Is the brain just a computer made of flesh?

What neuroscience says about who I am.

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Overview

- The brain as computer – yes and no
- Neuroscience
  - reductionism and emergence
  - Qualia or intentionality
  - Affective neuronal Darwinism
- Who am I? (How different from what is human?)
- Synthesis?
- Christian comments on our synthesis

The Brain as a computer

- Mind – software
- Brain – hardware
- Energy – glucose transported from the rest of the body to nerve cells by the blood stream
- Perceptive inputs integrating what is out there with what is already known
  - more than 5 senses
- Motor outputs – actions, words, oral or written

Buts…Technical Issues

http://scienceblogs.com/developingintelligence/2007/03/27/why-the-brain-is-not-like-a-co/

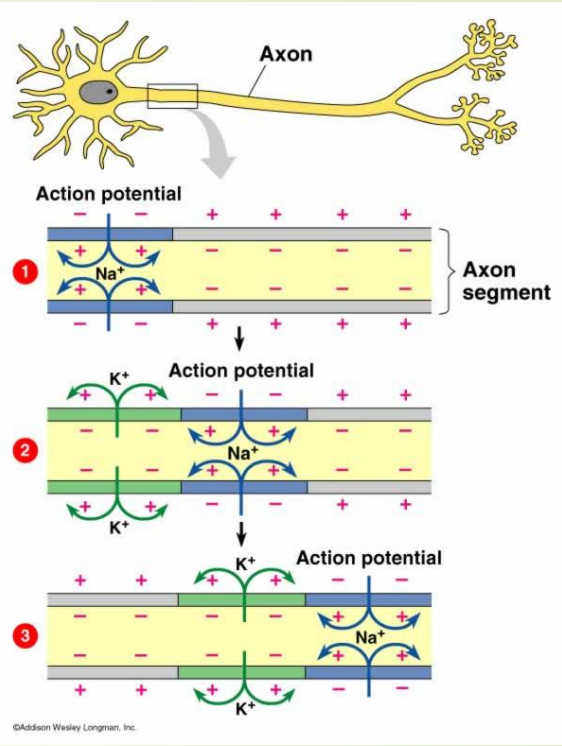
- Analogue vs digital
- Networks vs Algorithms
- Memory sites and processing sites
- Memory storage
- Synapses different from electrical logic gates
- Human brain capable of intuitive leaps
- Etc….

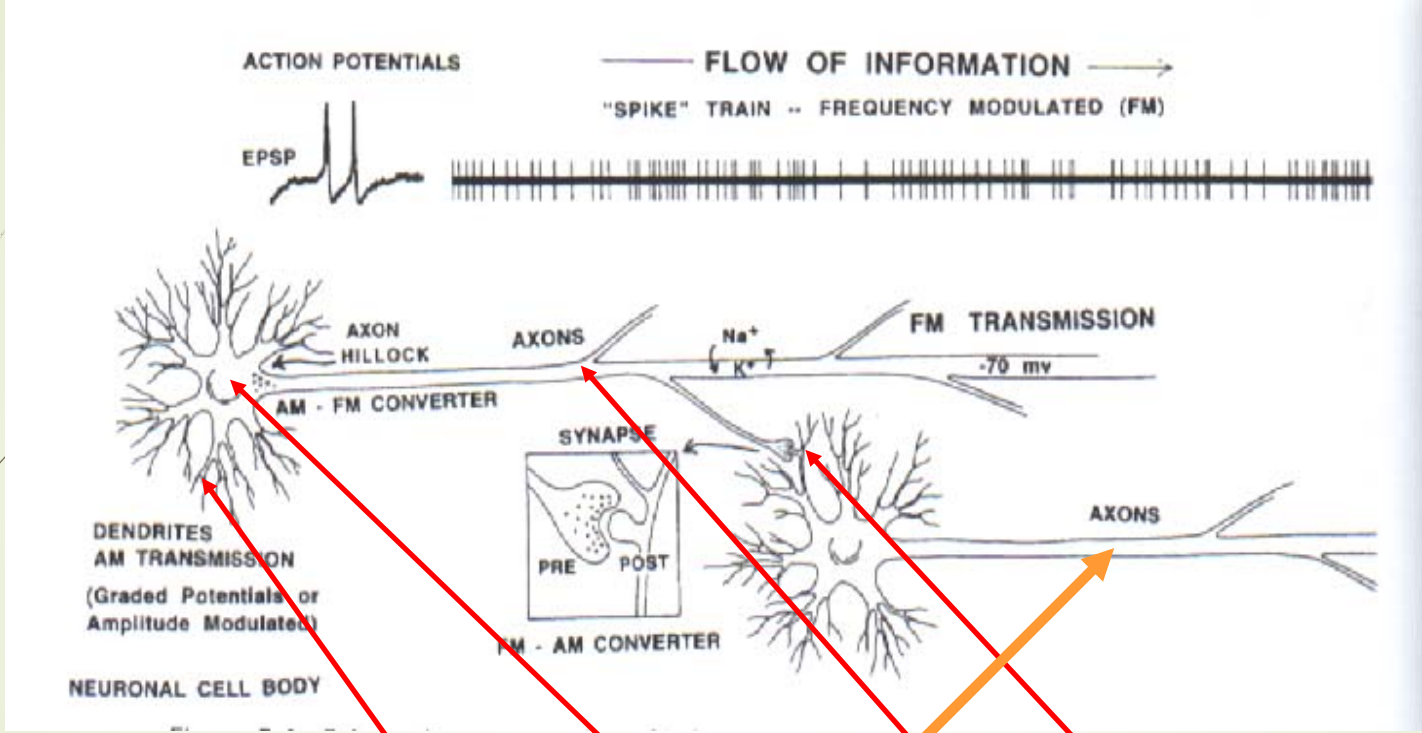
Issue of Self-awareness (Who am I?)

- Turing Test (the imitation game)
- Chinese room thought experiment (Searle)
  - Strong AI vs weak AI
- Does Hal have self-awareness?
- Is self-awareness important?
- The inside vs outside
- The me-ness of me
  - Qualia or intentionality
- The hard mind-brain problem

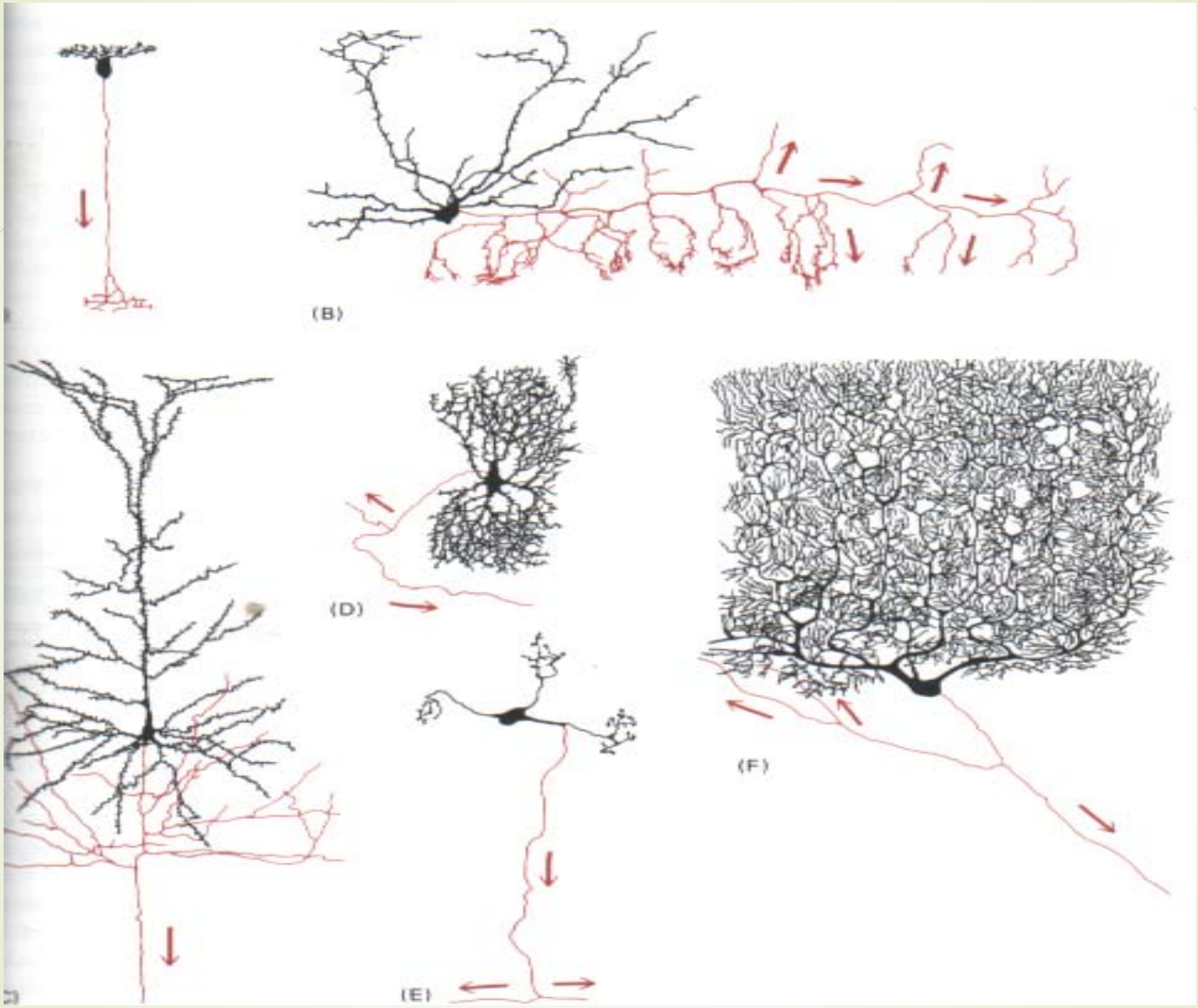
Basic neuroscience

- Nerve cell, among glial cells
  - Nerve impulses 0.1 volt, 1-2X10^{-3} sec, at 480 kph
- Synaptic transmission and neuroreceptors





- The brain is made of interconnected neurons
- Information flows: dendrites to nucleus to axon to synapse and on to another neuron



The complexity of real neurons ....

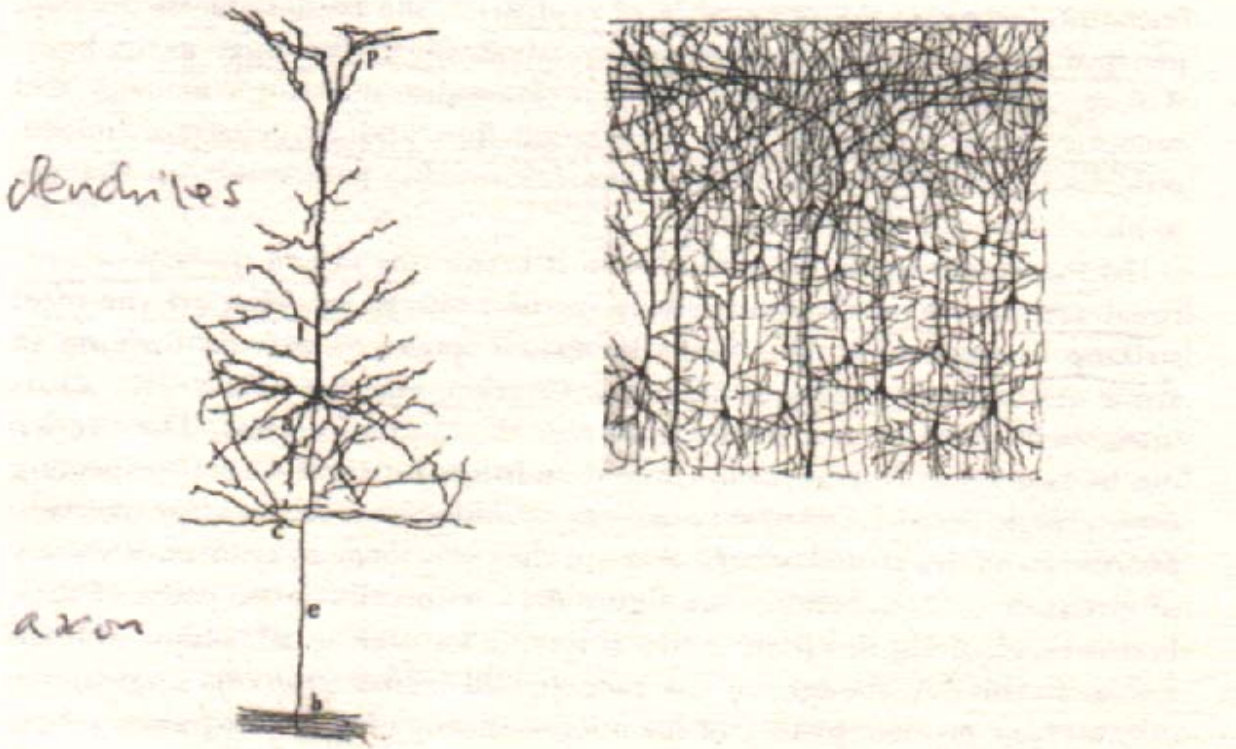
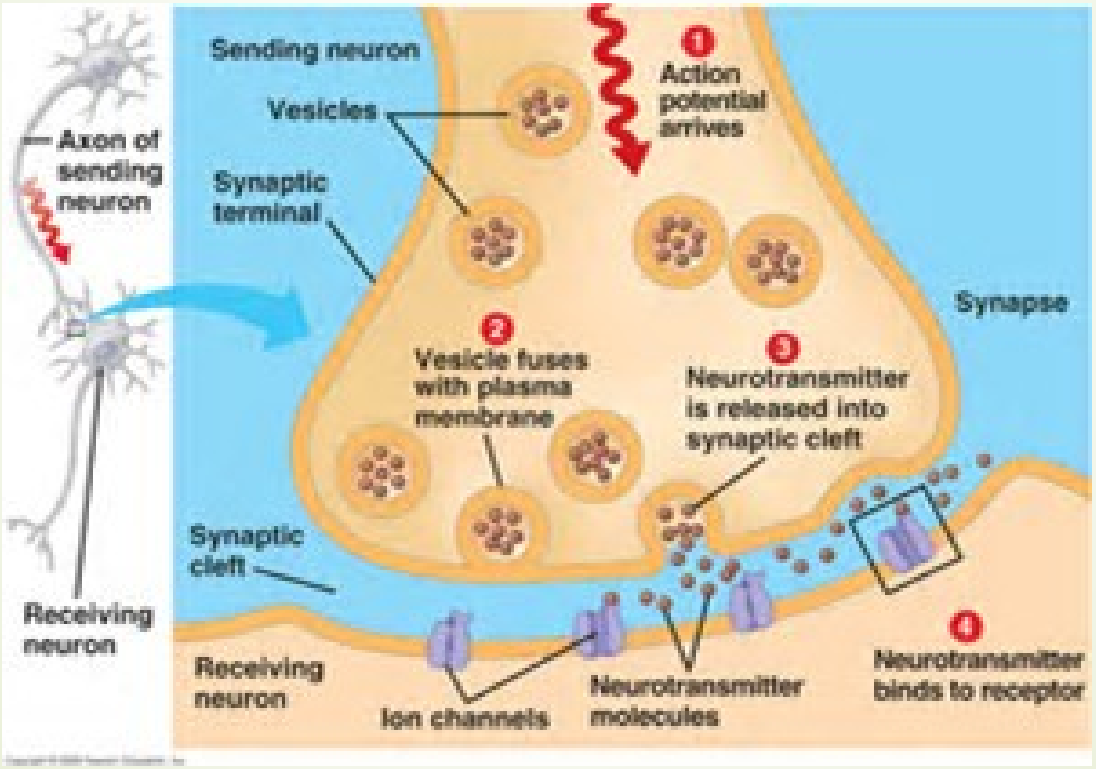


FIGURE 4.2 TWO ILLUSTRATIONS FROM THE GREATEST NEUROHISTOLOGIST OF MODERN TIMES, SANTIAGO RAMON Y CAJAL. The left-hand drawing shows a cortical neuron with an apical dendritic tree ascending and an axon descending from a small cell body. The right-hand drawing is a depiction of a meshwork of neurons in the cerebral cortex. The mesh that is stained with the so-called Golgi stain actually appears sparse because only a small proportion of the cells are impregnated by the stain.

The secret lies in the connections between neurons

Synapses – where messages are modulated



Neurotransmitters

- Small chemicals which pass signals from one neurone to the next via synapses

- Dopamine
- Noradrenaline
- Acetyl choline
- Serotonin
- GABA
- Glutamate
- Endorphins
- Anandamides

And the action of these neurotransmitters can be altered by ingested chemicals –

Anti-depressants
Anti-psychotics
Analgesics
Addictive agents etc

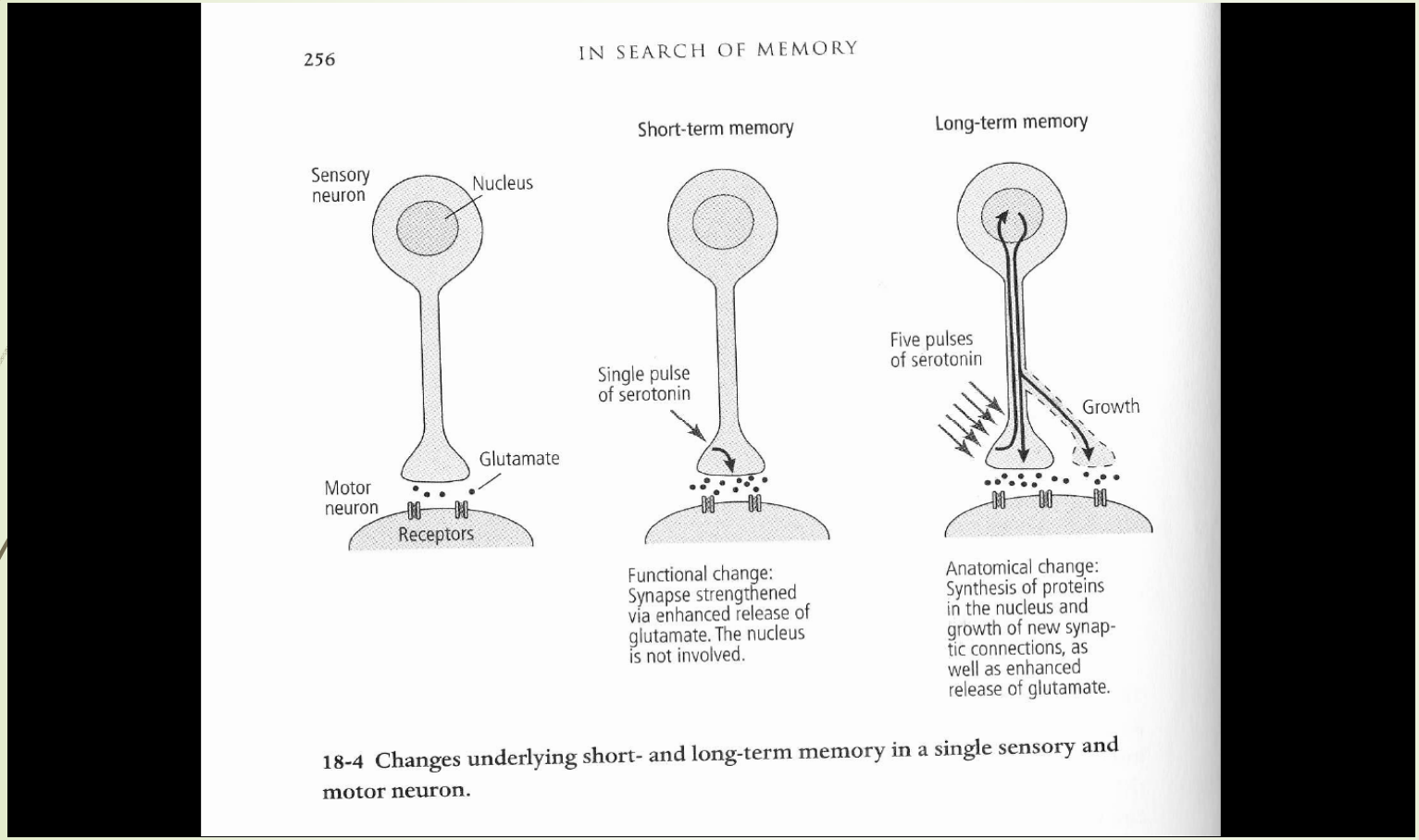
Tacit Philosophical Assumptions at this Point

- Foundationalism
  - The idea that once the basics are clarified the superstructure automatically and logically follows
- Reductionism
  - The idea that you can drill down to the basics and understanding these you then understand the whole
  - Eg
    - "now that we have clarified synaptic transmission, we understand depression.
    - sequenced the human genome, we understand human beings, (or the cause of a cancer etc)

Reductionism

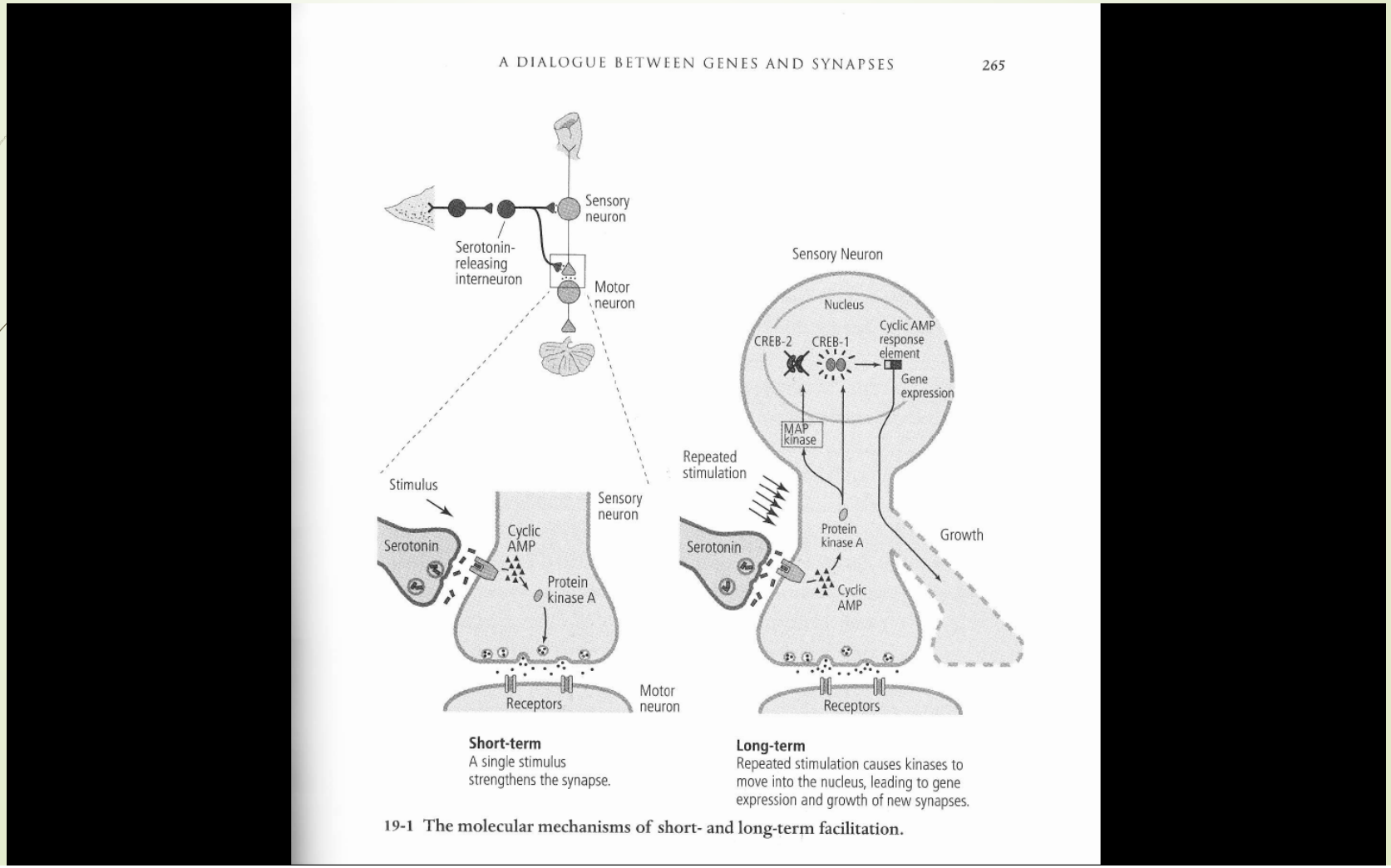
- Useful tool to analyse a problem by reducing it to its component parts and studying components within an isolated system however susceptible to:
- Nothing buttery….
  - Humans are nothing but a series of biochemical reactions
  - Addiction is nothing but an chemical aberration in the brain
  - Humans are nothing but a computer made of meat
- Challenged (at the least) by concepts of top-down causation.

Action of the Environment on Neural Expression – Eric Kandell



Kandel ER. *In Search of Memory: the emergence of a new science of mind.* Norton 2006.

Neuro-genetic Basis of Nerve Action



Kandel's principles

1. All mental processes derive from operations of the brain.
2. Genes determine neuronal functioning.
3. Social and developmental factors contribute importantly to the variance in mental illness. These factors express themselves in altered gene expression.

Nurture is ultimately expressed as nature.

Kandel's Principles (cont)

4. Altered gene expression induced by learning gives rise to changed patterns of neuronal connections, which give rise to different forms of thinking and behaviour.

5. Psychotherapy produces changes in long-term behaviour by learning which produces changes in gene expression, and hence changes in neuronal interconnection.

Erik Kandel, *Am Journ Psych* **156**: 505-524 (1999)

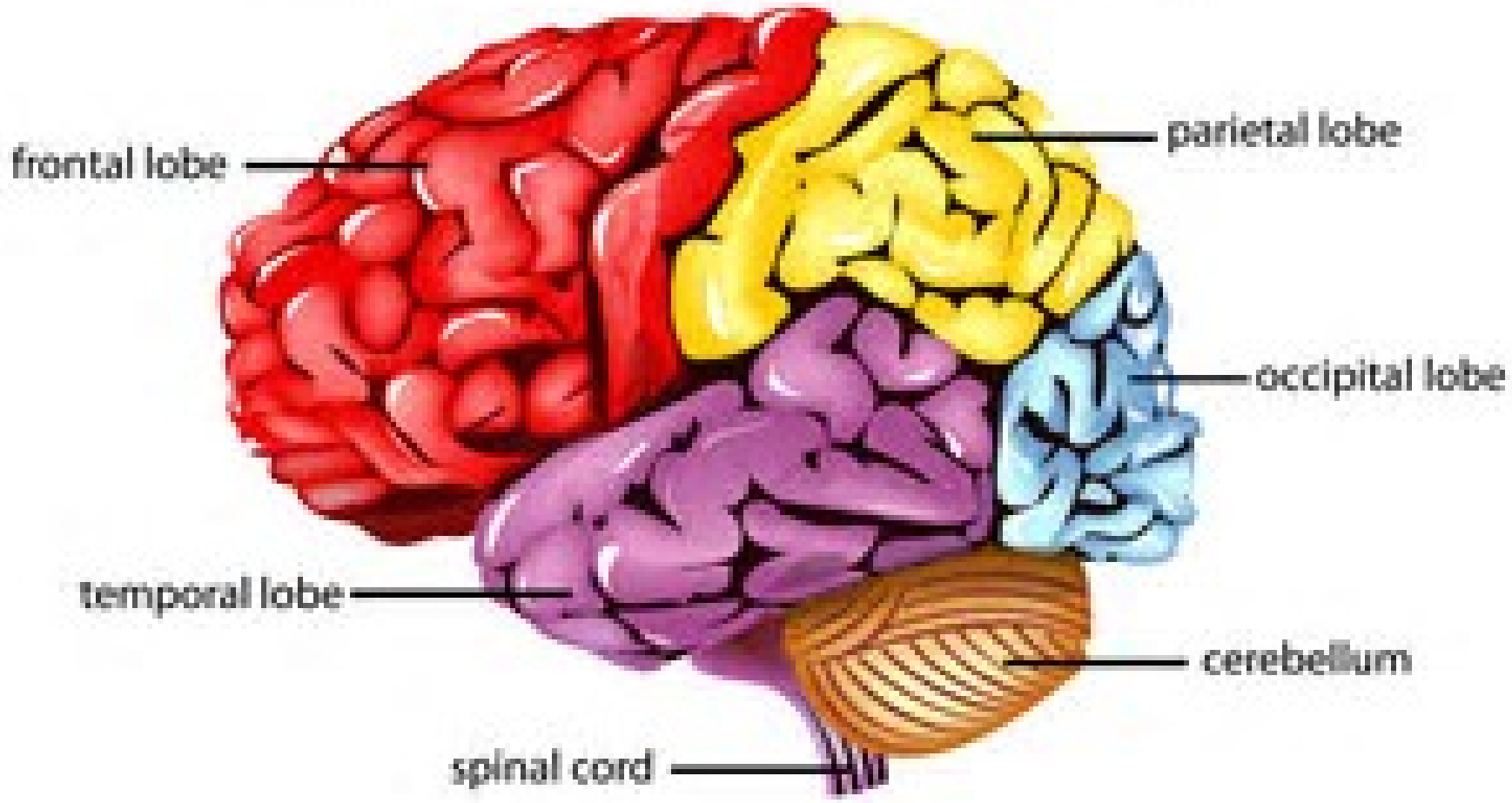
Note the interaction of the environment on genetic action to generate ‘neural activity’

Here is one mechanism for ‘top-down’ influence

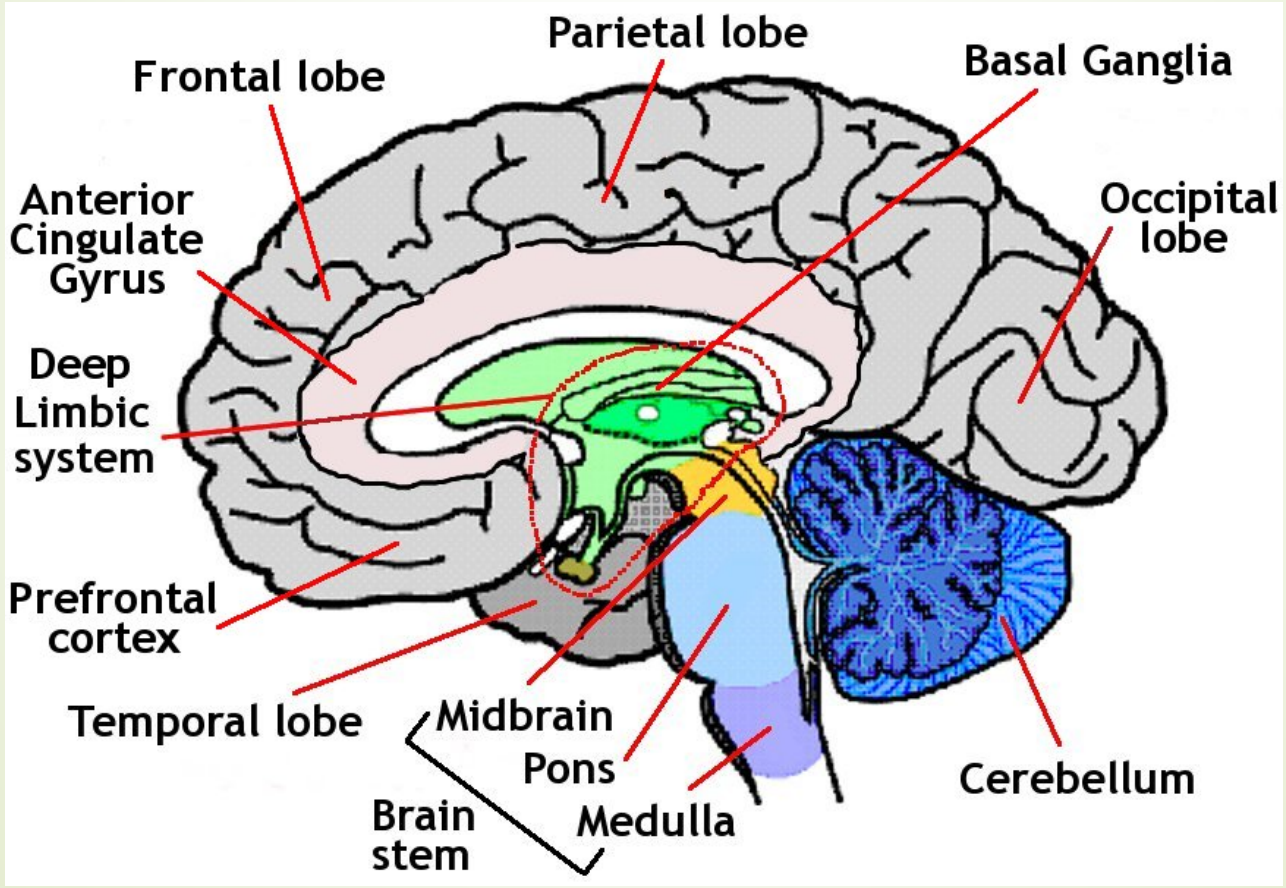
The environment influences the whole

Can the organism influence itself?

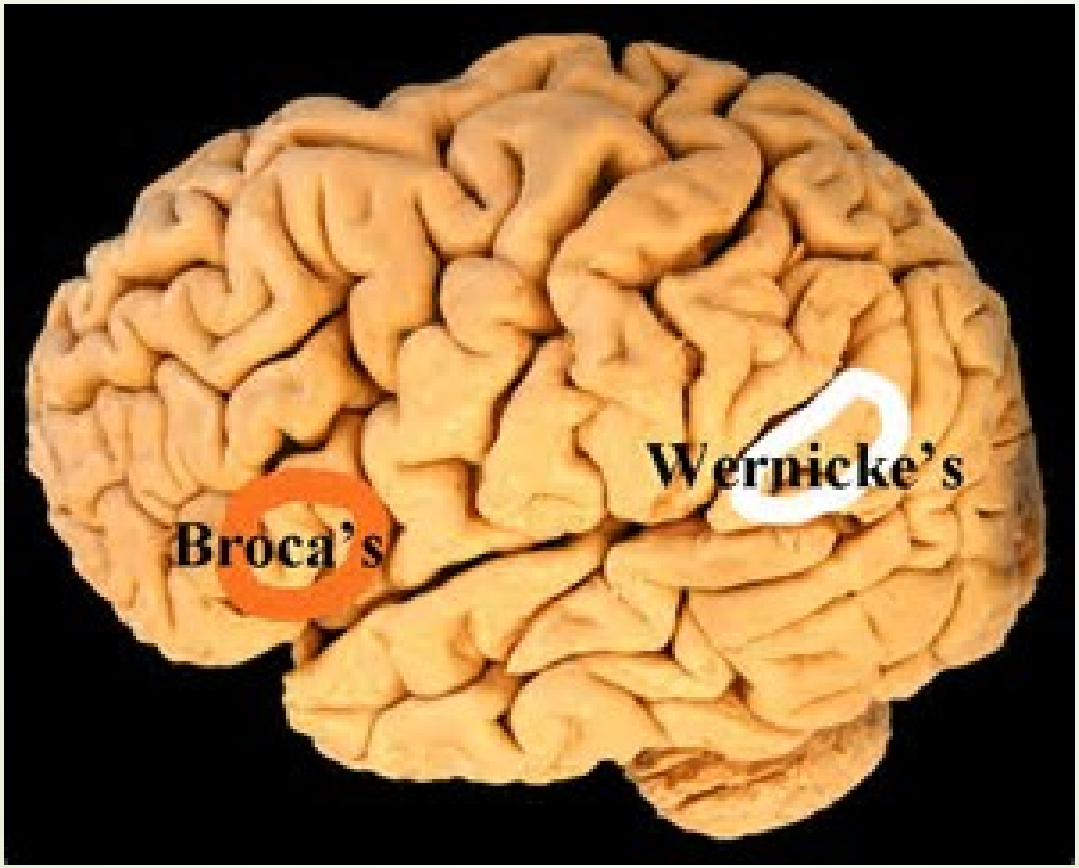
Parts of the Human Brain



Medial Side of the Brain

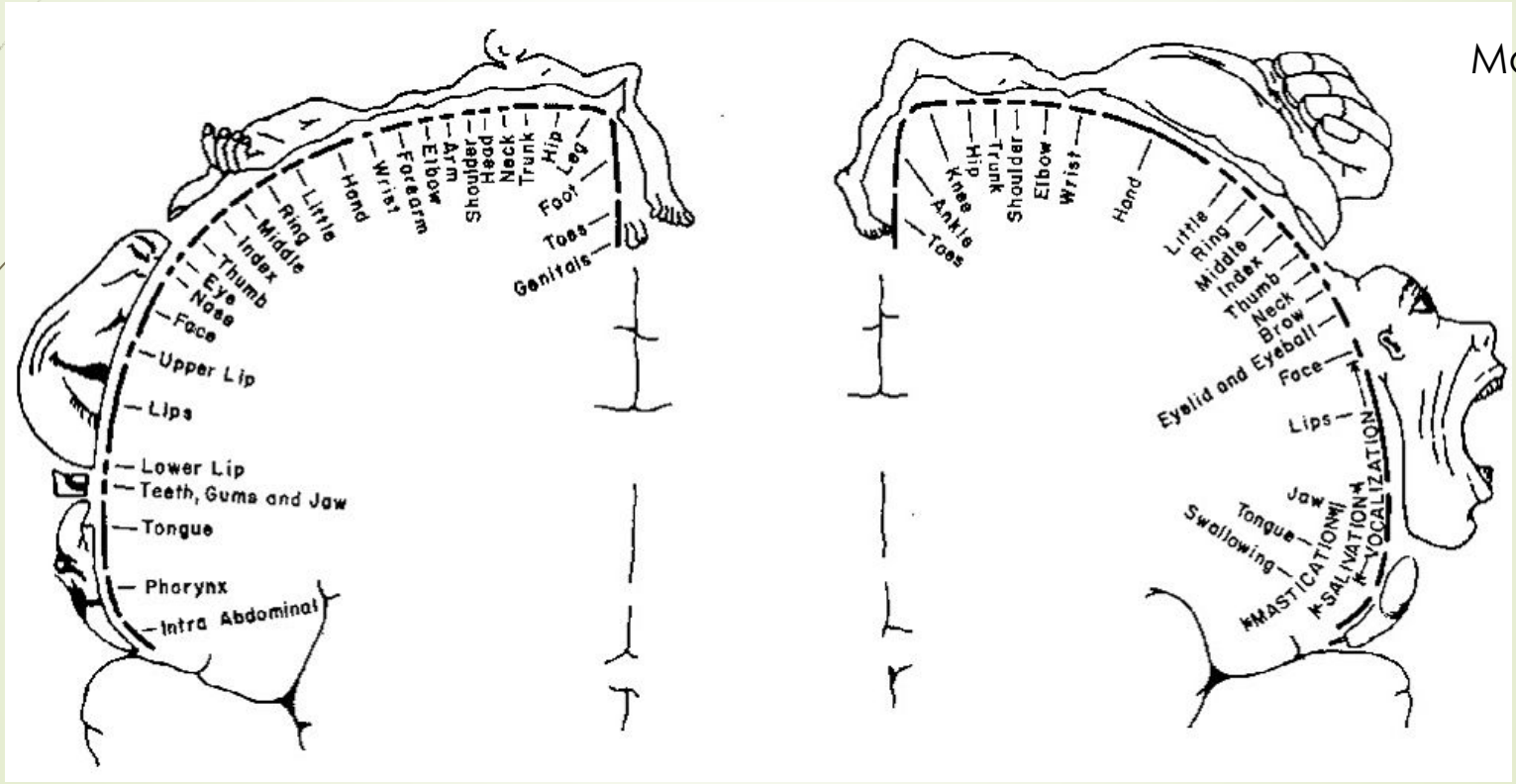


Localisation of Function – in Relation to Speech



Wilder Penfield's Sensory and Motor Homunculi

Sensory



Motor

Localisation vs interaction of many different networks

- Specific areas vs mass action of the brain
- Eg Cerebellum involved in memory, mood, language and attention
- "Silent areas' may not be that silent after all!

In Between

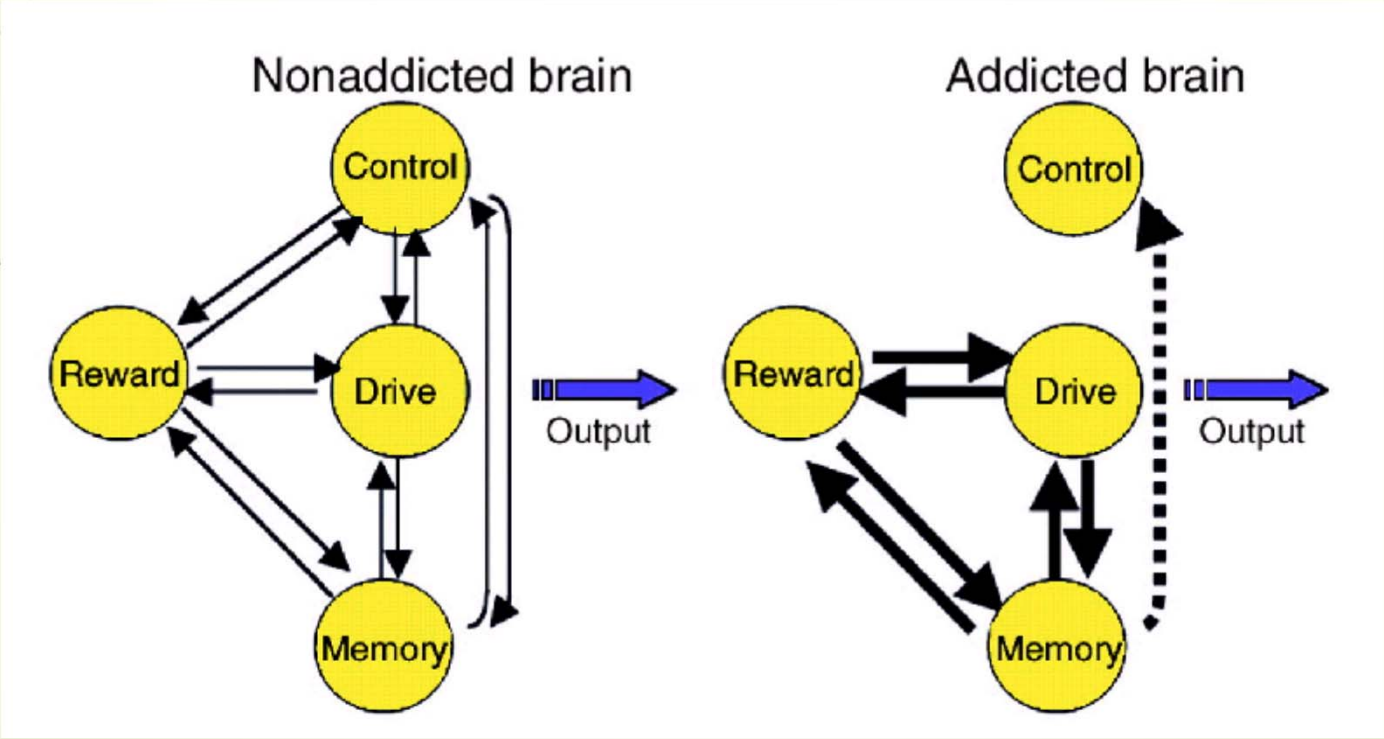
- How do we move between overall phenomena (higher functions) and basic nerve cell function?
- Higher functions:
  - Perception
  - Decision
  - Emotion
  - Reasoning
  - Drive
  - Qualia/intentionality
  - Sense of self

Circuits in Addiction

"Circuits that serve to colour an experience with emotion and direct the individual's response to rewarding stimuli, including food, sex and social interaction."

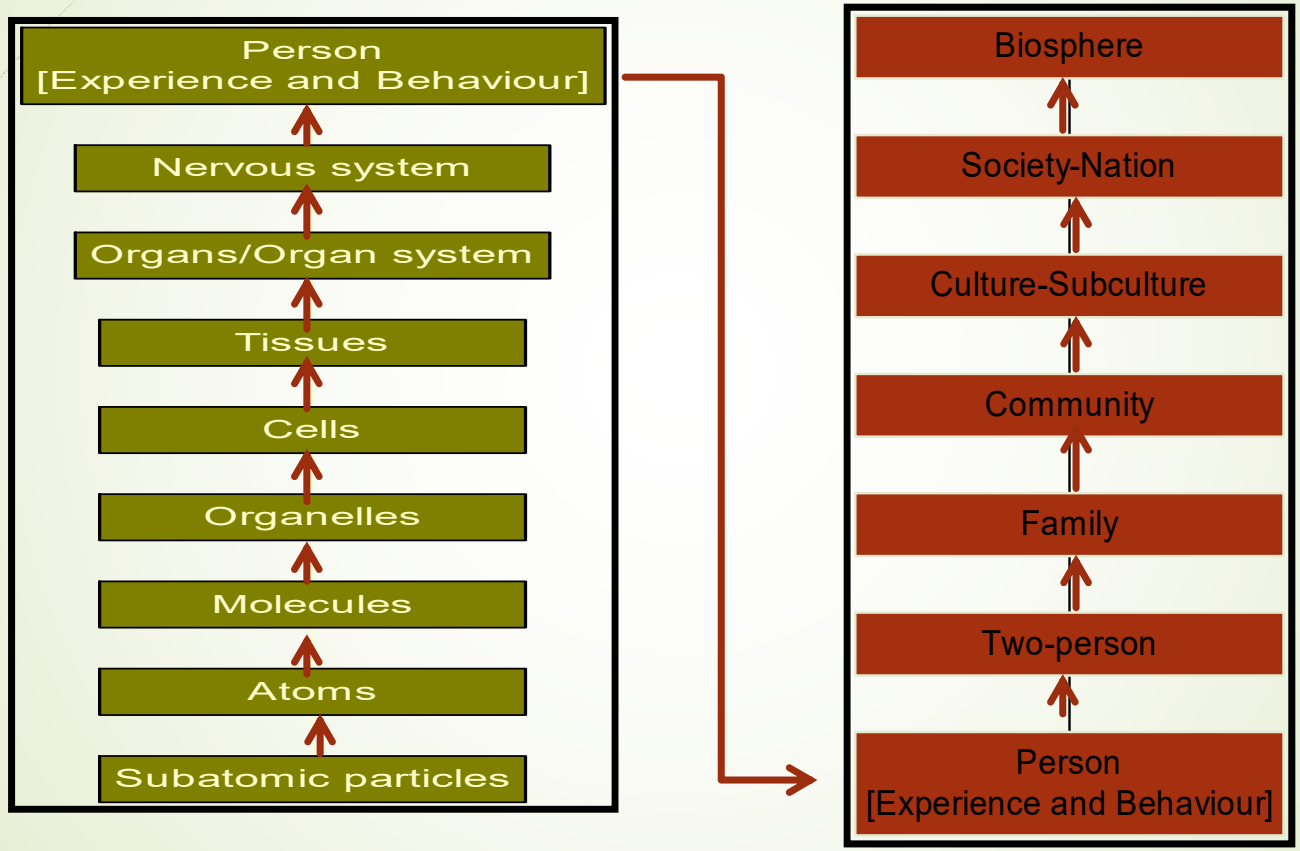
Nestler Ej, Malenka RC. The addicted brain.
Sci Am March 2004:50-7

Integration of Pleasure Pathways



Engel's Biopsychosocial Model

American Journal of Psychiatry 1980;137:535-544



Emergent Complexity

- Emergent complexity directly challenges radical reductionism which states that addiction is nothing but the aberration of the limbic system and addiction is nothing more than a brain disease.

- Does so by arguing that
  - The components act within a wider context.
  - the whole is greater than the sum of its components.

Principles of Emergent Complexity

- Science becomes increasingly complex from physics through biology to sociology
  - Modular hierarchical structures
- Each higher layer depends on the layer below
  - Bottom-up causation
- New phenomena emerge on the next layer which were not predictable from the layer below
  - Supervenience or emergence
- Each layer is relatively unaffected by lower layers
  - Autonomy
- More complex layers can alter the layer below
  - Top-down causation

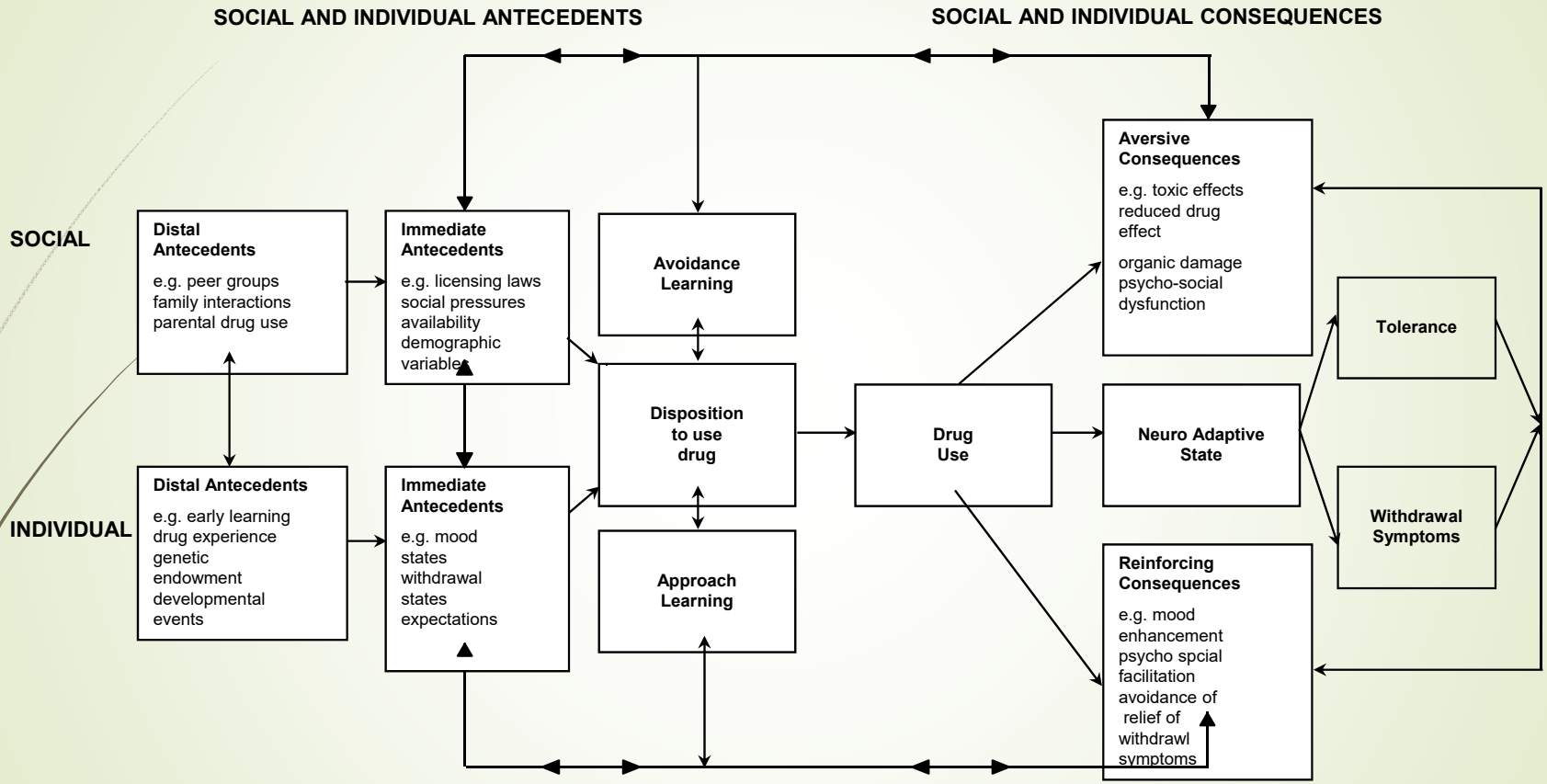
Principles of Emergence

- Hierarchy
- Bottom-up causation
- Emergence
- Autonomy
- Top-down causation

Emergent Complexity

- In contrast to reductionism
- Addiction is not just a biochemical reaction in the brain but a biopsychosocial condition requiring multiple inputs from multiple dimensions
  - Drug solutions
  - Multidisciplinary approach
- Hence higher functions can be regarded as emergent properties
  - This just articulates the mind-brain problem

WHO MODEL OF DRUG USE



Neural Darwinism

Biological Complexity is generated in each individual by a developmental process based on reading the genetic information stored in the sequence of bases in DNA:
- Creates a highly structured organism out of differentiated cells
- Influenced by information from the environment.

- [Gerald Edelman] Principles of Darwinian natural selection apply when using genetic information in each individual for brain development (hence *Neural Darwinism*):
- both because the *stored information is far too little to control brain development by itself*, Cf. the Human Genome Project: 45,000 genes but 10^{13} cells and 10^{11} neurons
- even if read multiple times and in different combinations
- and because *this allows the brain to optimally adapt to the local environment*

Affective Neural Group Selection

- In the cortex, broad functional areas are determined; then neurons send out random connections to other neurons

- Those that have a positive survival value are strengthened, others are killed off or allowed to decay
  [hence *Neural Darwinism:* Edelman and Tononi]

Neural Darwinism

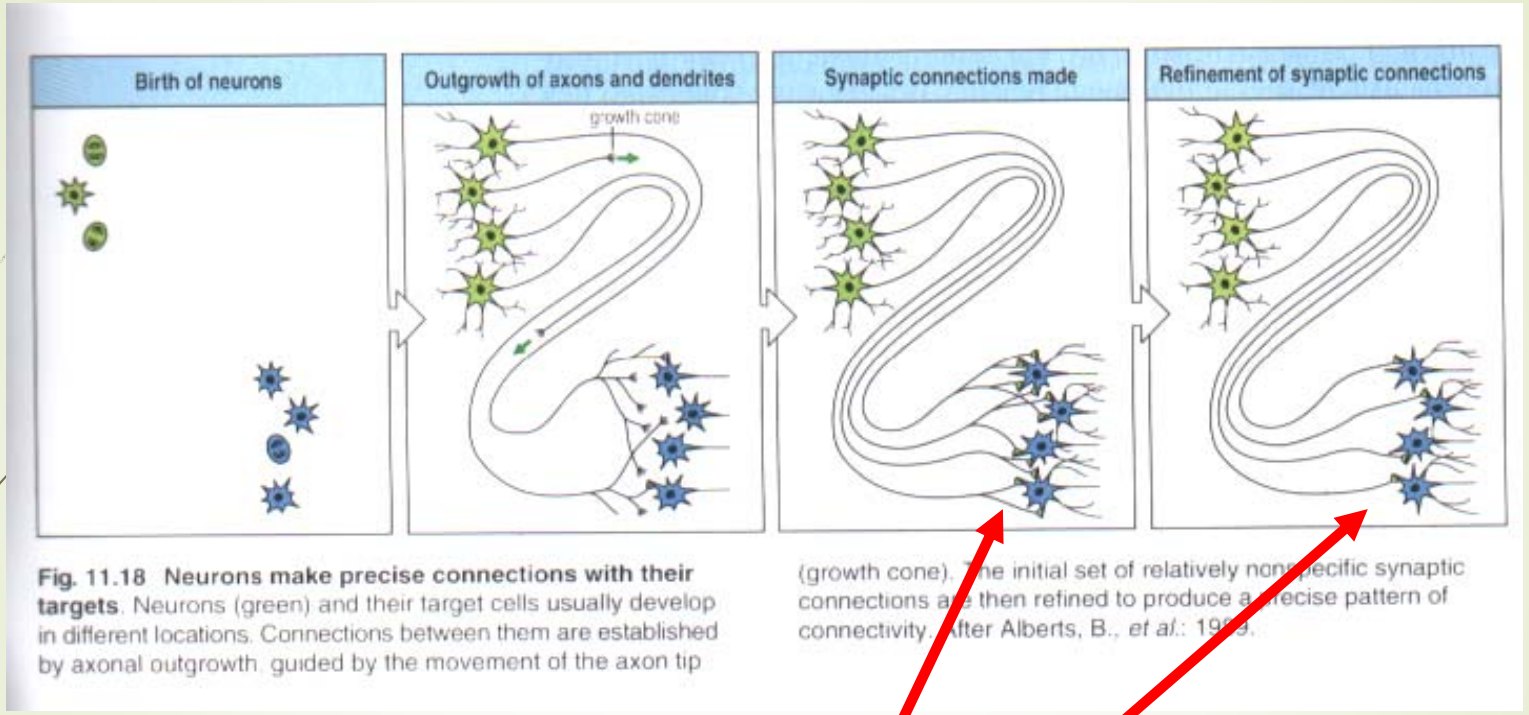


Fig. 11.18 Neurons make precise connections with their targets. Neurons (green) and their target cells usually develop in different locations. Connections between them are established by axonal outgrowth, guided by the movement of the axon tip (growth cone). The initial set of relatively non-specific synaptic connections are then refined to produce a precise pattern of connectivity. After Alberts, B., *et al.*: 1989.

The initial set of relatively non-specific synaptic connections are refined to produce a precise pattern of connectivity'

- Neurotransmitters alter gene expression

Affective Component

- A value system is required to decide which should be regarded as `positive' or `good' from a survival viewpoint (Crick's criticism of Neural Darwinism as lacking a mechanism for replication)

- This is provided by the primitive emotions whose seat is the pre-cortical area of the brain, sending out neuro-transmitters characterised in detail by Panksepp [*Affective Neuroscience*]

From Edelman and Tononi

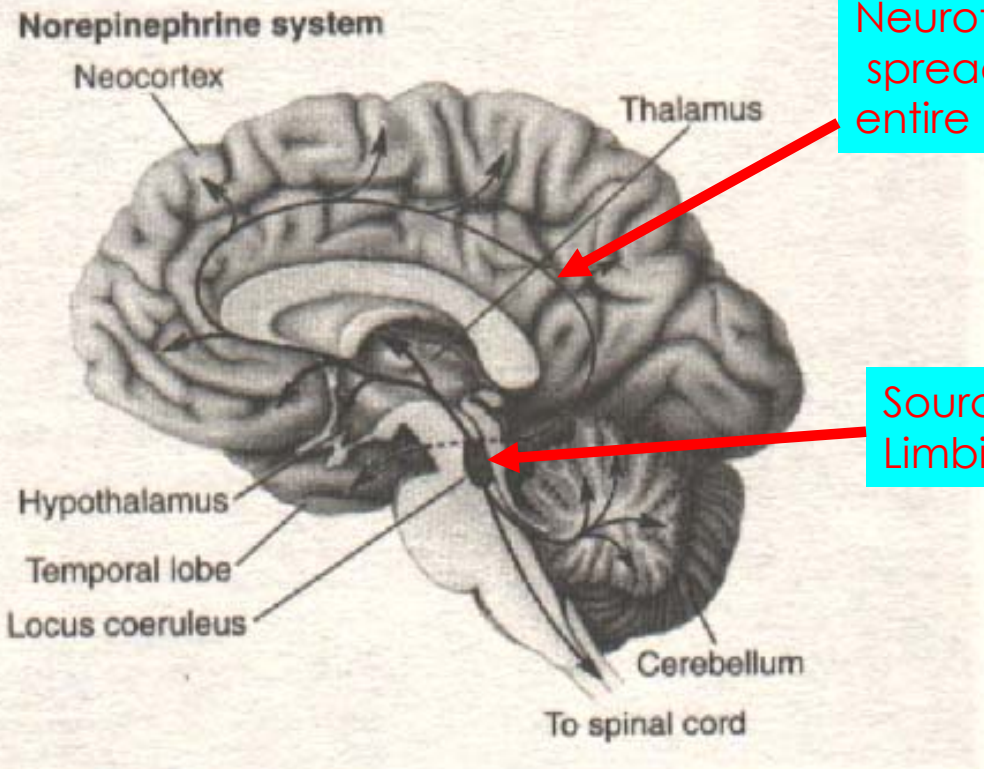
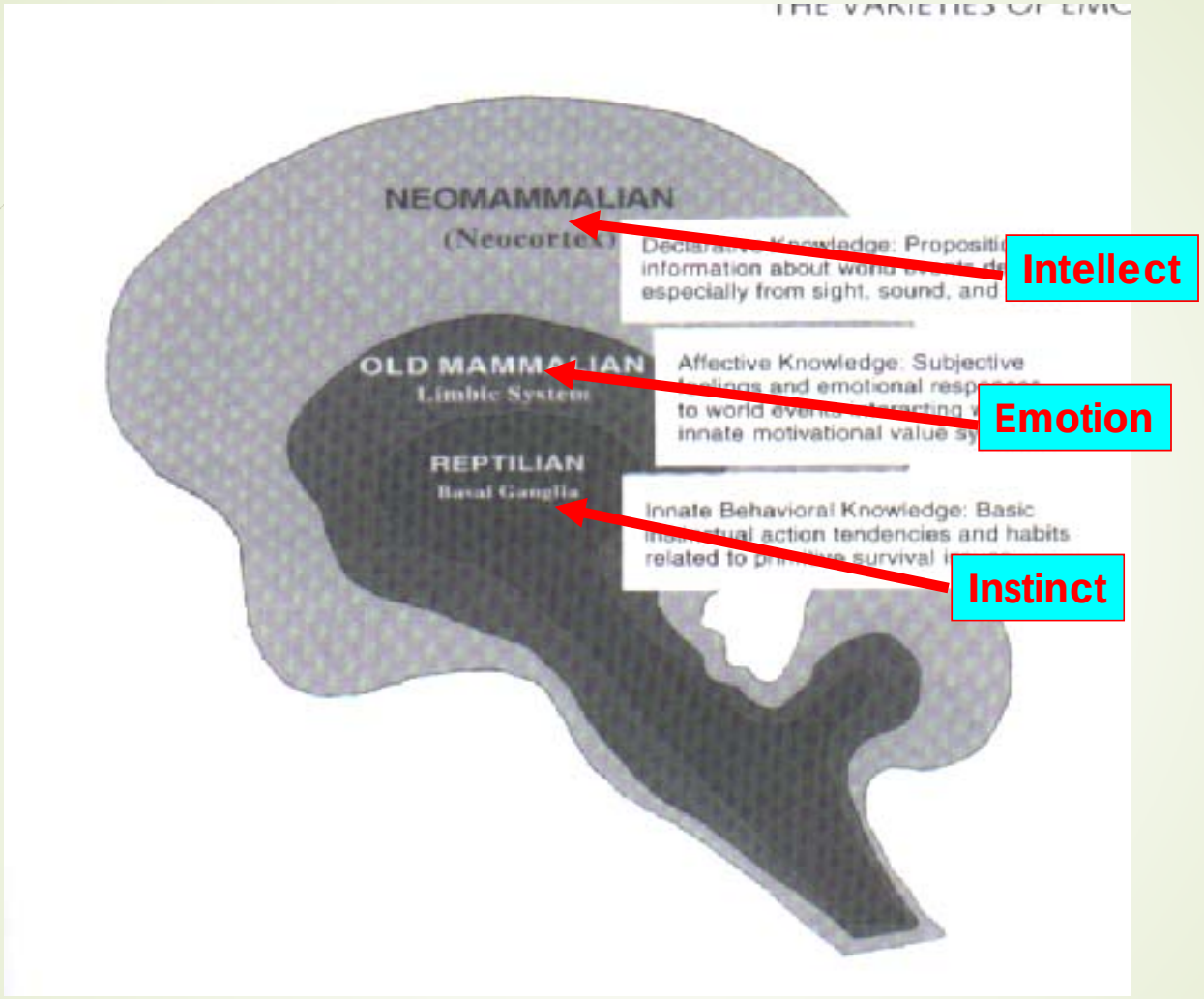


FIGURE 7.3 DIAGRAM OF A VALUE SYSTEM. The noradrenergic system originating in the locus coeruleus projects diffusely to the entire brain and releases the neuromodulator noradrenaline.

Neurotransmitters spread to entire brain

Source is in the Limbic system

Noradrenaline, Dopamine, Serotonin



The value system originates in the limbic (affective) system

The basic (primitive) values

The basic emotional systems identified by Panksepp (1998), based on structures in the limbic system, are the following:

E1: The SEEKING system: general motivation, seeking, expectancy
E2: The RAGE system: rage/anger
E3: The FEAR system: fear/anxiety
E4: The LUST system: lust/sexuality
E5: The CARE system: providing maternal care/nurturance
E6: The PANIC system: panic/separation, need of care
E7: The PLAY system: roughousing play/joy

On the present view: *it is the basic emotional systems [particularly the SEEKING system] that underlie brain development and intellect*
- relates to *evolutionary development* and to *animal behaviour*

The Basic Affective Neuronal Darwinism Hypothesis

Hypothesis: The basic emotional systems E1-E7 identified by Panksepp, together with inputs from the endocrine and immune systems, are necessary and sufficient to provide the value system of neural Darwinism identified by Edelman and Tononi.

On this view, the primary emotions E1 to E7 characterised above [with endocrine and immune system inputs] become the lynch-pin linking neurophysiology to experience and the social and physical environment. They link macro-events to neural micro-structure by top-down action from the macro to the micro scale.

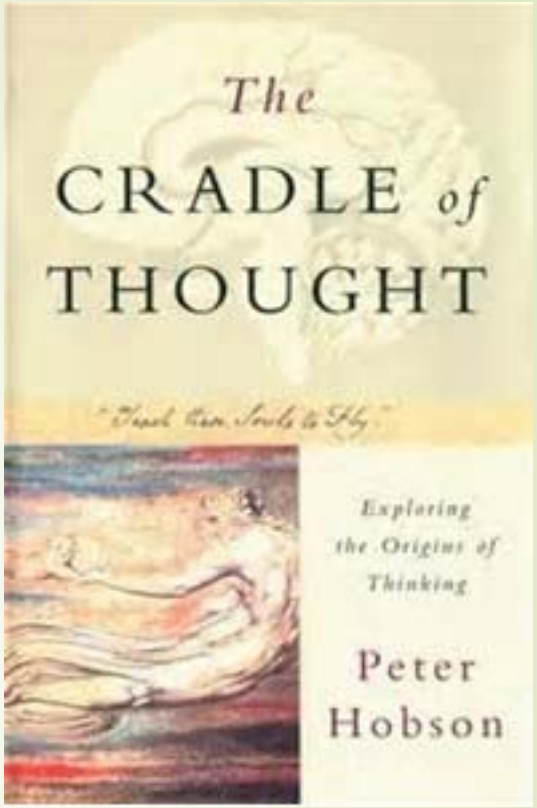
Consequently they are a key both to brain physiological development and to evolutionary development of secondary emotions and higher cognitive functions. The assumption is that *nothing else is left out: this is the total value system*.

Hence

- Hardwired emotions firing in the limbic system send out connections to the higher centres
- Those circuits that are used remain and are strengthened; those that are not used; wither
- Emotions expressed in a social environment drive the development of those higher connections.

Peter Hobson

- Cradle of thought – "Teach these souls to fly"
- A Child through play and socialisation learns
  - A sense of self
  - A sense of the other
  - The rules of interaction
  - The modes of persuasion
  - The benefits of being persuaded
  - Conflict and cooperation
  - Boundaries
  - Borderline mum – intrusive and unresponsive



OUP 2002

Artificial Intelligence

"Any thinker needs the appropriate kind of body and capacity to feel and act in order to connect with the world that contains the object of thought...It is not just that computers do not have the right kind of relations with things around them – it is also that they do not have the right kind of relations with each other. If computers want to think they had better get a social life."

Peter Hobson

The Cradle of Thought: Exploring the origins of thinking

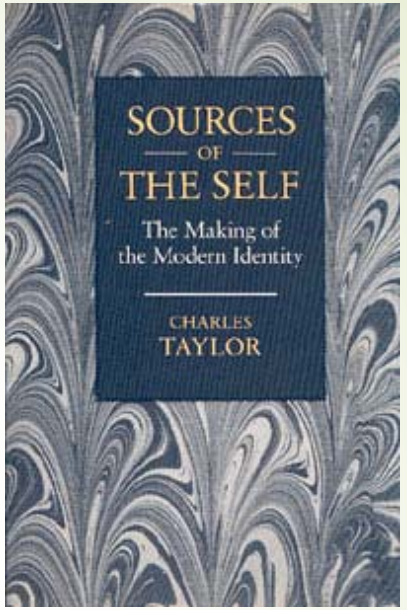
OUP 2002:xv

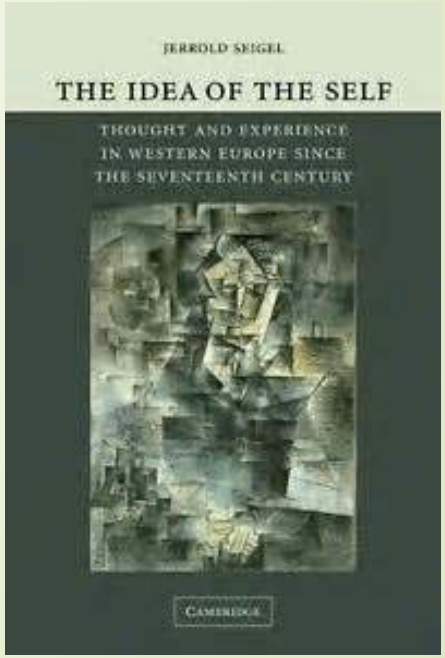
The Hard Mind/Brain Question

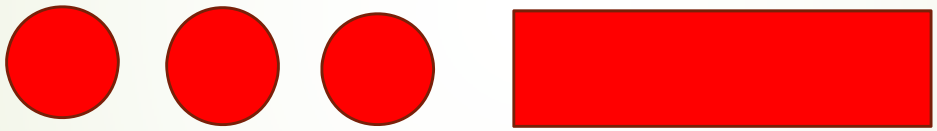
- How do mind functions arise out of brain activity?
  - Emotions
  - Thoughts
  - Drives
  - Decisions
  - Intentionality/Qualia
  - Sense of self
- Apart from (mutter, mutter) emergent (or supervenient) properties: ???????

Who Am I?

- Taylor *Sources of the self* Harvard 1989
  - Choices
  - Narrative
- Segal *The idea of the self* CUP 2005
  - Embodied
  - Reflective
  - Relational
- Hobson *Cradle of thought* OUP 2002
  - Neurodevelopmentally within an emotional context







Hermeneutics of the Self

"there is no self-understanding that is not *mediated* by signs, symbols, and texts; in the final analysis self-understanding coincides with the interpretation given to these mediating terms"

Paul Riccour

On Interpretation, in *From Text to Action*

In Dauenhauer, Bernard and Pellauer, David, "Paul Ricoeur", *The Stanford Encyclopedia of Philosophy* (Summer 2014 Edition), Edward N. Zalta (ed.),

<http://plato.stanford.edu/archives/sum2014/entries/ricoeur/>.

What Stories Shape us?

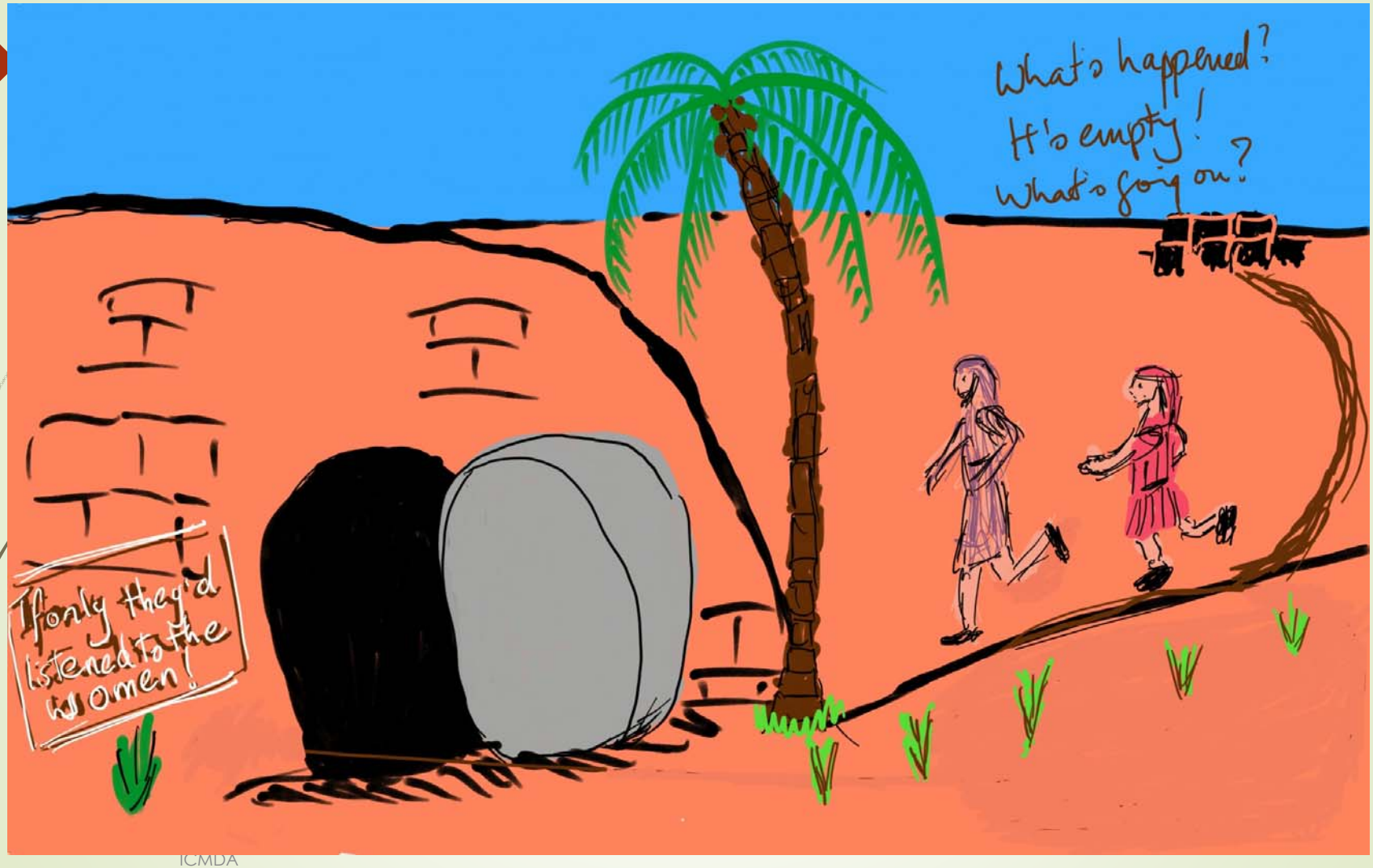
- Family narrative
- Cultural narrative
- Formative stories
- God's story

Jesus of Nazareth: King of the Jews

ICMDA

"The Christ must suffer these things..." (Luke 24:26)

On the Third Day



Review

- The brain as computer – yes and no
- Neuroscience –
  - reductionism and emergence
  - Qualia or intentionality
  - Affective neuronal Darwinism
- Who am I? (different from what is human)
  - Embodied (enfleshed) chooser of options
  - Narrative development of a sense of who I am
- Synthesis – provisional incomplete
- Christian comments on our synthesis
  - we see ourselves within the stories of the believing community
  - We invite others to reflect on and join in the stories we tell