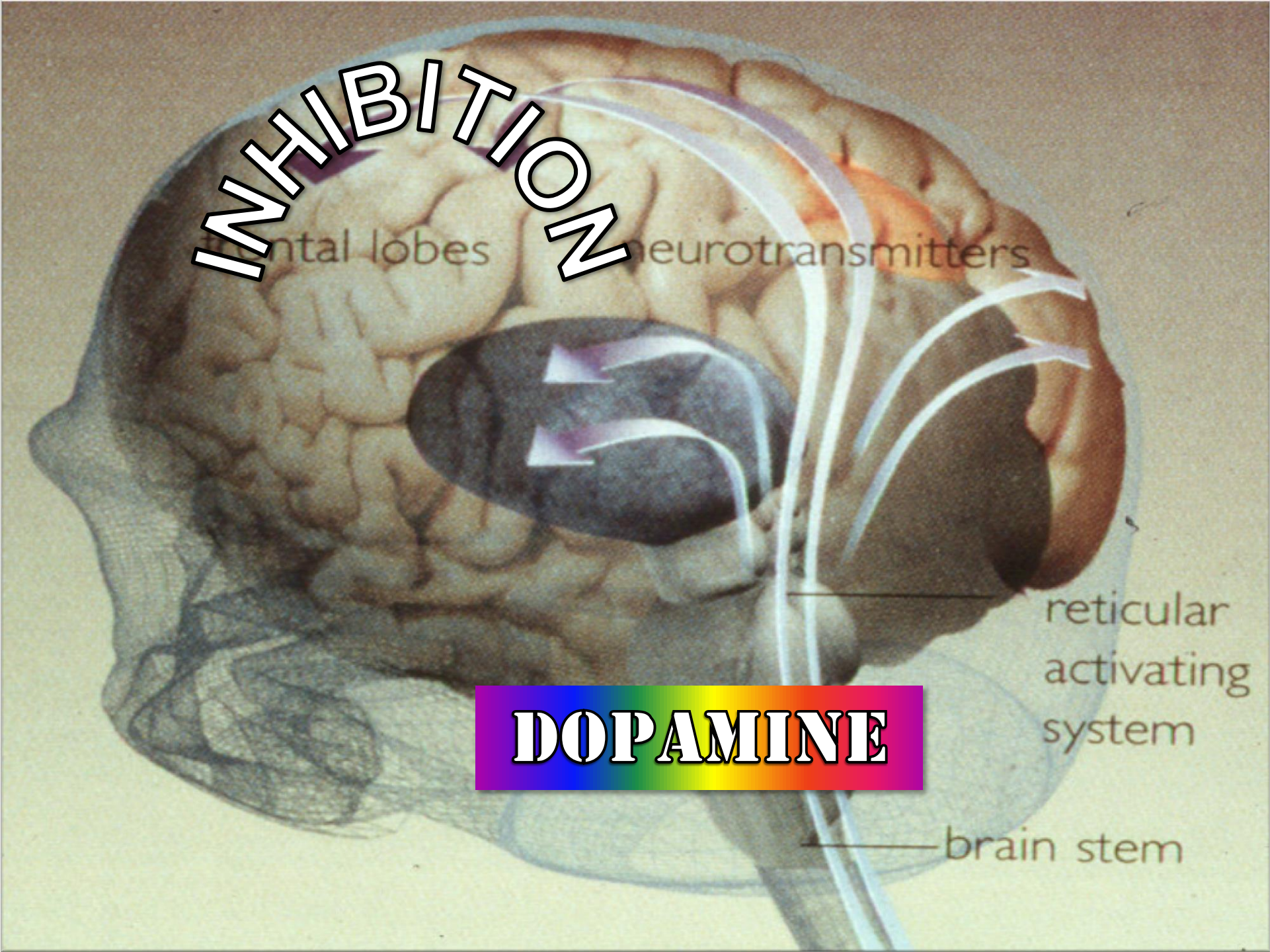
Addiction



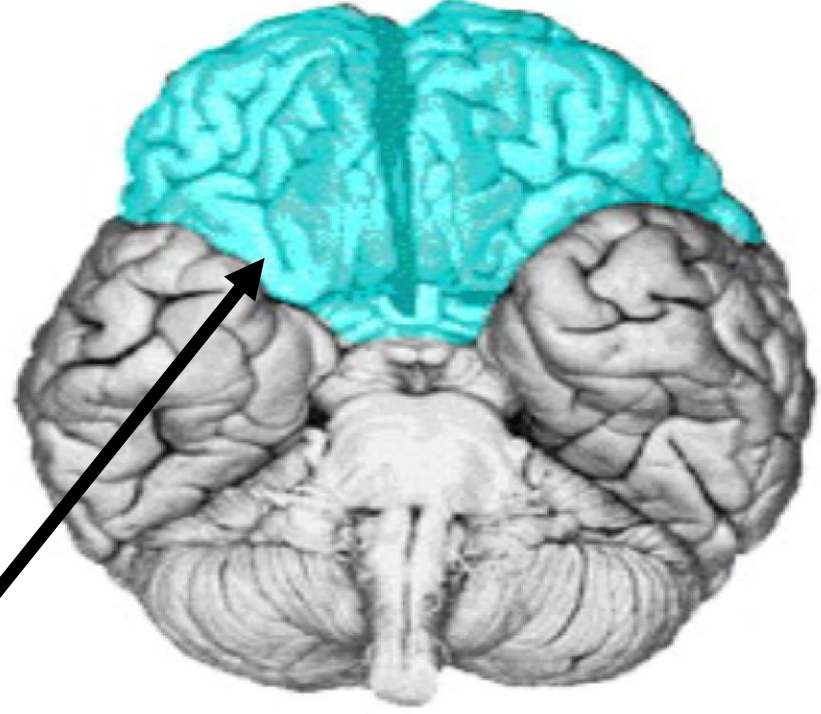
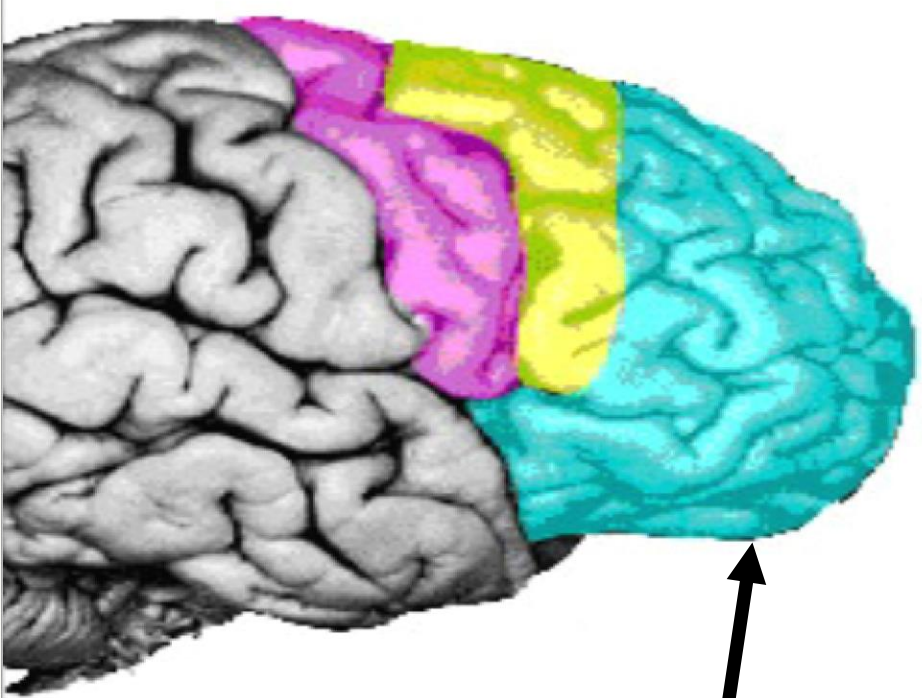
Reward

DOPAMINE

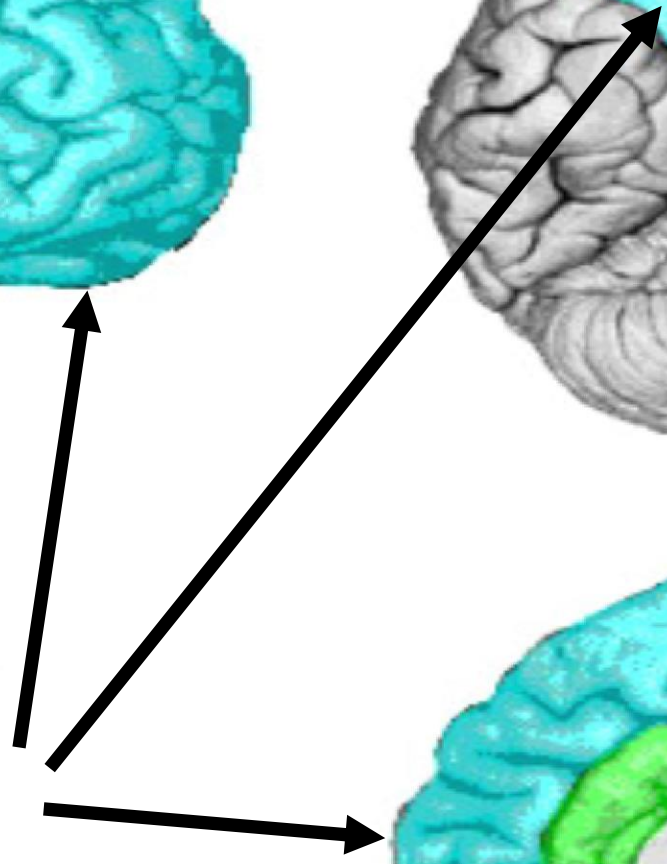
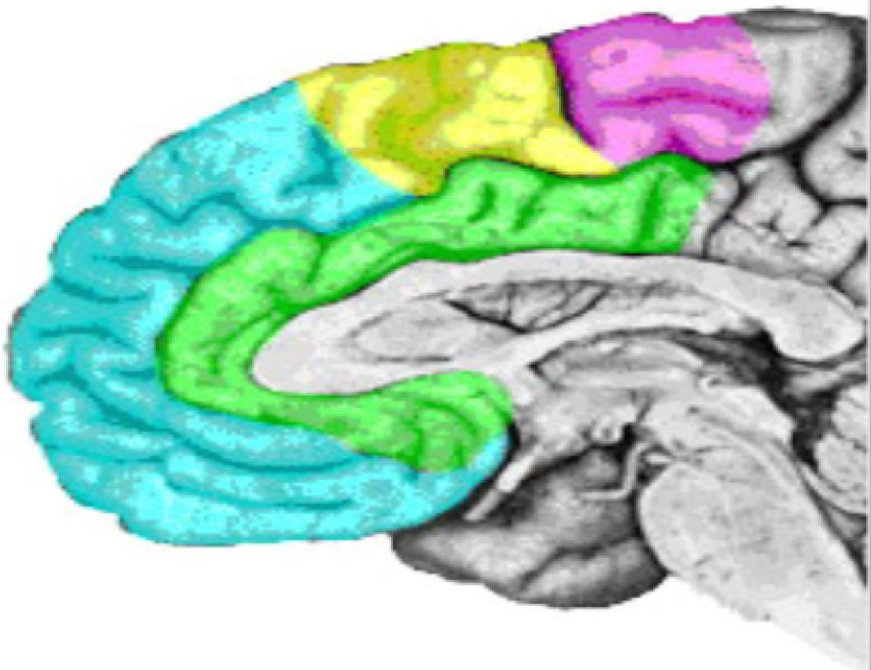
INHIBITION



DOPAMINE



-  **Motor**
-  **Premotor**
-  **Prefrontal**
-  **Limbic**





A COMMON FACTOR:

The Press of the Senses?



TWO BASIC MODES FOR THE HUMAN BRAIN

SMALLER ASSEMBLIES

PREFRONTAL UNDER-FUNCTION

- Strong feelings
- Sensory
- Here-and-now
- External stimuli dominant
- Little 'meaning'
- Reduced sense of self
- No time-space
- Infants and children
- More **DOPAMINE**

LARGER ASSEMBLIES

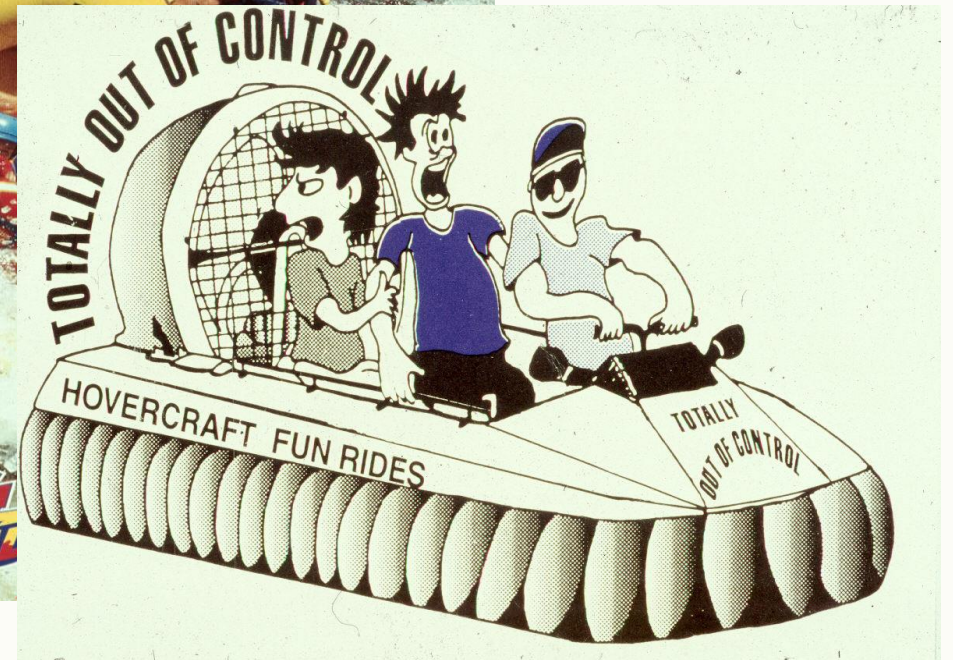
PREFRONTAL ACTIVATION

- Thinking dominates
- Cognitive
- Past / present / future
- Internal stimuli dominant
- Personalised 'meaning'
- Strong sense of self
- Clear time-space reference
- Older children and adults
- Less **DOPAMINE**

HYPOACTIVE PFC MIGHT BE A FACTOR IN 'SMALL ASSEMBLY MODE'



**Having a
sensational time...**



Letting yourself go...

A photograph taken from inside a train. In the foreground, a woman with short, wavy white hair is seated by a large window, looking out. She is wearing a dark turtleneck sweater and has a gold ring on her finger. Behind her, two men are seated. The man in the middle ground is wearing a tan baseball cap with a logo and a dark jacket. The man in the background is wearing a dark jacket over a light-colored shirt. The train's interior features dark leather seats and wooden handrails. A red "NO EXIT" sign is visible on the window frame to the left. The text "GOING HOME" is overlaid in the center of the image.

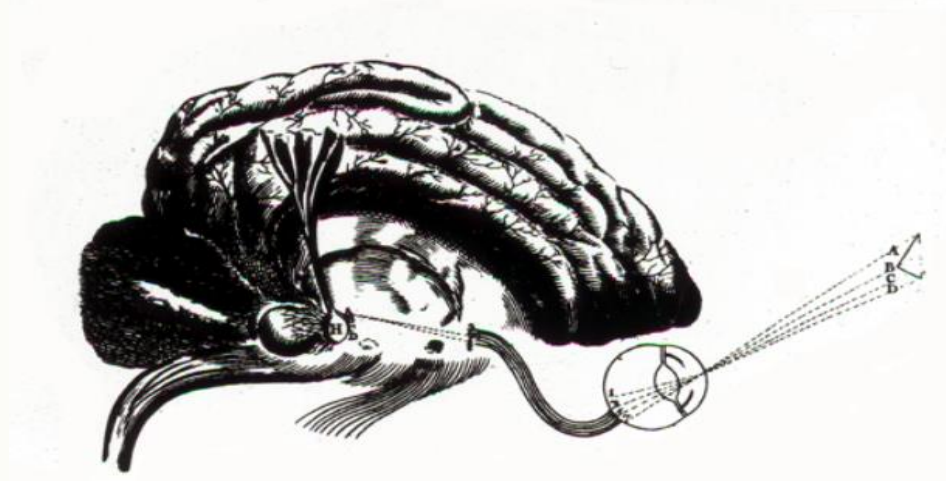
GOING HOME

CLINICAL DEPRESSION

- **Lack of pleasure (Anhedonia)**
- **Lack of emotion**
- **Imbalance of modulatory ‘fountains’**
- **Disengagement with outside world**
- **Greater sensitivity to pain (Hyperalgesia)**



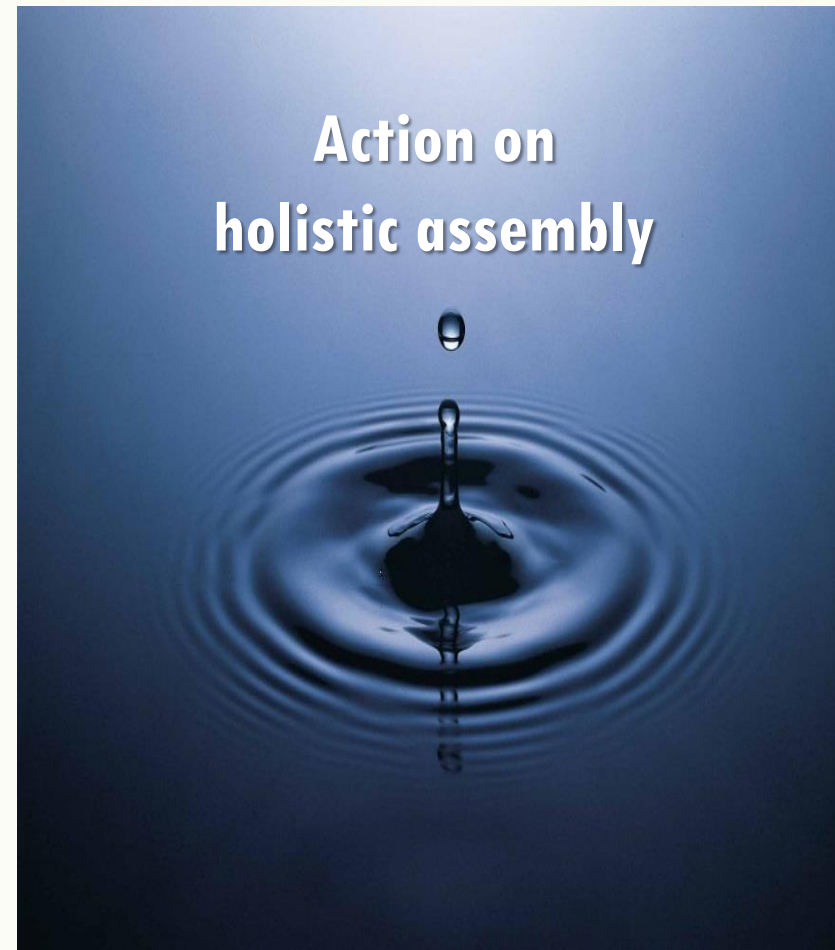
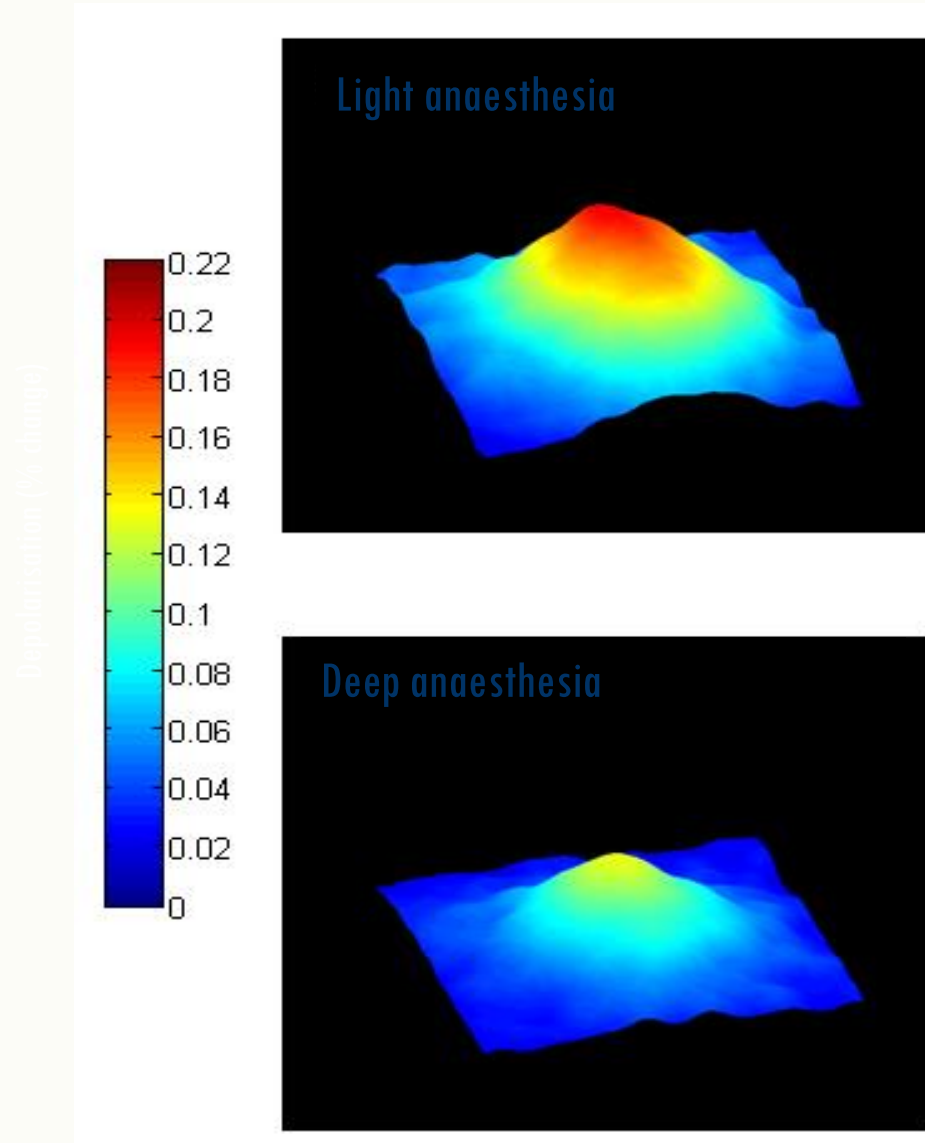
(6) WHY IS PAIN PERCEPTION VARIABLE?



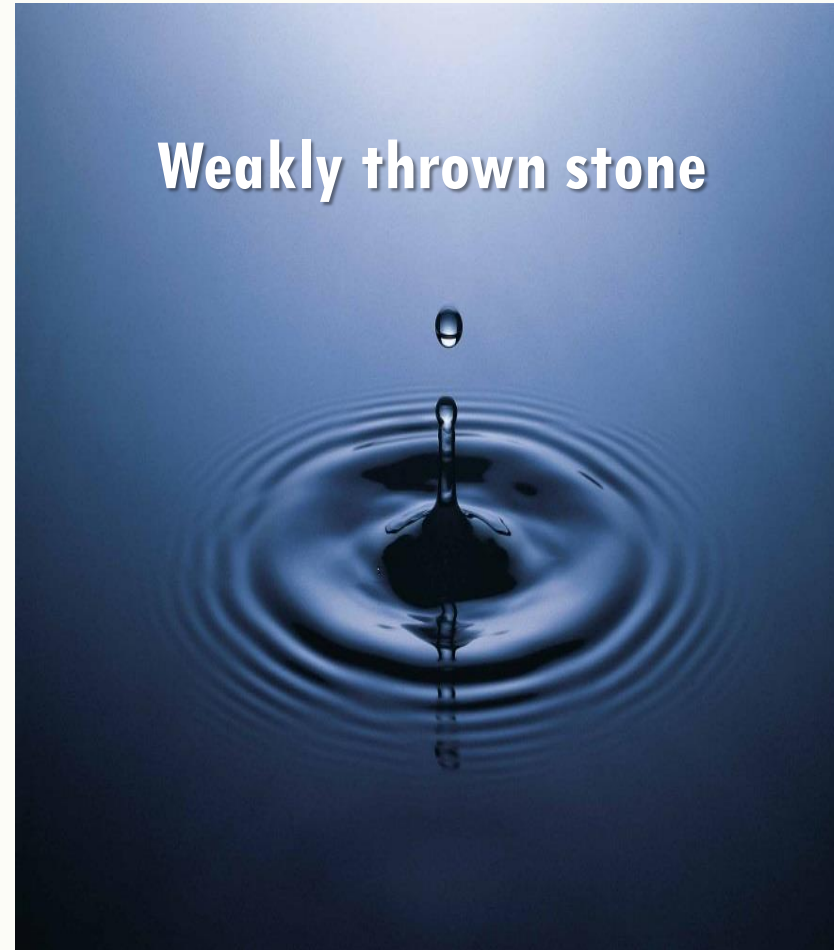
THE LARGER THE ASSEMBLY, THE GREATER THE PAIN AND VICE VERSA.

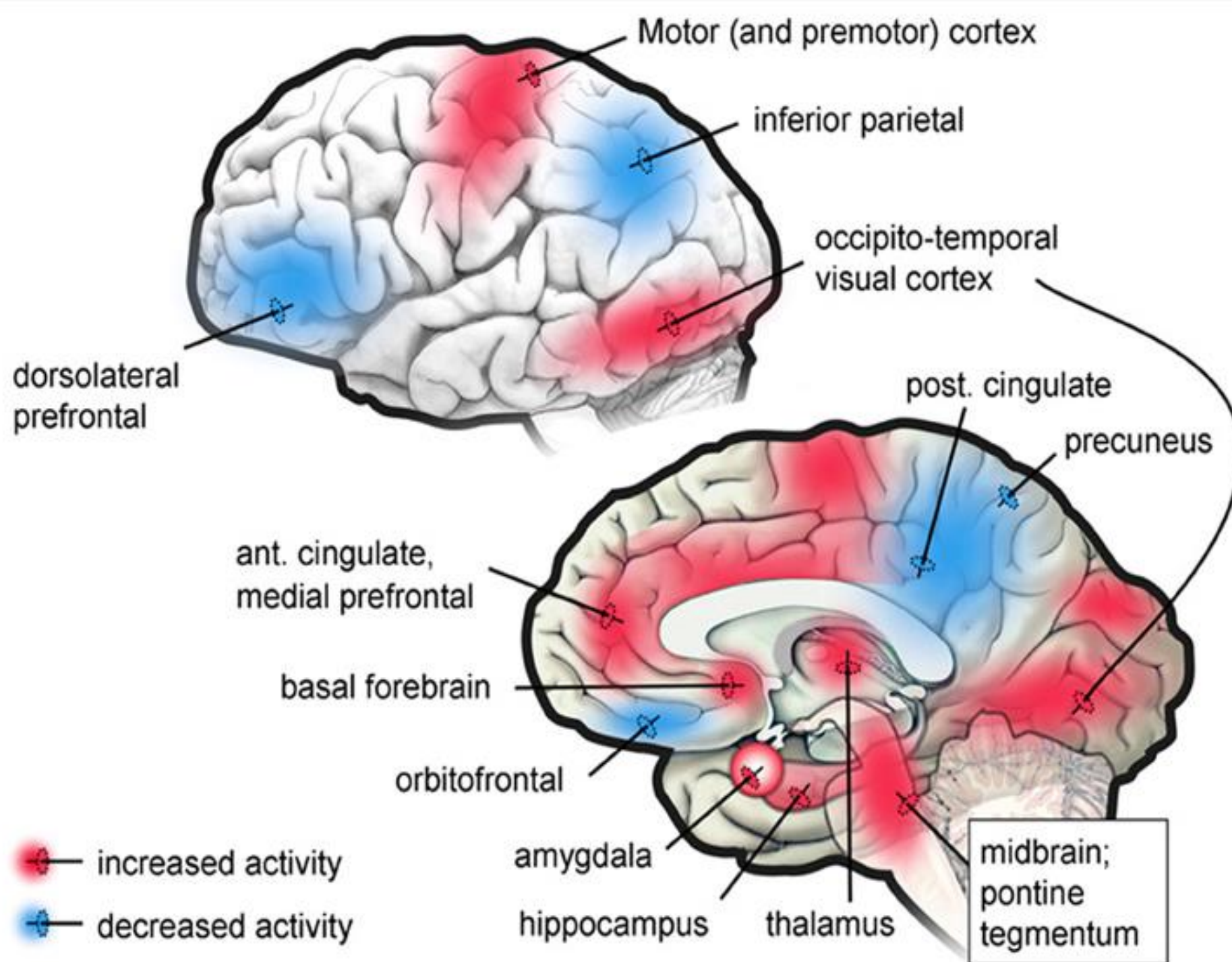
- **Pain expressed as other associations**
- **Diurnal threshold**
- **Greater anticipation, greater the pain**
- **Phantom limb (neuron matrix)**
- **Morphine, pain no longer 'matters'**
- **Morphine (analgesic), dream like euphoria**
- **Anaesthetic action explicable...**

(7) HOW DO ANAESTHETICS WORK?



(8) WHAT HAPPENS IN DREAMING?





DREAMING:

SMALL ASSEMBLIES WOULD EXPLAIN...

- **Smell (externally driven sense) absent in dreams**
- **Effects of sleep deprivation**
- **Lucid, REM and non-REM dreaming: quantity not quality**
- **Paradox: max in infant BUT related real-life**
- **Reconciles Top Down and Bottom Up descriptions**

A vibrant sunset scene over a dark ocean. The sun is a bright yellow-orange orb on the horizon, with its light reflecting on the water. Numerous rays of light fan out from the sun across a sky filled with scattered white and grey clouds. The sky transitions from a deep blue at the top to a lighter orange near the horizon. The word "TOMORROW" is centered in the middle of the image in a bold, pink, sans-serif font with a slight drop shadow.

TOMORROW

FACTORS INFLUENCING FORMATION OF NEURONAL ASSEMBLY

- **Degree of neuronal activity:** Intensity of senses
- **Extent of pre-existing associations:** 'Significance'
- **Availability of modulators:** Arousal
- **Availability of other modulators:** Predisposition / mood
- **Formation of competing assemblies:** Distraction
- **Input from prefrontal cortex:** Narrative

OPTICAL IMAGING COULD REVEAL FACTORS GOVERNING FORMATION OF TRANSIENT NEURONAL ASSEMBLIES



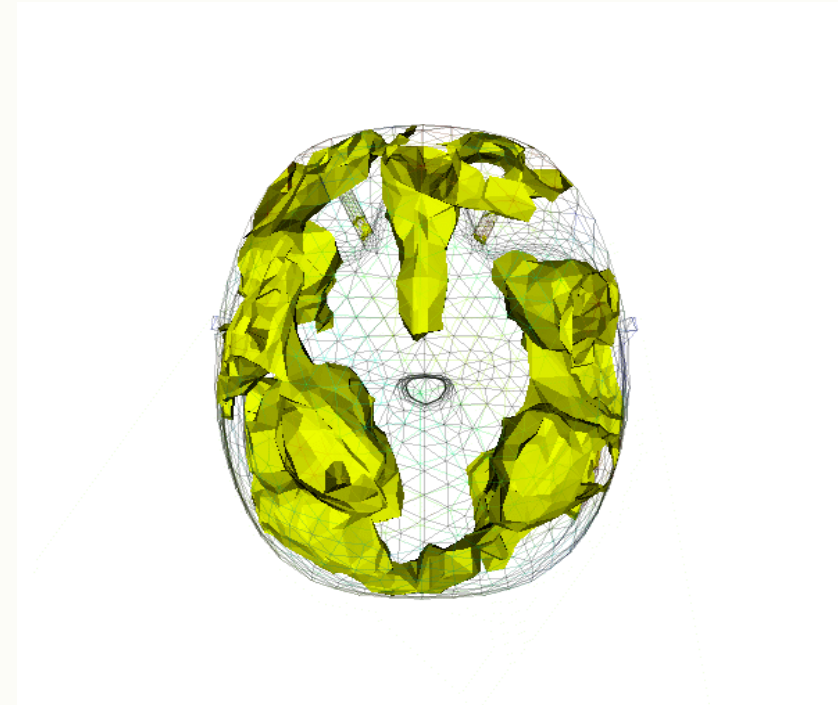
The model could be tested as a means of linking phenomenology and physiology

FUNCTIONAL ELECTRICAL IMPEDANCE TOMOGRAPHY BY EVOKE RESPONSE (FEITER)



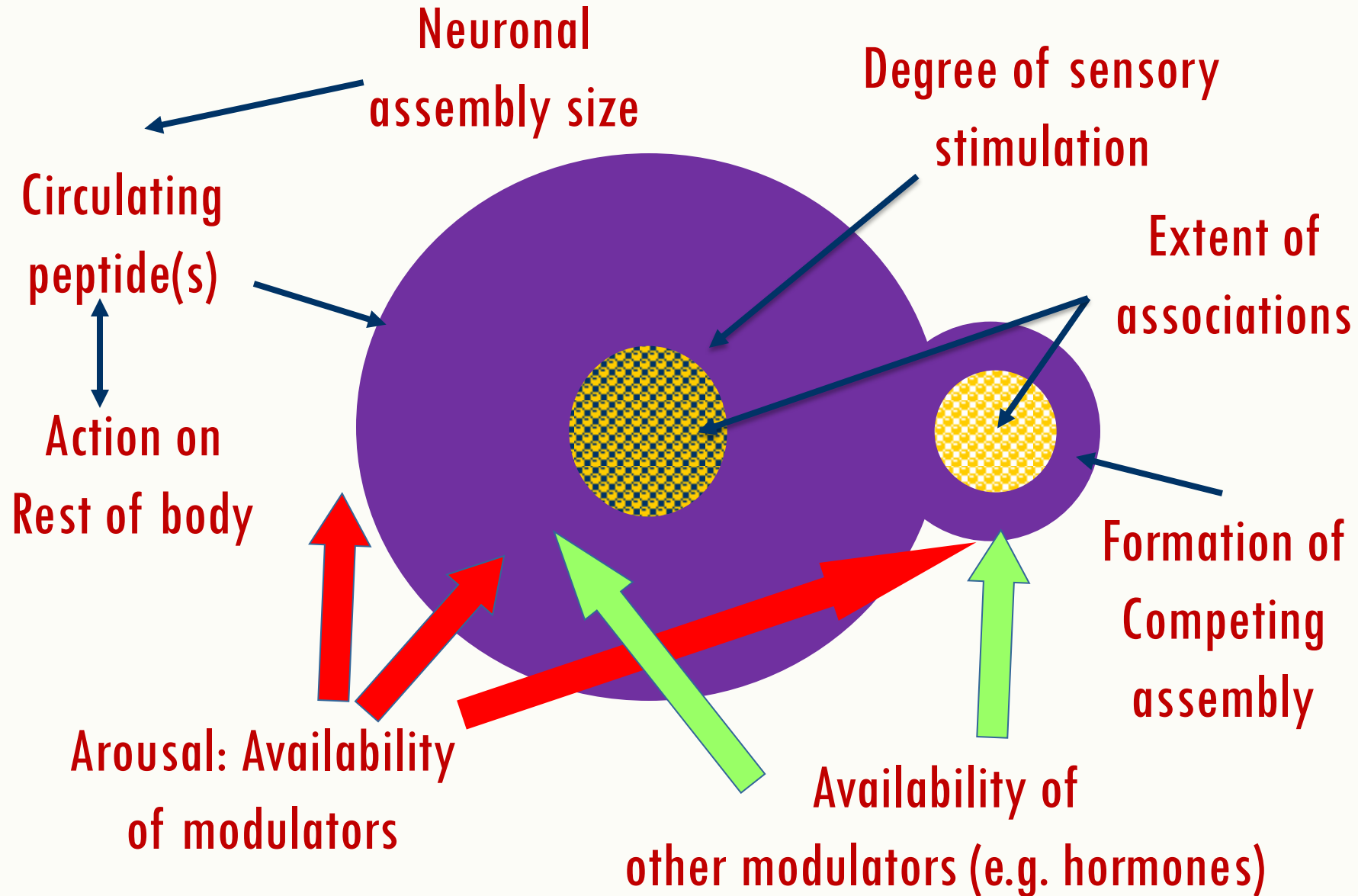
Prof Hugh McCann

Brian Pollard: Manchester University

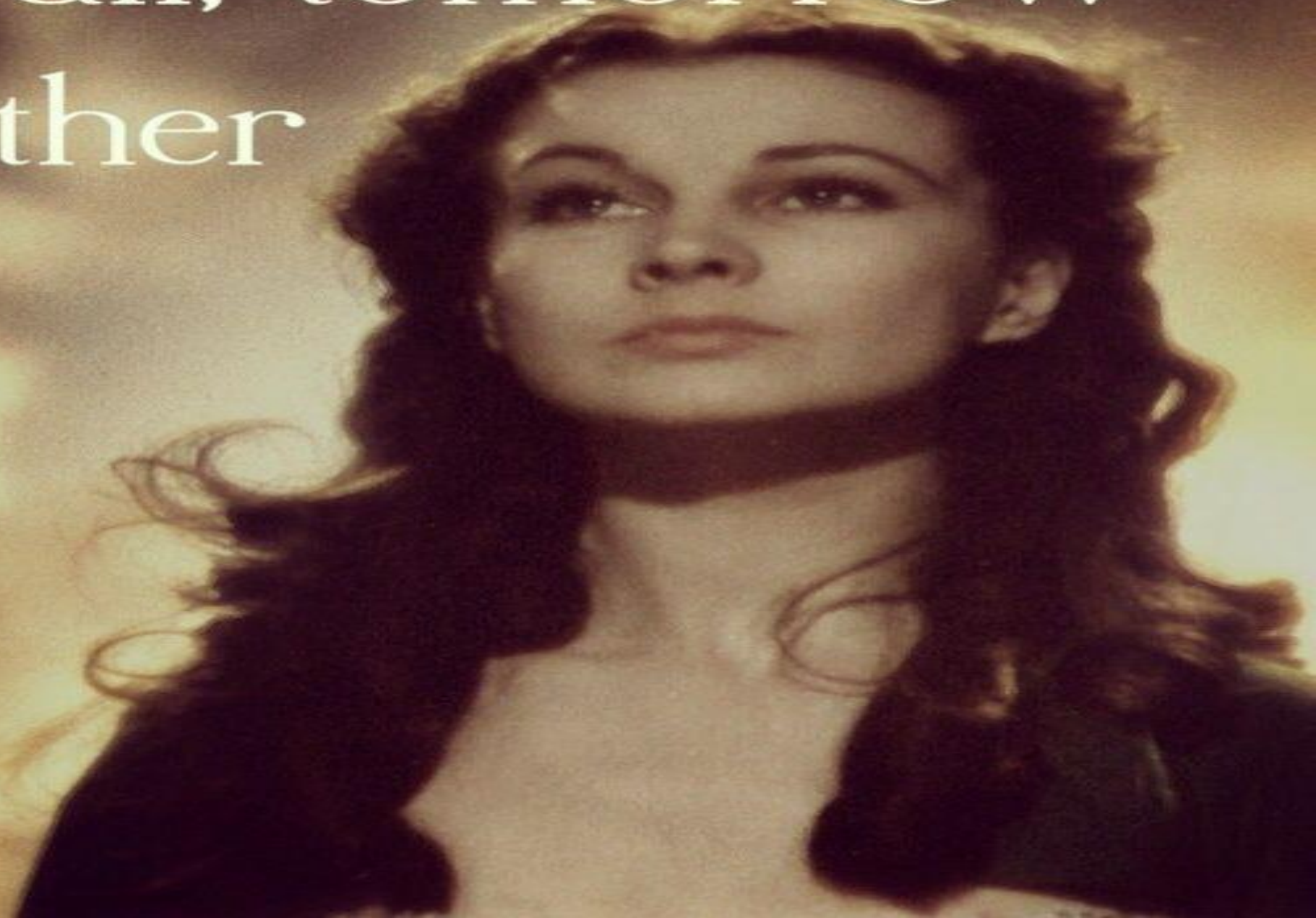


*A Bryan. CJD et al. (2011). British Journal of
Anaesthesia, 106, 441-442*

THE GENERATION OF CONSCIOUSNESS



After all, tomorrow
is another
day.



Susan
Greenfield



A Day in the
Life of the Brain

The Neuroscience of Consciousness
from Dawn Till Dusk

Department of Psychological and Behavioural Science public lecture

A Day in the Life of the Brain: the neuroscience of consciousness from dawn 'til dusk

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Senior Research Fellow, Lincoln College Oxford and Co-founder, Neuro-Bio Ltd
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