Machines like us

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The missing algorithm of thought

- Computational approach hasn't achieved much in 30 years or more
  - The model is not the system
  - Random abstractions
  - Combining incompatible solutions
  - Insufficient attention to grounding
- What we need is a breakthrough
- We have one existence proof but we don't know how it works
- Biology may use some unfamiliar principles

Methodology: What we need here is a robot orang-utan…

- Biologically *plausible* (neither slavish nor abstract)
- Physical robot in complex environment
- Human-*style* (mammal-style) intelligence, not human-level
- Self-organising architecture – find the meta-machine
- Work solo & assume nothing

Vision (monocular)

Anamorphic retina

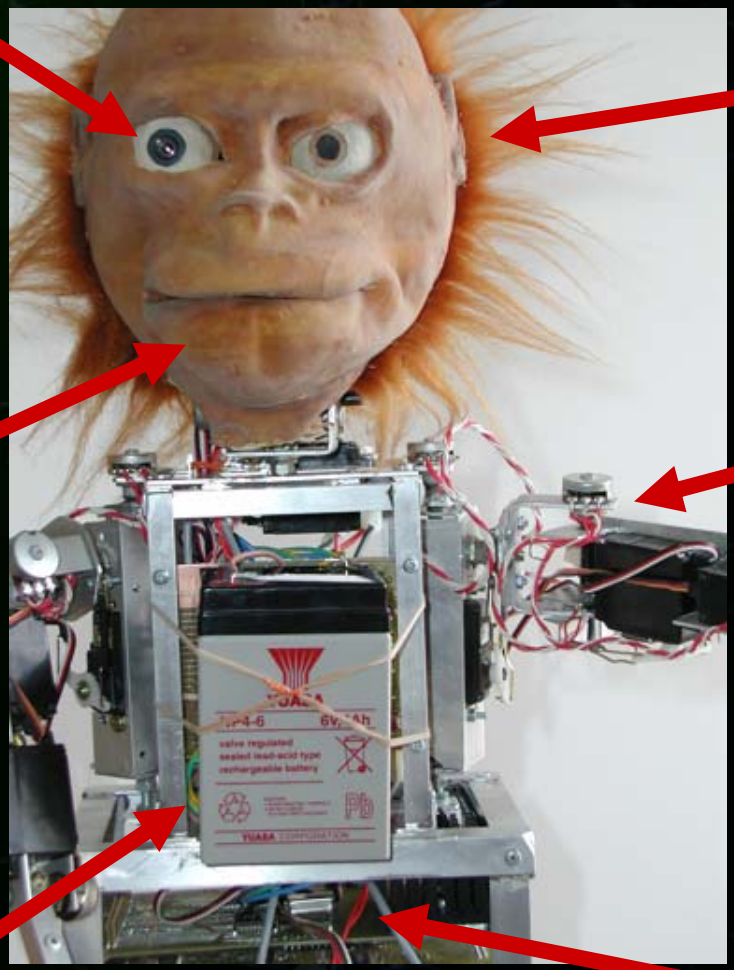
Ganglion cells
(contrast/motion)

Superior colliculus
(visual saccades)

Hearing (binaural)

Cochlea
(frequency discrimination)

Lateral superior olive
(phase discrimination)



Voice

Virtual/electronic model of vocal tract:

Lungs (volume, flow, pressure)
vocal cords,
glottis,
mouth resonance

Muscles

13 degrees of freedom

Virtual antagonistic pairs of compliant muscles

Proprioceptors for sensing joint position & motion

Other sensors

Touch
temperature
balance/motion
energy consumption

Lucy MkI

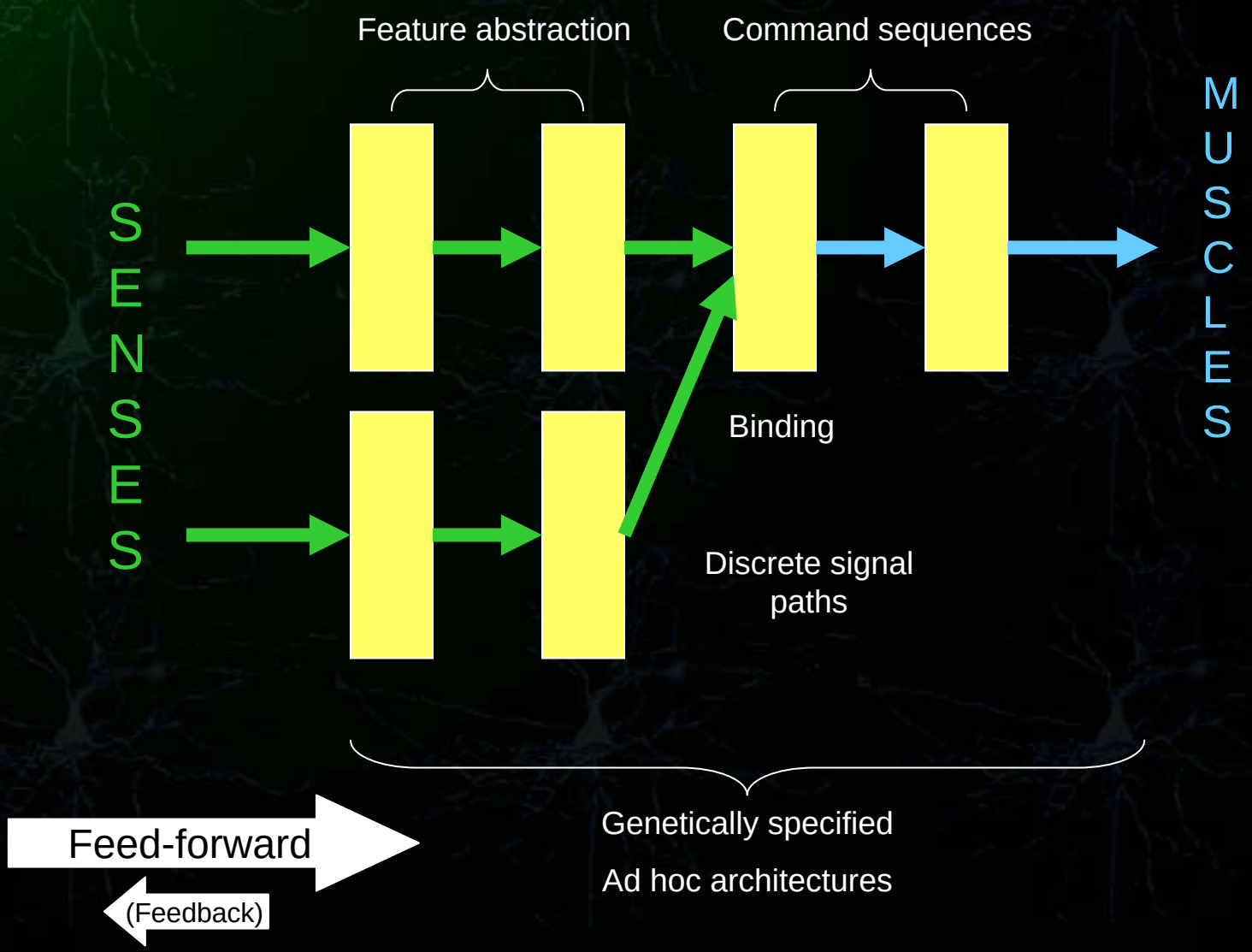
Onboard computers

5 x 16-bit sensory processors with shared memory

2 x 8-bit motor processors

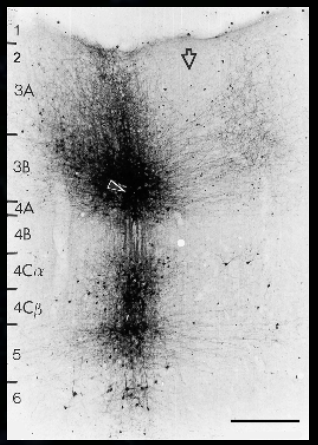
Plus desktop PC for brain modelling

Inside the brain of an AI researcher…

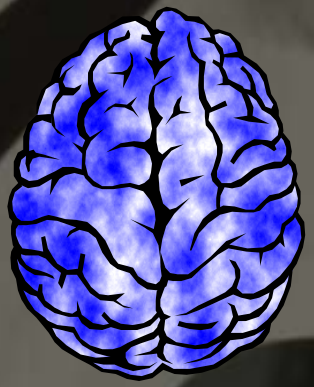


McCulloch and who?

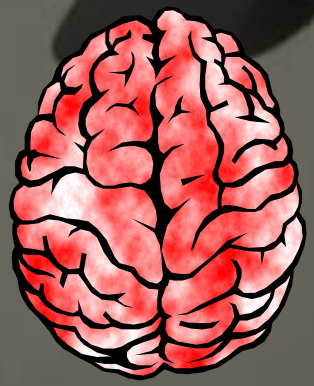
Feedforward	BUT…	So much traffic goes the wrong way The wiring diagram doesn't work
Discrete circuitry	BUT…	Neurons are promiscuous
Hard-wired	BUT…	Scotomas heal too quickly God didn't design beaches
Ad-hoc & Specialised modules	BUT…	Cortex is cortex is cortex
Refining and combining	BUT…	No place where it all comes together No data can be lost through abstraction



Servos: a model of the world?



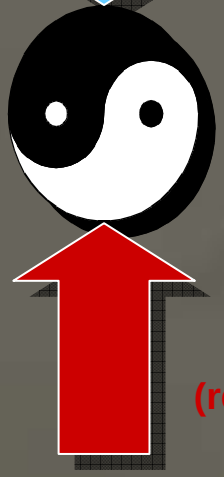
"Mental" state



Actual (sensory) state

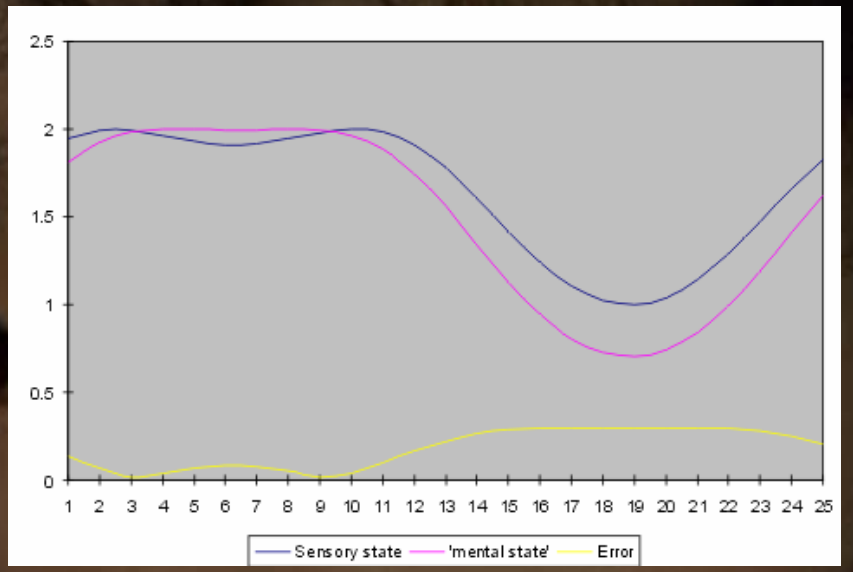
anticipation
attention
intention

YANG (model)

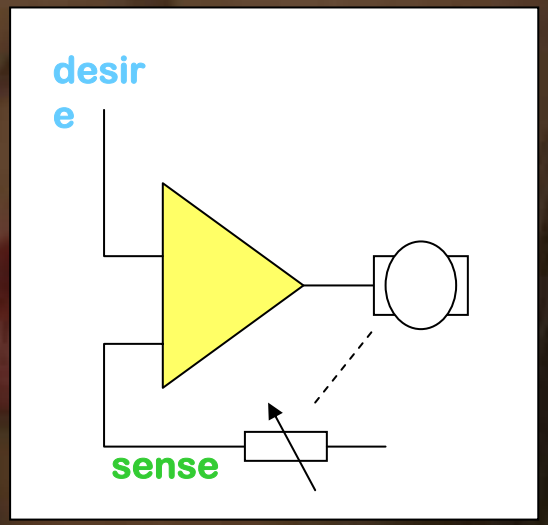


YIN (reality)

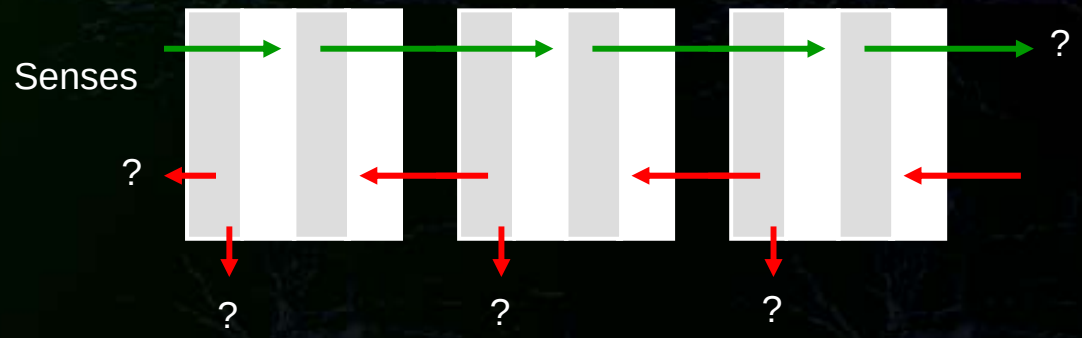
sensation
feedback

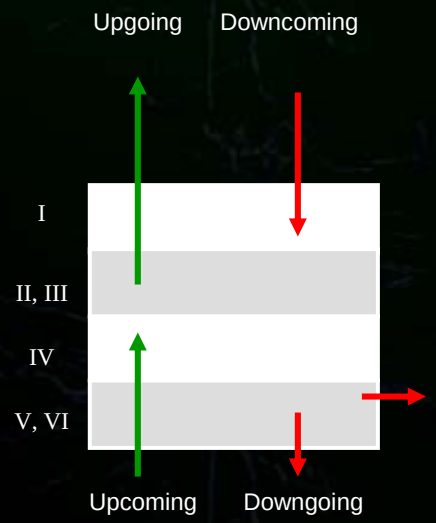


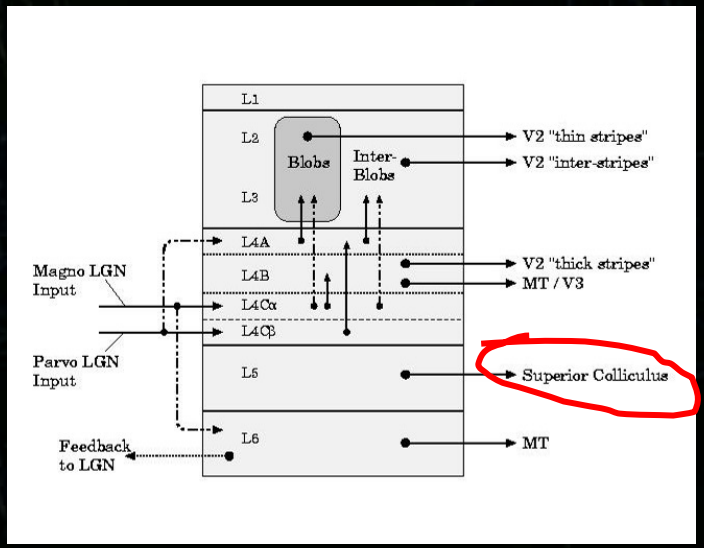
expectation/attention ⟷ intention



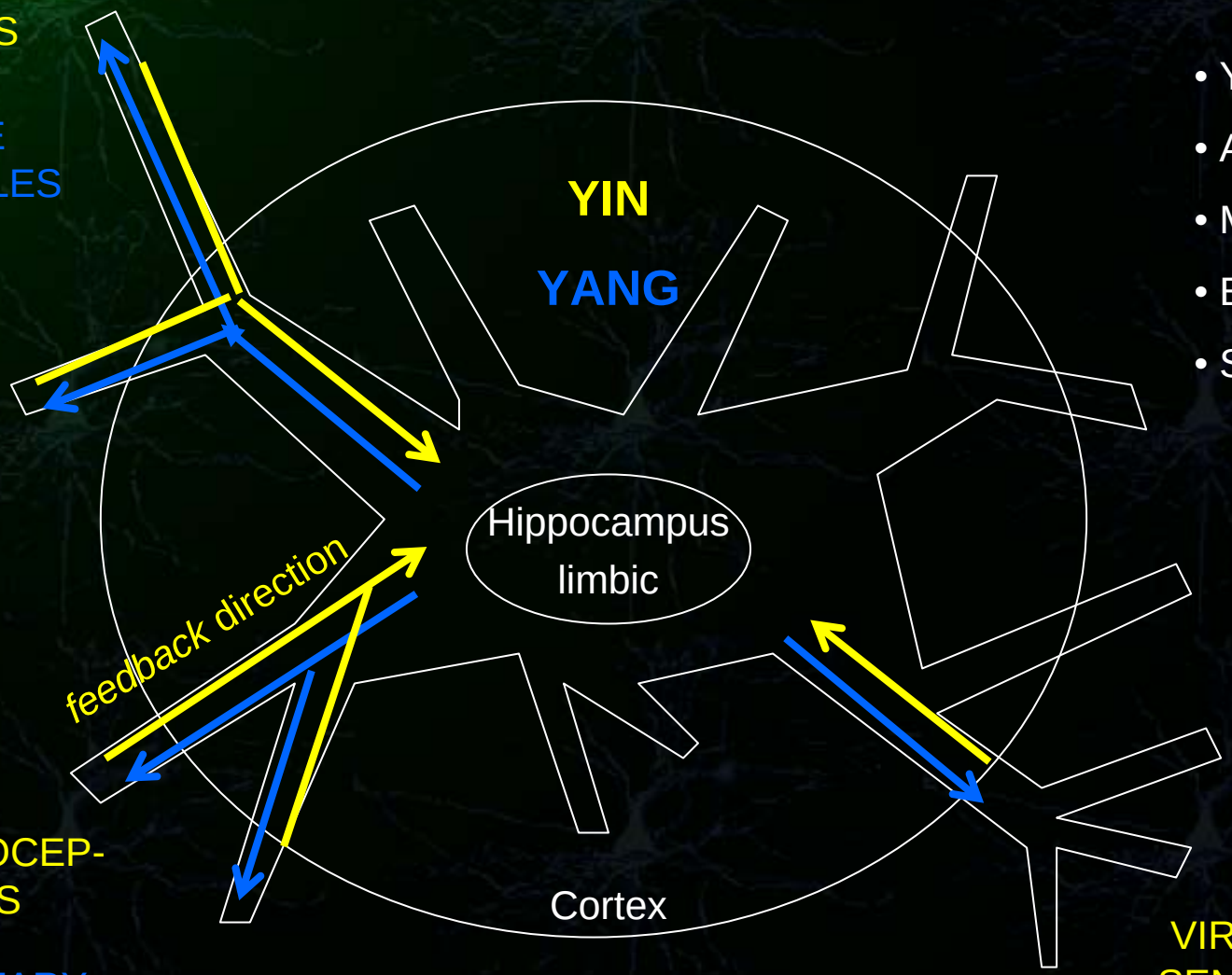

2 mm
A
B


Senses
?
?
?
?
?


Upgoing
Downcoming
I
II, III
IV
V, VI
Upcoming
Downgoing

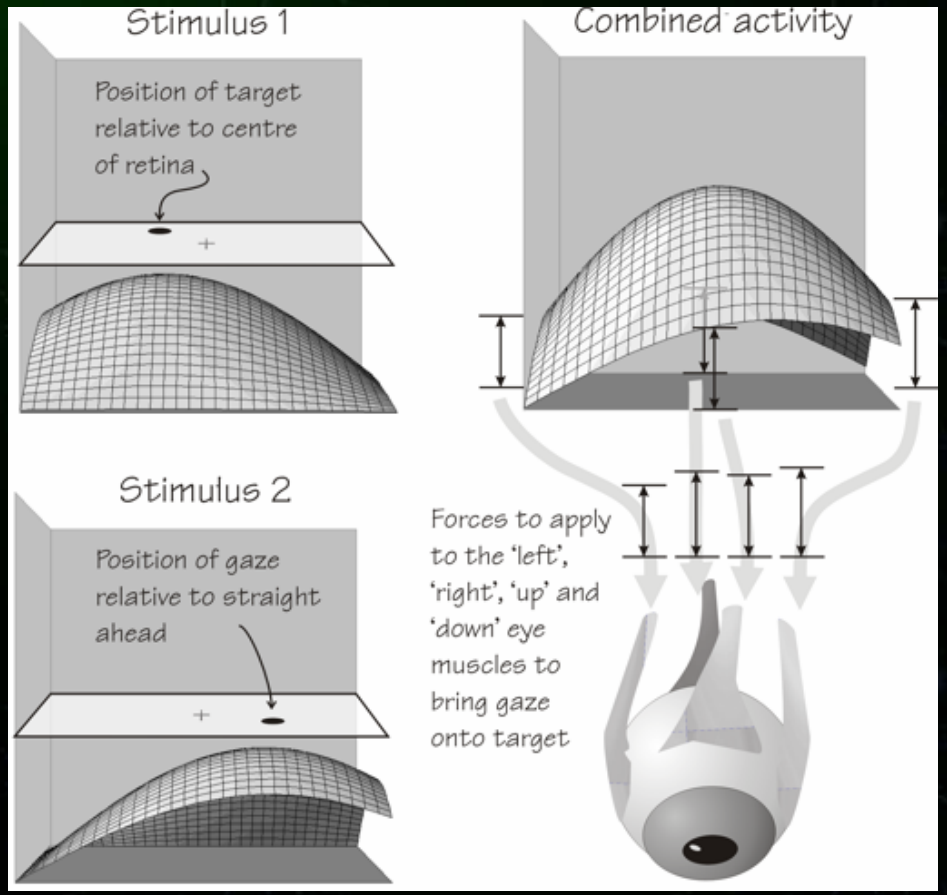

L1
L2
L3
Blobs
Inter-Blobs
V2 "thin stripes"
V2 "inter-stripes"
L4A
L4B
L4Cα
L4Cβ
Magno LGN Input
Parvo LGN Input
V2 "thick stripes"
MT / V3
L5
Superior Colliculus
L6
MT
Feedback to LGN

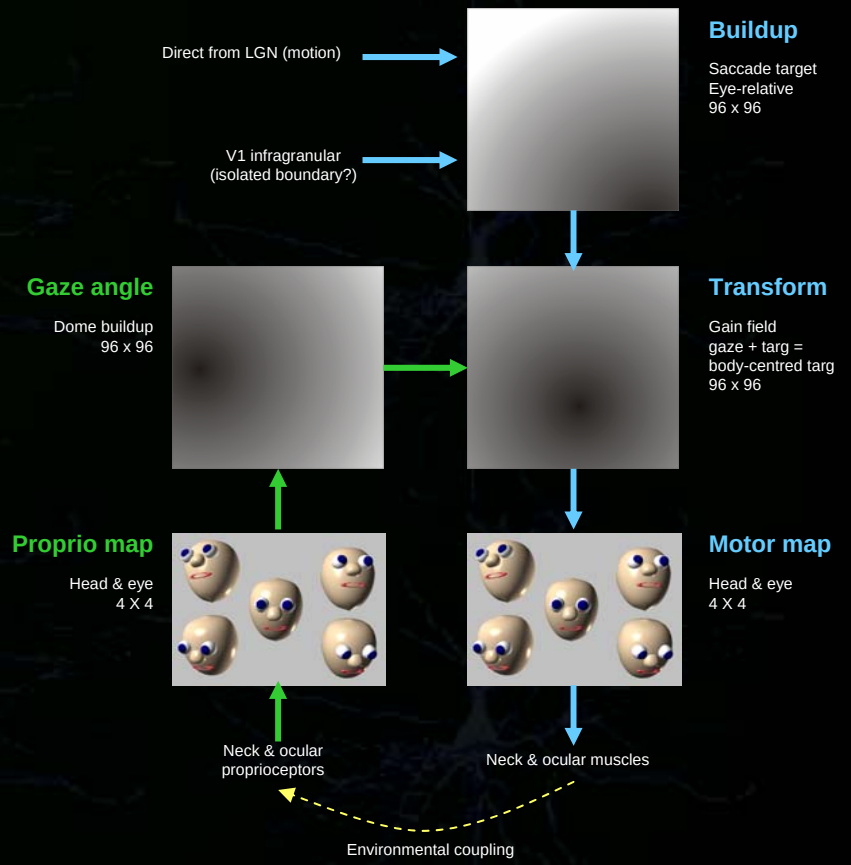
Lucy's brain



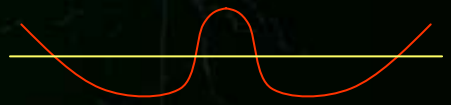
- Yin/yang servos
- Active vision
- Morphs
- Bandwidth
- Symbols

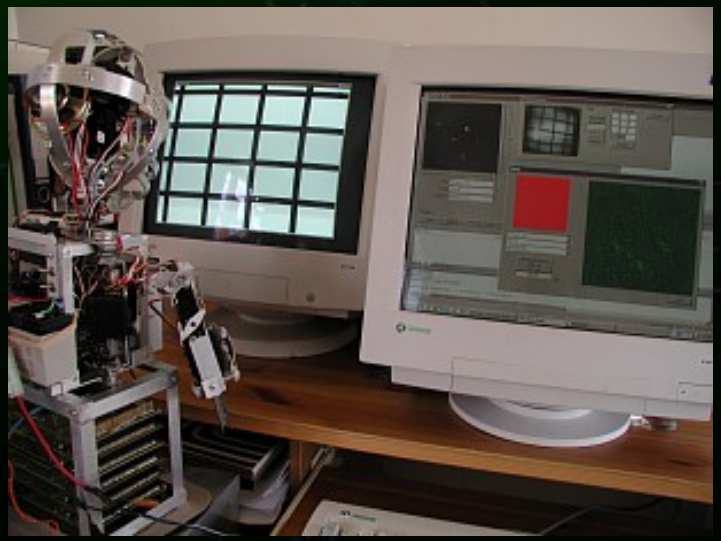
Lucy's Superior Colliculus

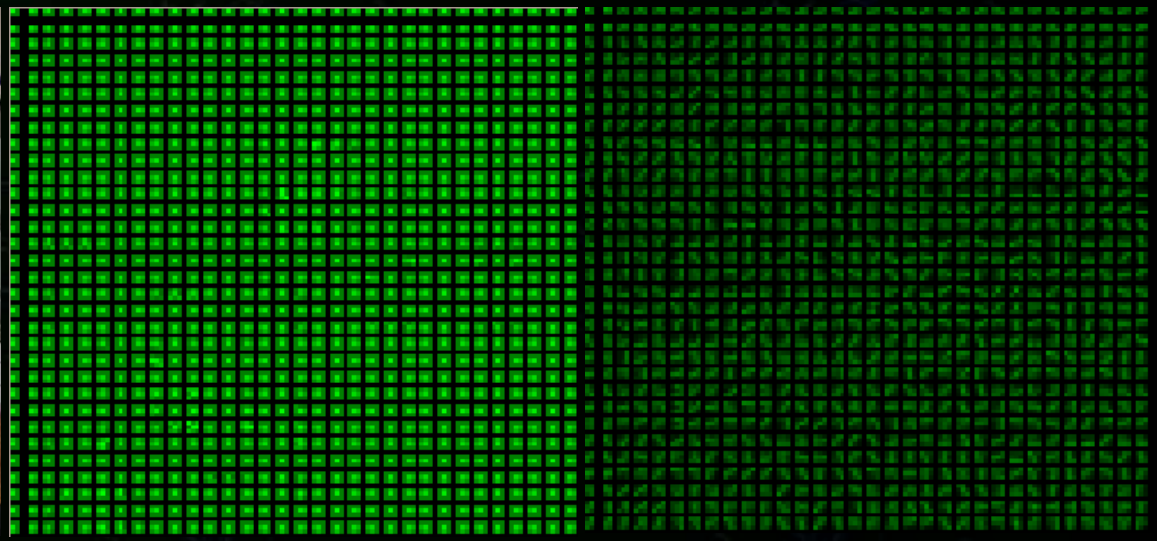




Lucy learning her lines

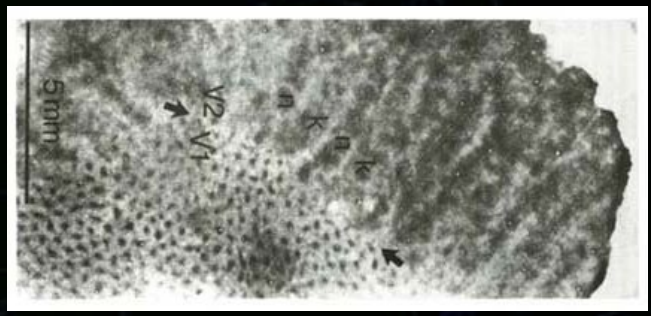


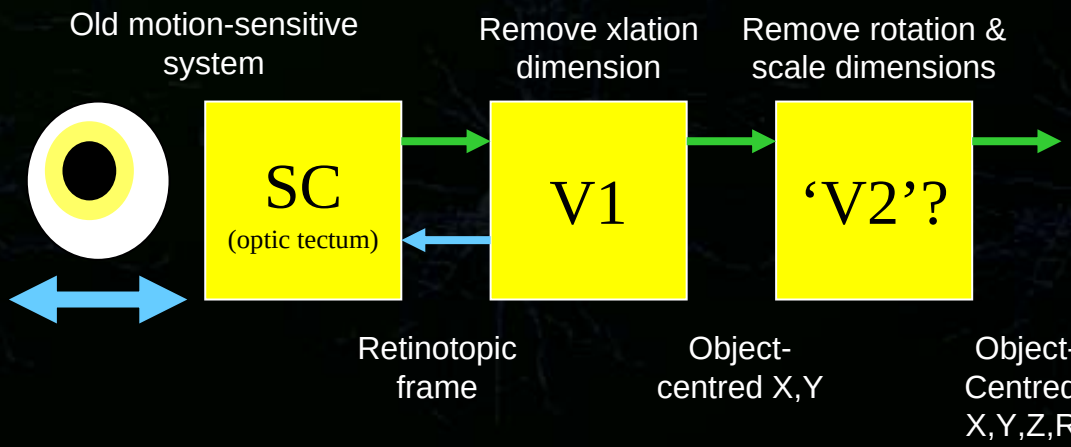


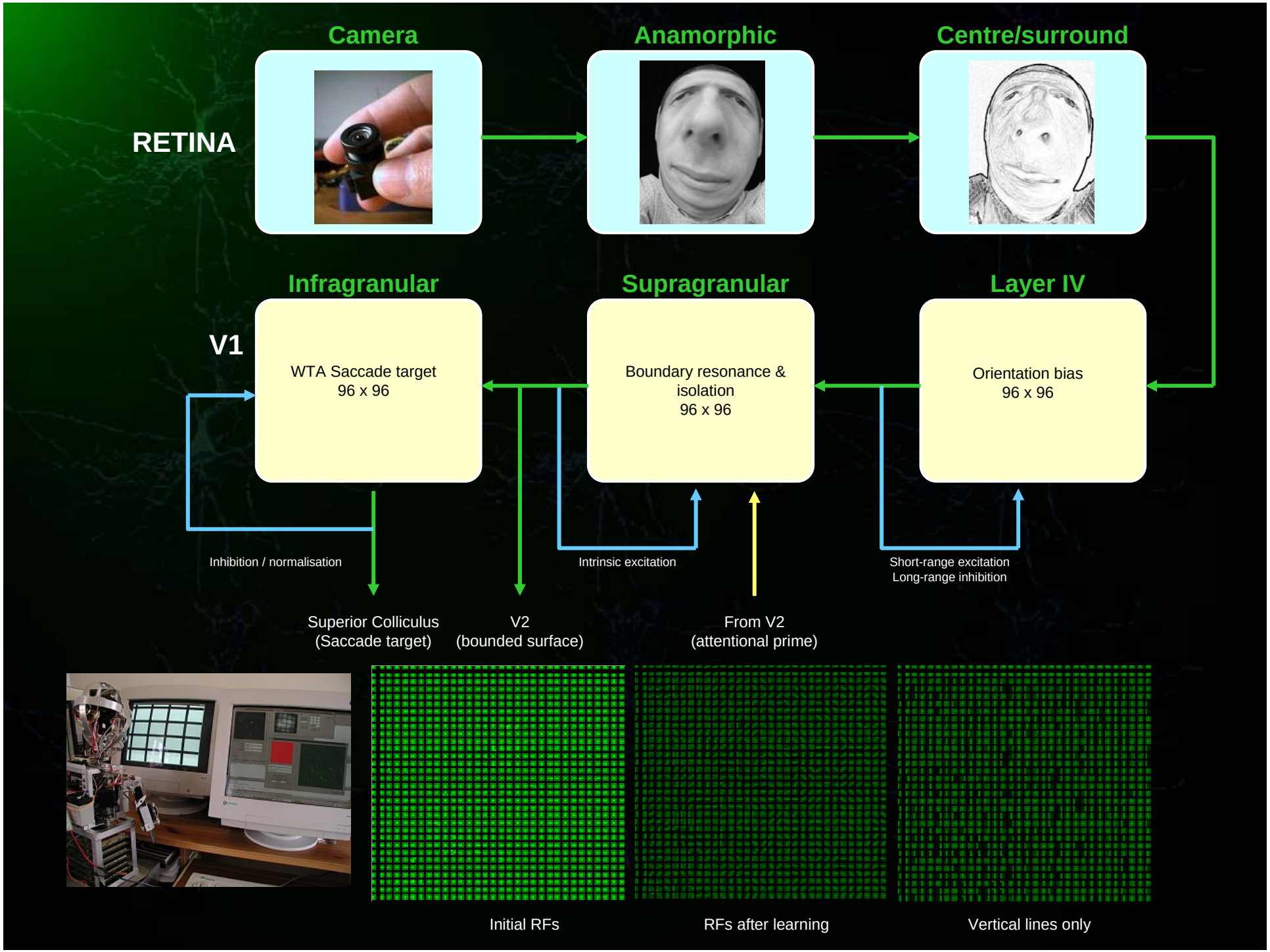


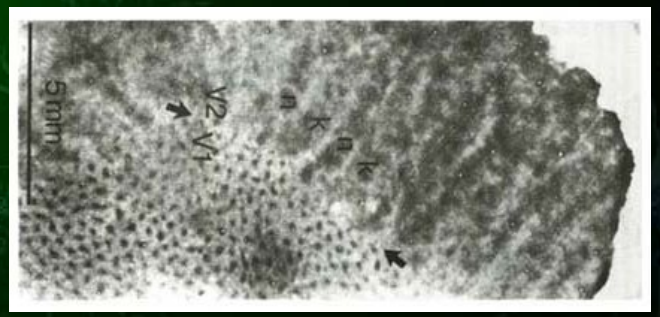
But is this *really* just the start of a feature extraction pipeline?
Is it primarily a cortical extension of the saccade reflex

Extending the frog?






Camera
Anamorphic
Centre/surround
RETINA
Infragranular
Supragranular
Layer IV
V1
WTA Saccade target
96 x 96
Boundary resonance &
isolation
96 x 96
Orientation bias
96 x 96
Inhibition / normalisation
Intrinsic excitation
Short-range excitation
Long-range inhibition
Superior Colliculus
(Saccade target)
V2
(bounded surface)
From V2
(attentional prime)
Initial RFs
RFs after learning
Vertical lines only



Cytochrome Oxidase

From V1

Concentric

Radial

Layer IV

V2

Summation & wave synchronisation – rotation invariance

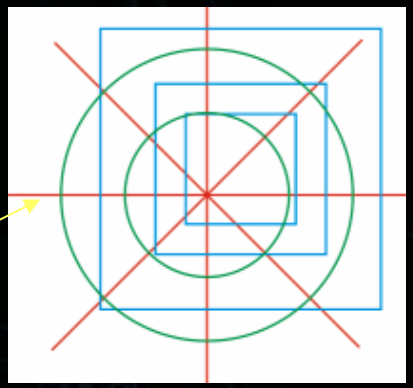
Travelling waves – scale invariance

Fusion of orientation columns into macrocolumns
32 X 32

Concentric excitatory

Concentric inhibitory

Prime – wave synchronisation



Embyological wiring from test-card signals

Signature map

Correlated time signatures – surface classification

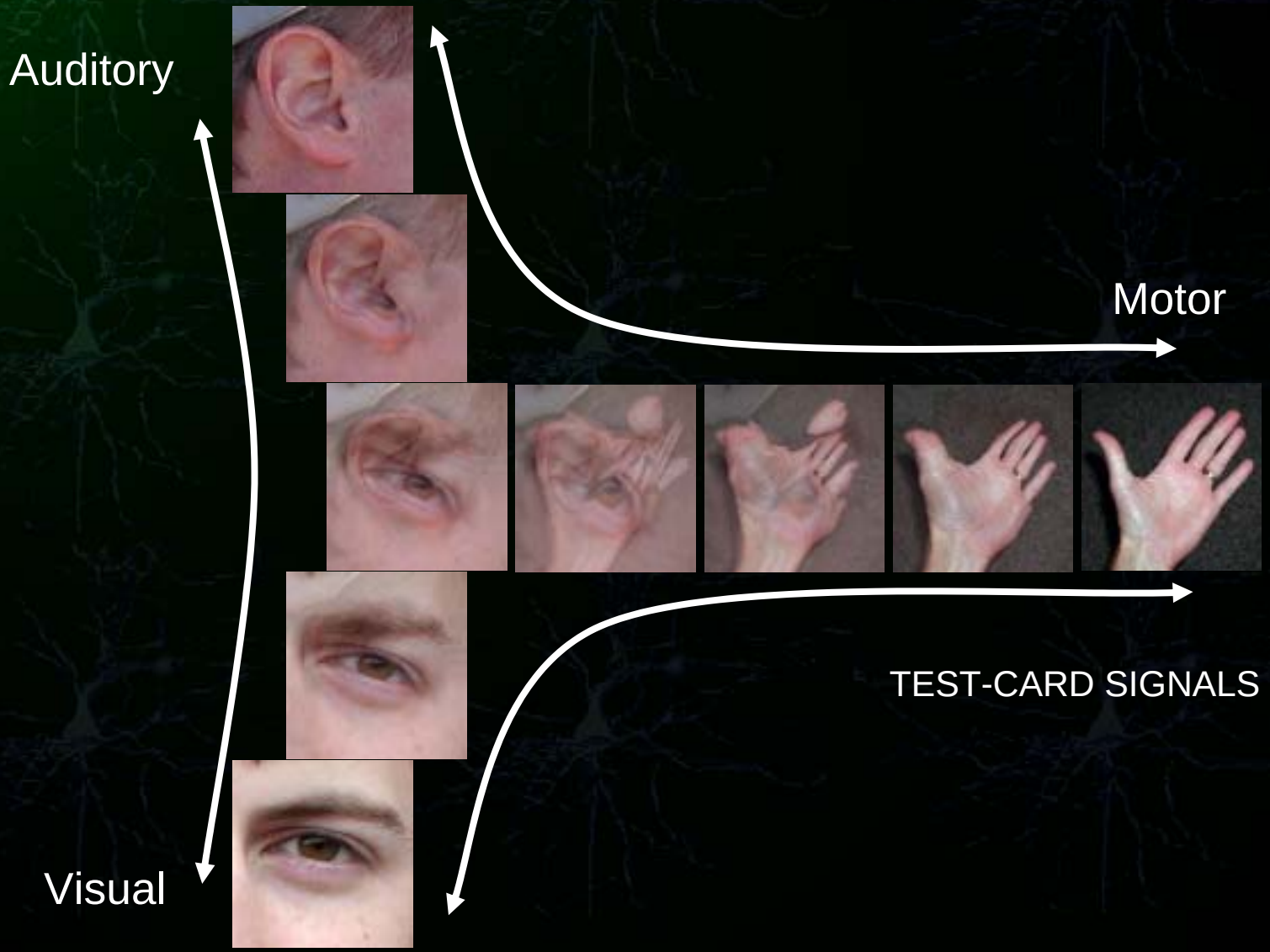
To V4 etc.

To V1 attentional prime

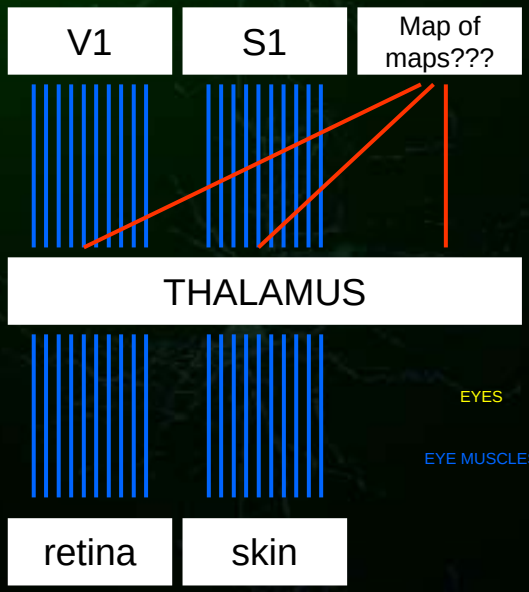
Local excite / long-range inhibit

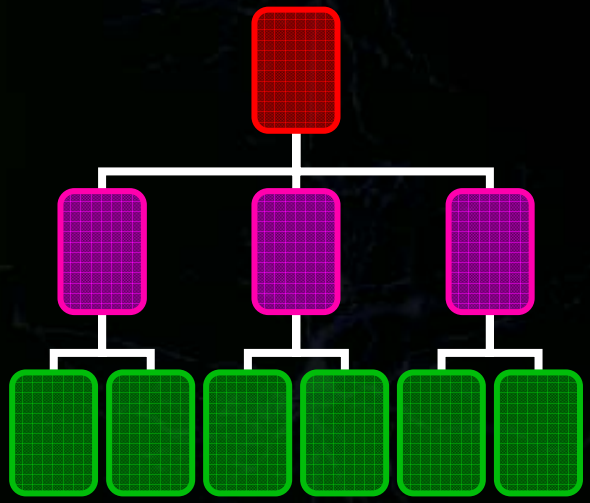
Hypothetical
"V2 + MT"

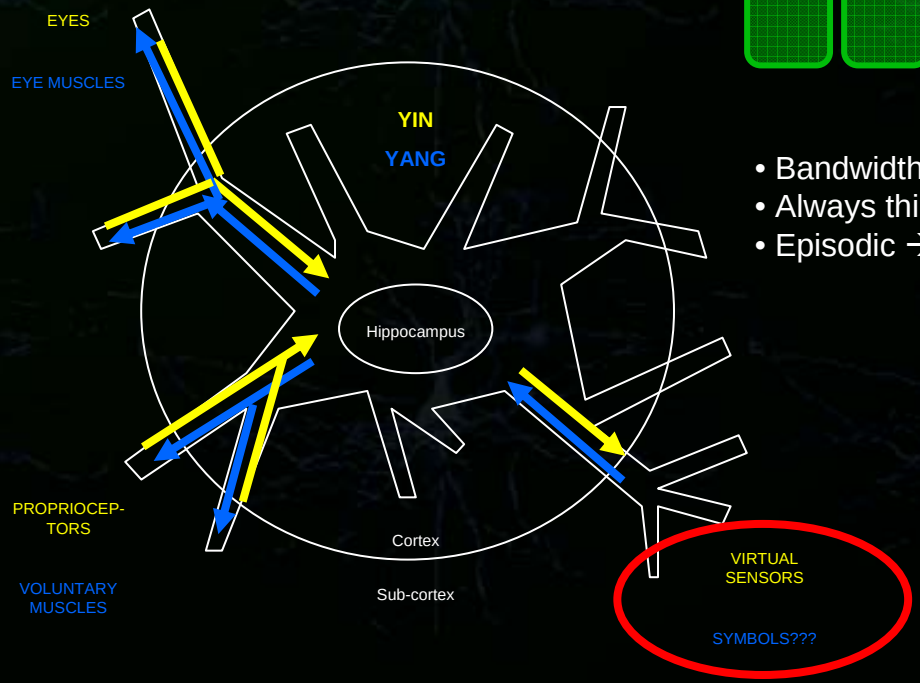
Coordinate morphs



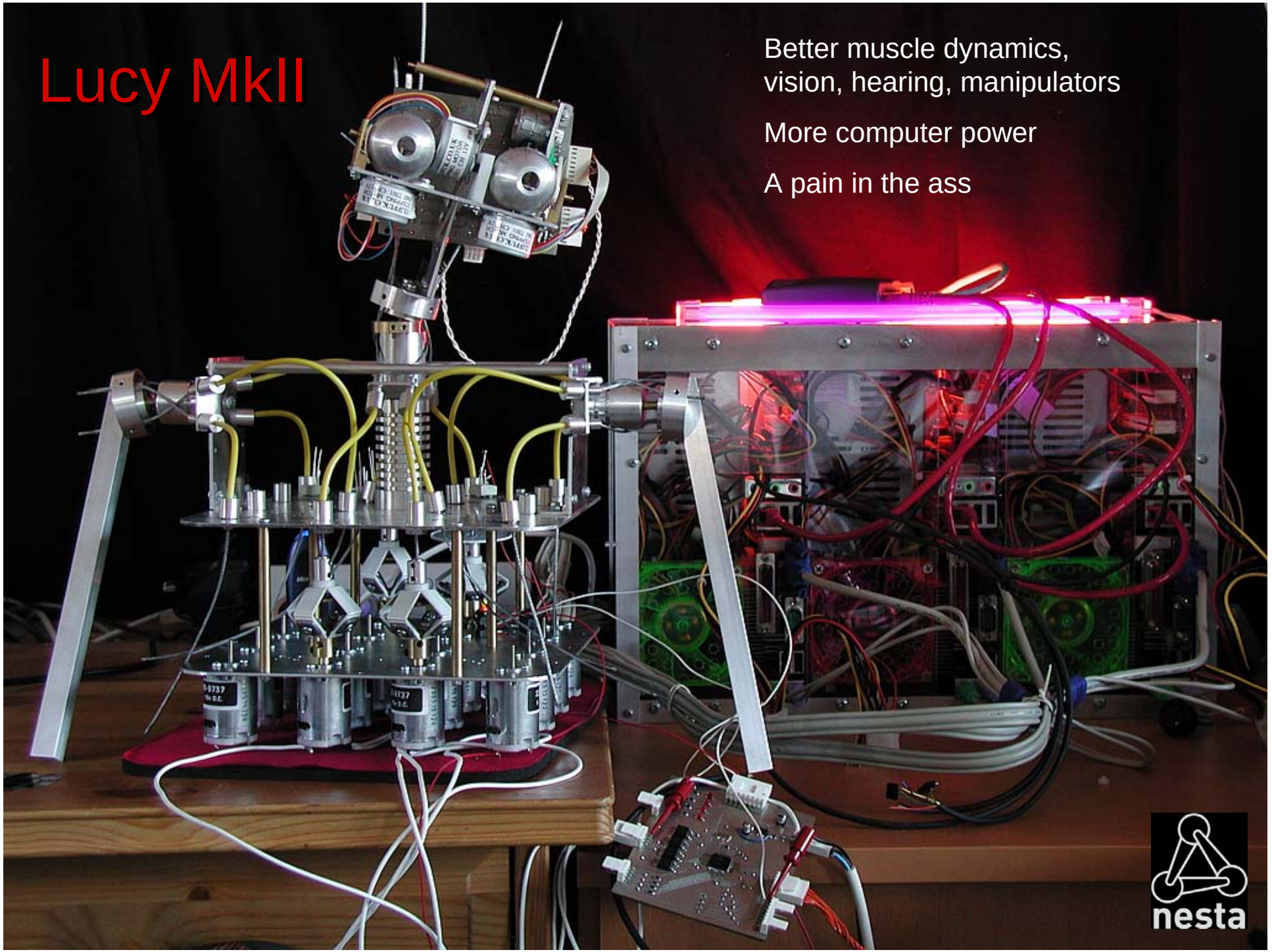
Virtual pebbles, maps of maps, and the bandwidth of conscious attention



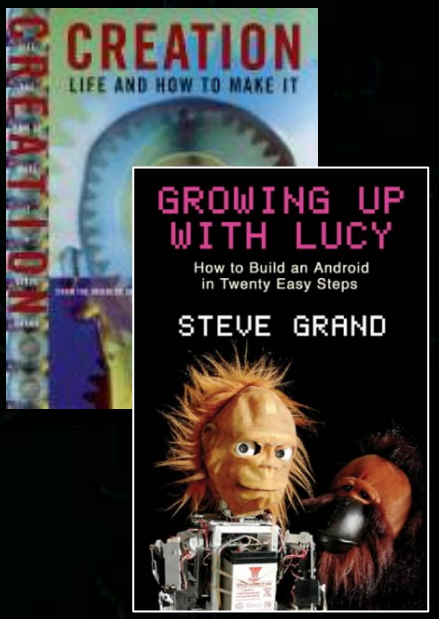




- Bandwidth hogging
- Always thinking of something
- Episodic → semantic memory migration


Lucy MkII
Better muscle dynamics,
vision, hearing, manipulators
More computer power
A pain in the ass
nesta

Subliminal plug for my books



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Weidenfeld & Nicolson
Very modestly priced!

Thanks to nesta for supporting the Lucy project