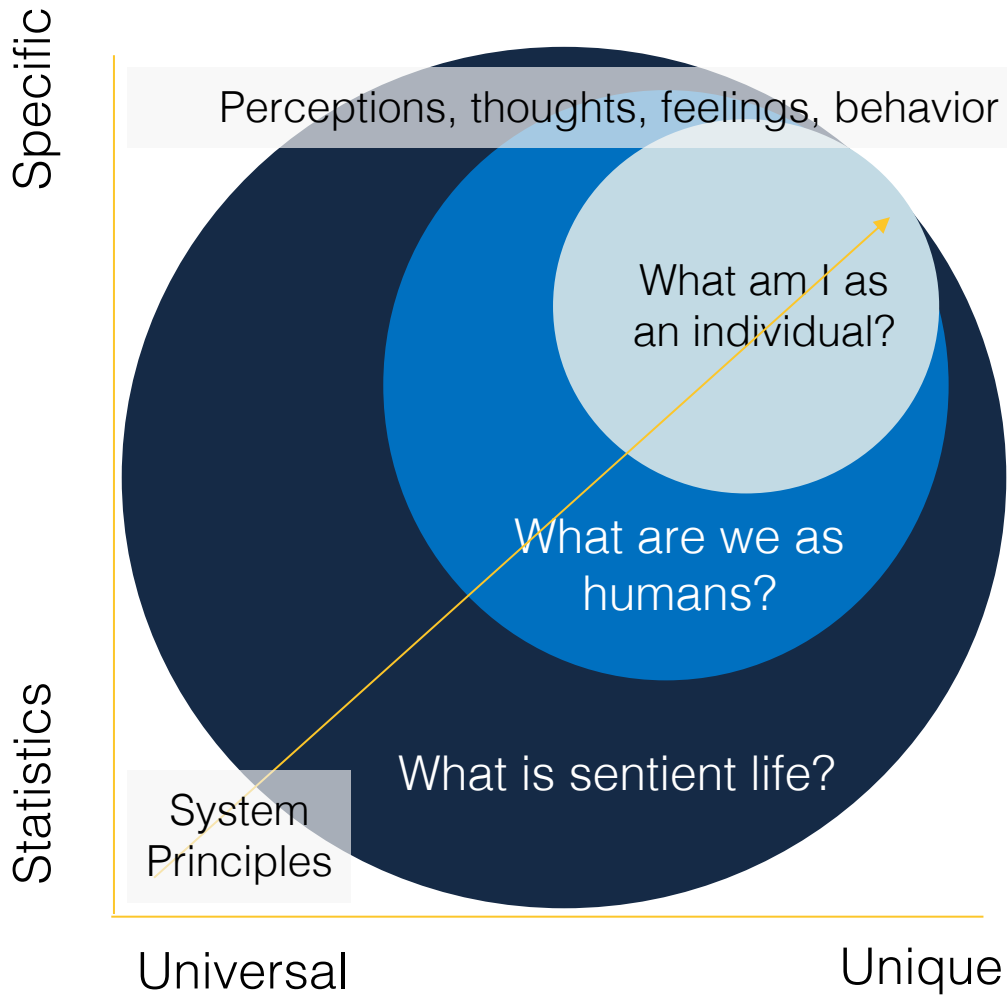


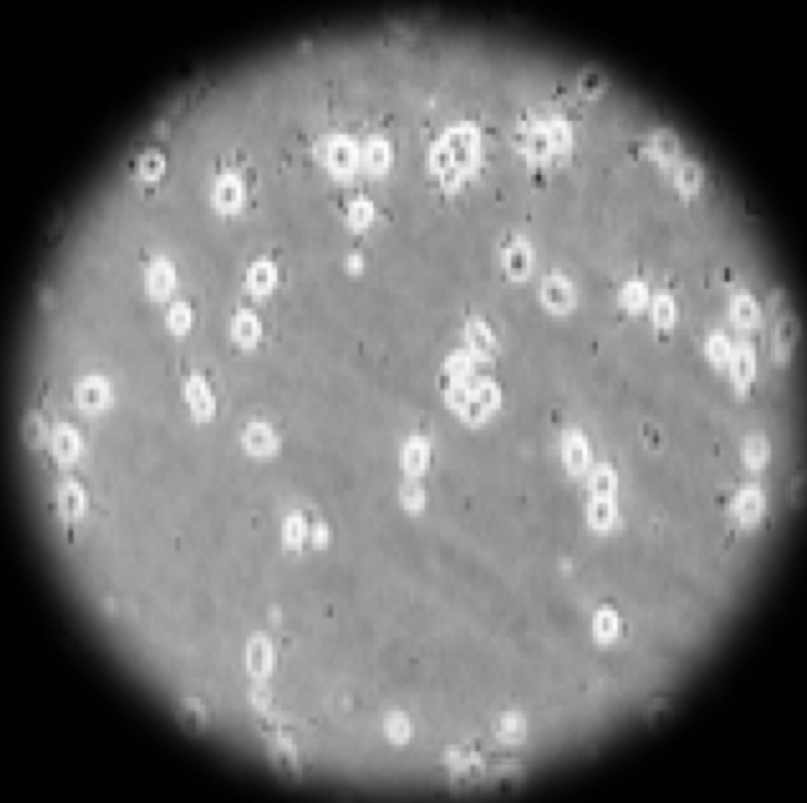


FRAMING THE QUESTION FINDING AN APPROACH

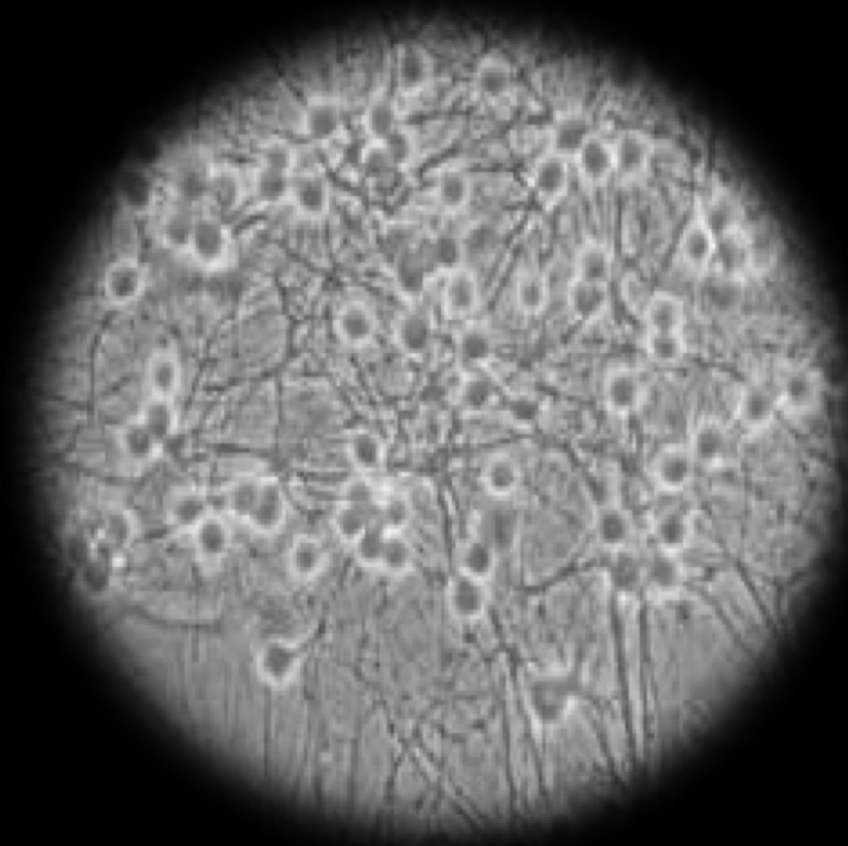
TARA THIAGARAJAN





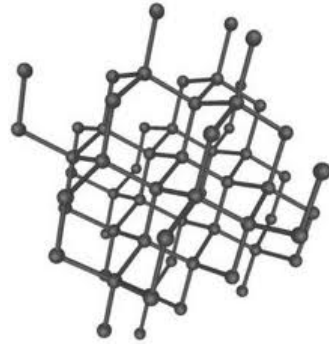




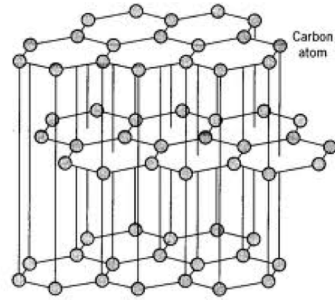




The same element can produce diametrically opposite system outcomes.



Depends on link structure and therefore the way energy is absorbed.



Often macro system properties (e.g. color and hardness) are more insightful than details of individual elements.



Conclusion #1

YOU CAN'T UNDERSTAND THE
SYSTEM FROM THE INDIVIDUAL UNIT
IN ISOLATION

Neocortex

Brainstem





Conclusion #2

YOU HAVE TO STUDY THE SYSTEM IN
ITS INTACT FORM

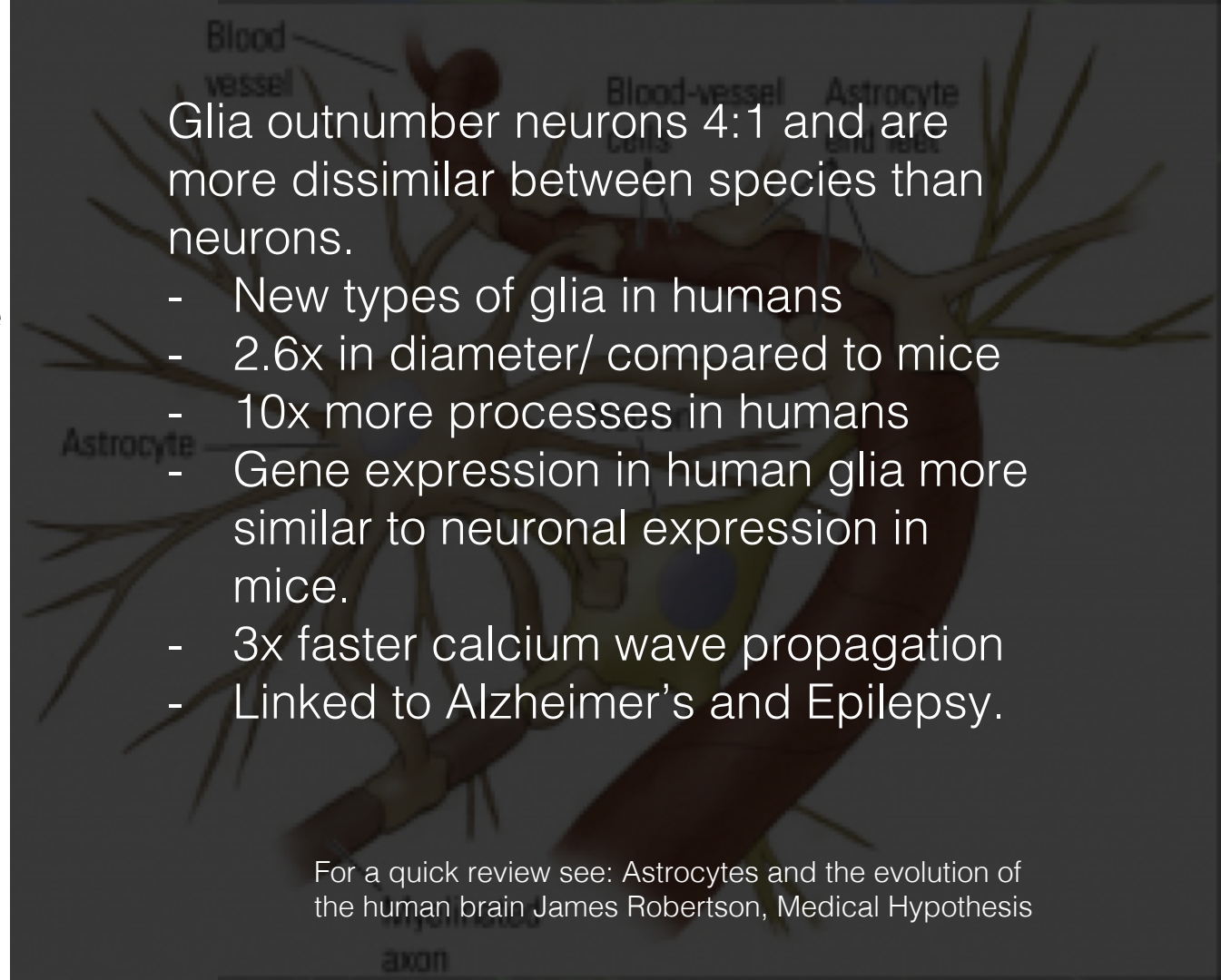
Size

Links

- Nature of synapse
- Speed

Elements/Nodes

- Neurons
- Glia

A grayscale microscopic image of brain tissue. A large, dark, branching structure, likely an astrocyte, dominates the center. Labels with arrows point to various parts: 'Blood vessel' at the top left, 'Astrocyte' on the left side, and 'axon' at the bottom center. The background shows a network of smaller fibers and structures.

Glia outnumber neurons 4:1 and are more dissimilar between species than neurons.

- New types of glia in humans
- 2.6x in diameter/ compared to mice
- 10x more processes in humans
- Gene expression in human glia more similar to neuronal expression in mice.
- 3x faster calcium wave propagation
- Linked to Alzheimer's and Epilepsy.

For a quick review see: Astrocytes and the evolution of the human brain James Robertson, Medical Hypothesis



Conclusion #3

MAYBE NEURONS ALONE ARE NOT
THE RIGHT THING TO FOCUS ON



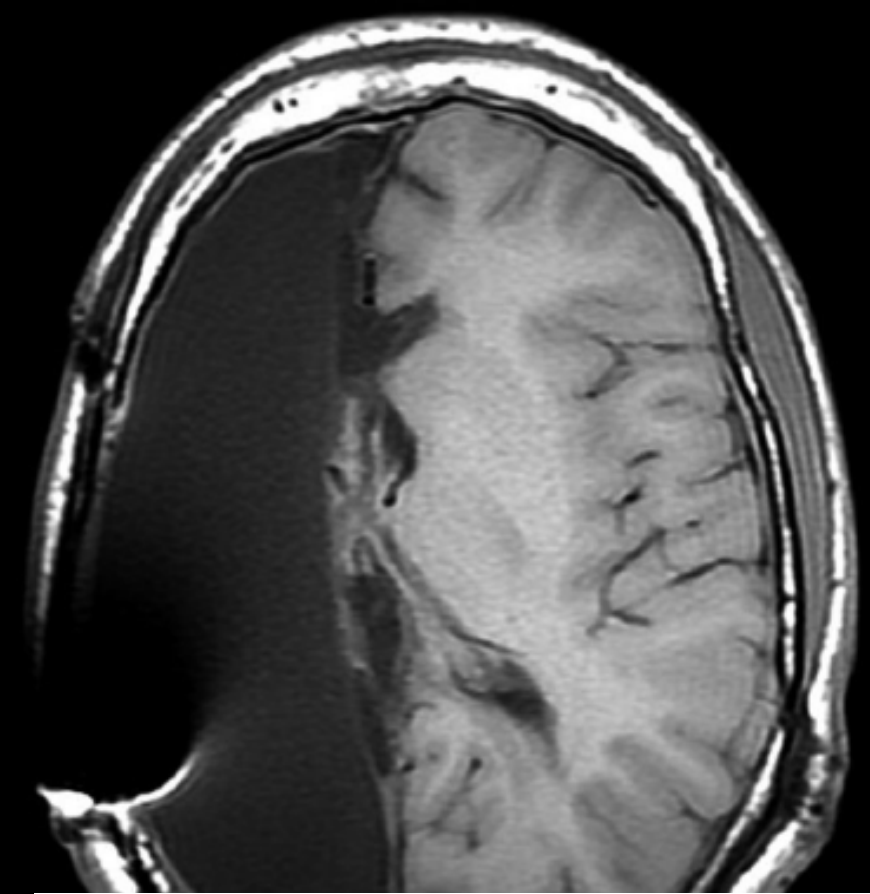
Conclusion #4

YOU CAN'T UNDERSTAND THE
HUMAN BRAIN BY STUDYING OTHER
SPECIES



THE HUMAN BRAIN





Cameron Mott

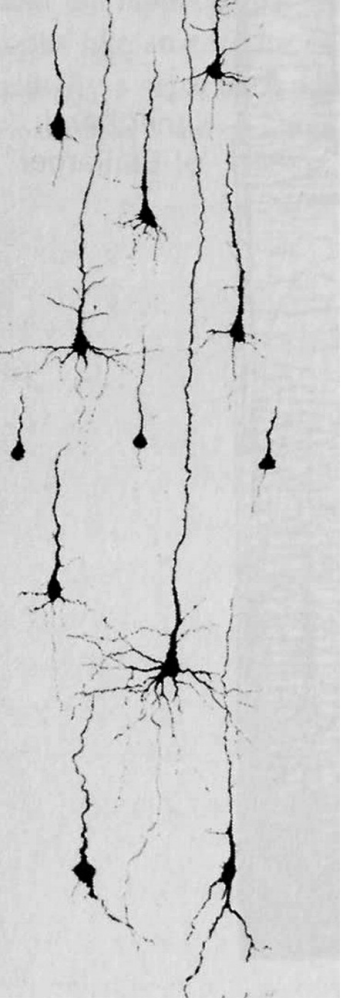


An example of reorganization after lobotomy to restore normal function. Suggests 'localization' of function is circumstantial and not intrinsic to local properties.

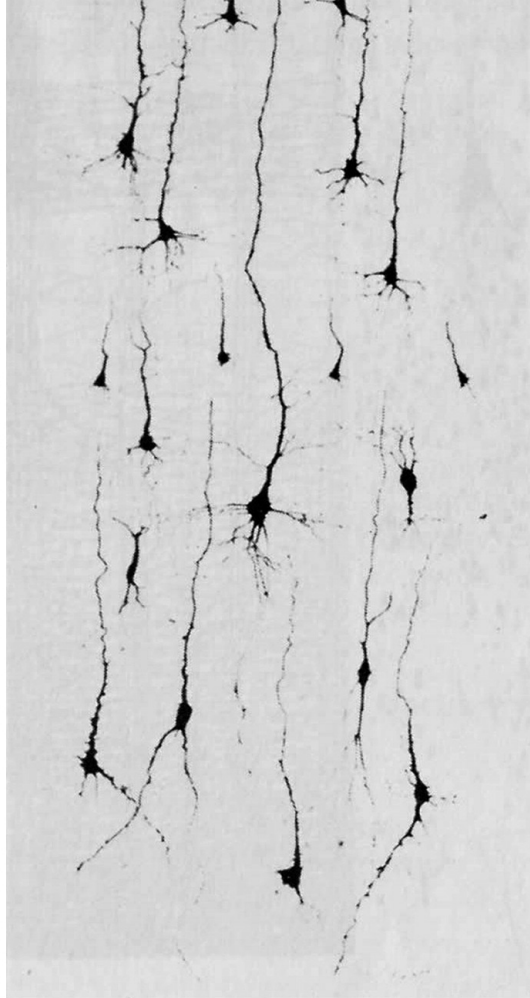


Conclusion #5

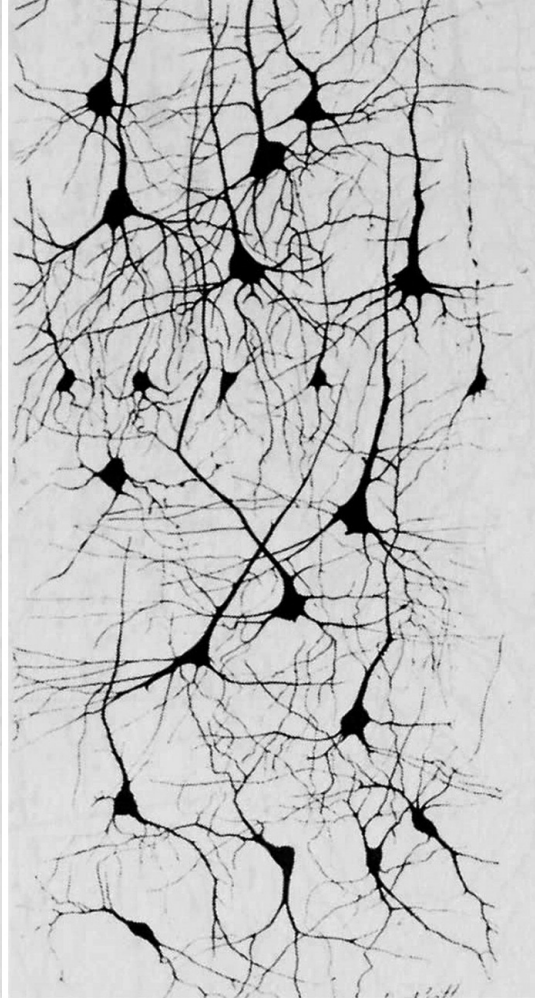
FOCUS ON DYNAMICAL FEATURES
RATHER THAN LOCALIZATION



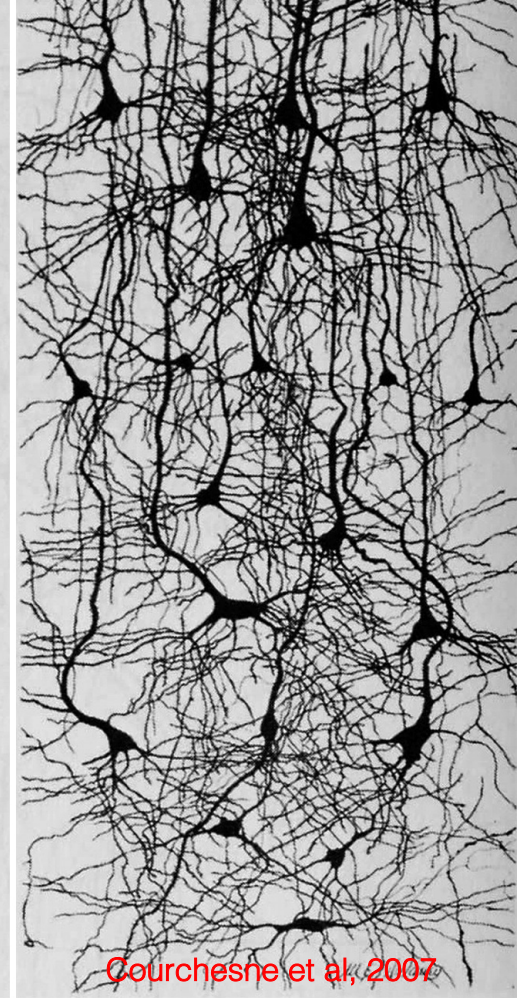
Newborn



1 month



6 months



Courchesne et al, 2007

2 years

Differences arise on every dimension



Anatomy



Structure

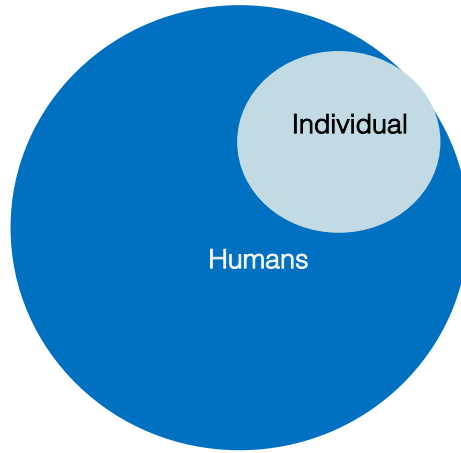


Gene Expression



Function



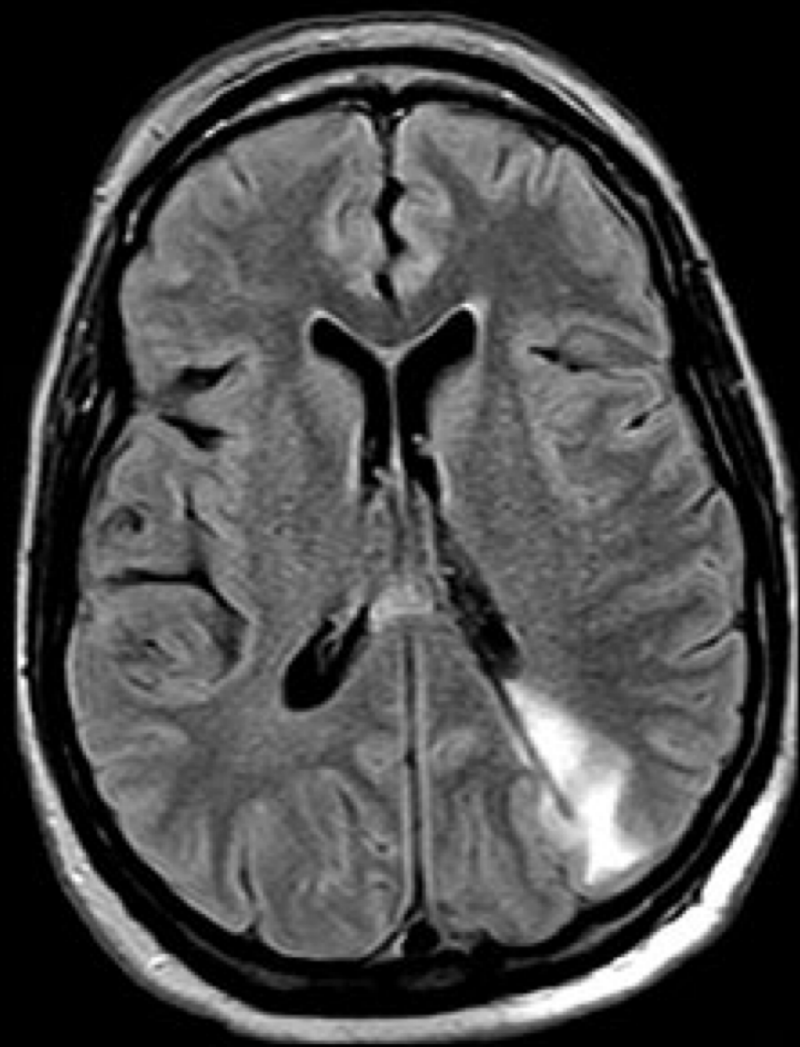


Inputs → Dynamics → Outputs



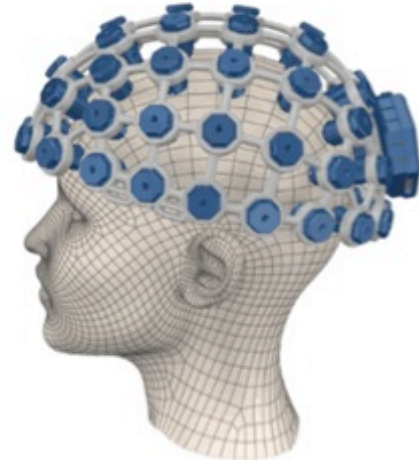


fMRI is expensive and does not allow normal activities during recording.





EEG is relatively inexpensive and does not require lying still.

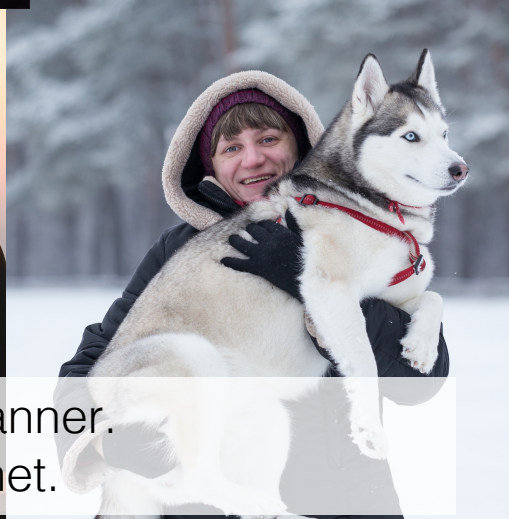


New devices are now increasingly cost effective and portable out of the lab.

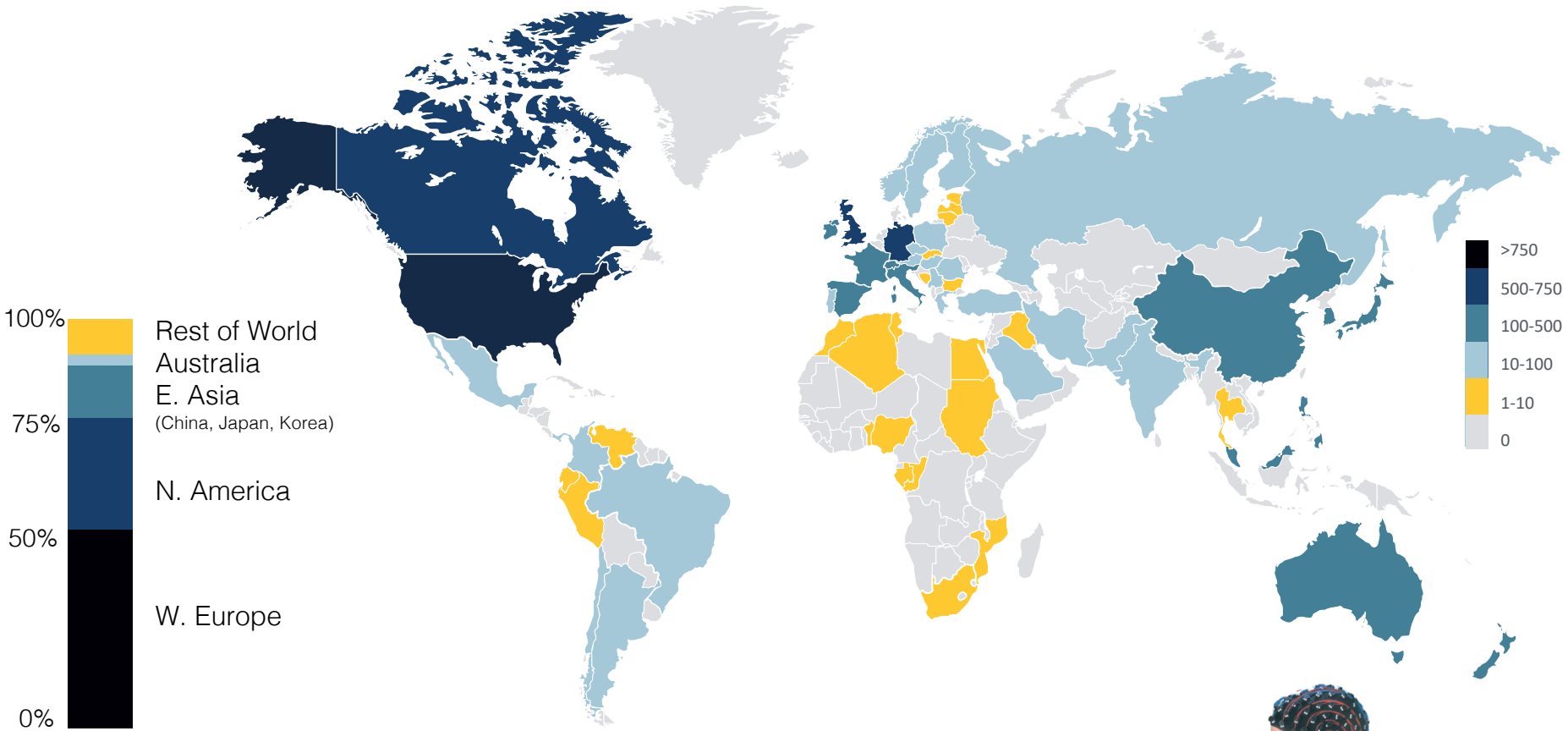


7 BILLION BRAINS

How are we different? What does it mean?



The brain wires in an experience dependent manner.
Wide range of human experience on the planet.



EEG Publications (2015)





Most human brain studies are focused on small samples of western college students that are not representative of a global humanity.

Diverging Human Experience

1700s

200 fold range of incomes

Mobility constrained by horse speed

No telecommunications

Limited energy use (wood, horsepower)

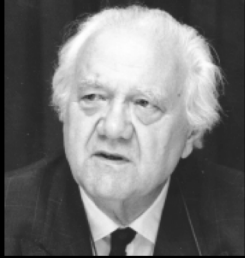
2000s

200 Million fold range of incomes

Wide range of mobility

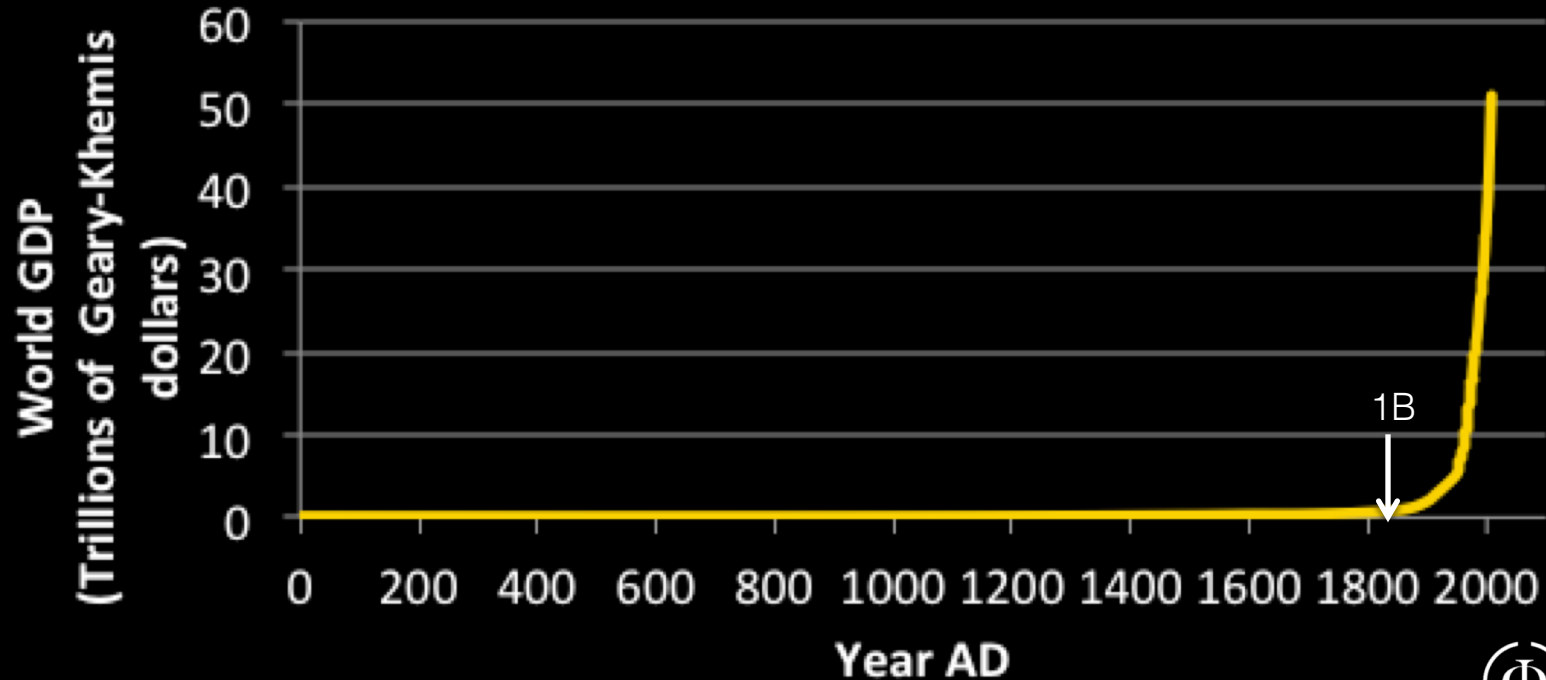
Wide range of communications

Wide range of energy use

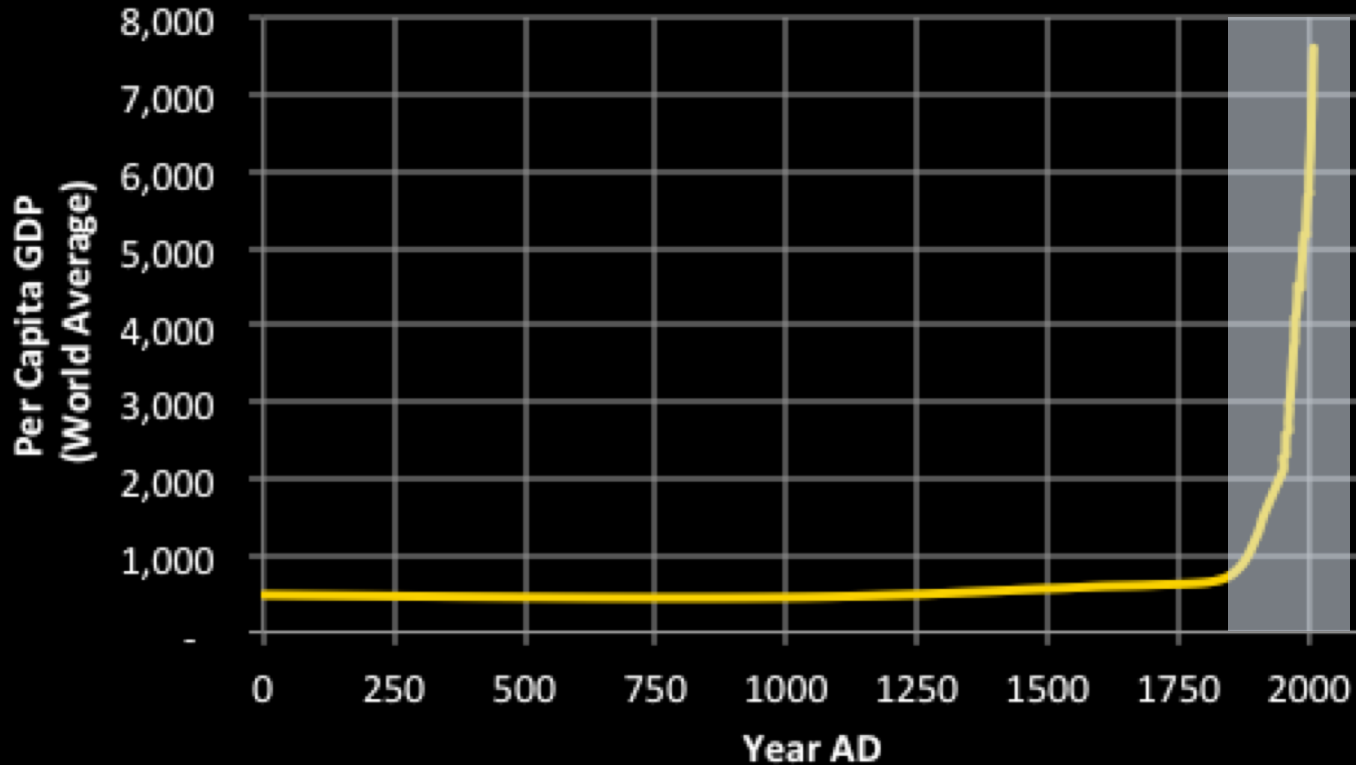


Maddison Project

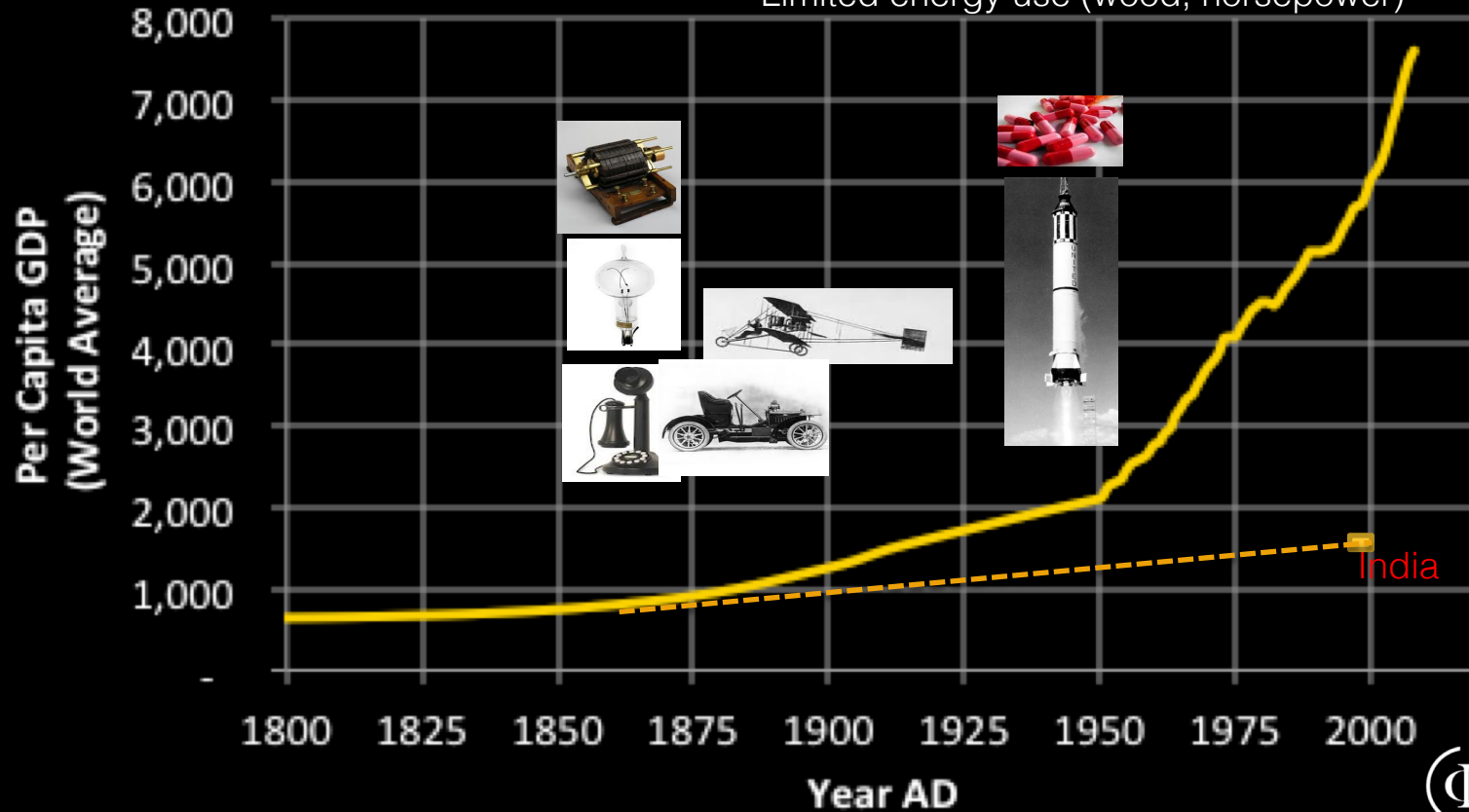
A historical and socioeconomic context for human experience (and therefore divergence of experience dependent brain function)



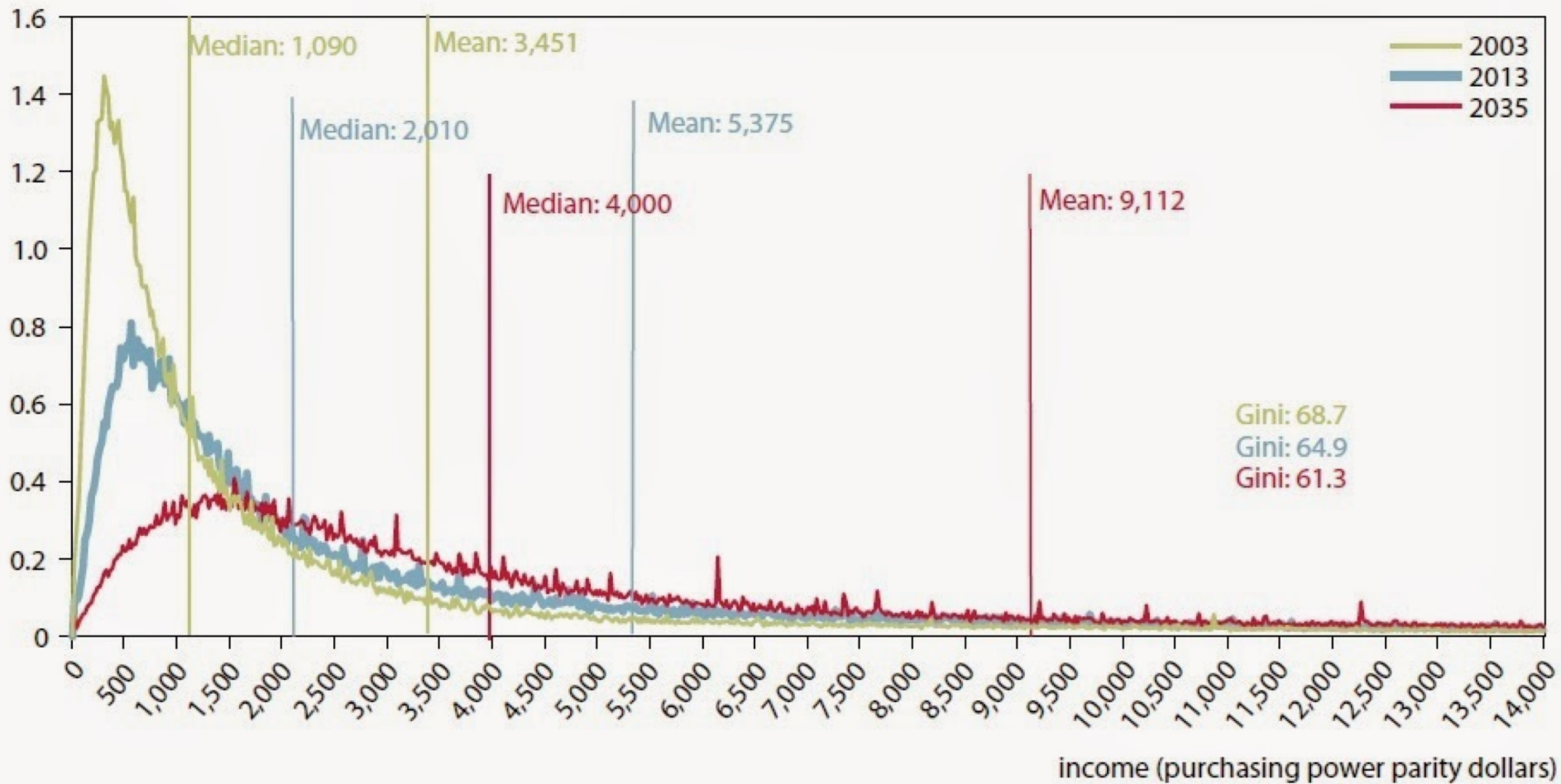
Per Capita GDP

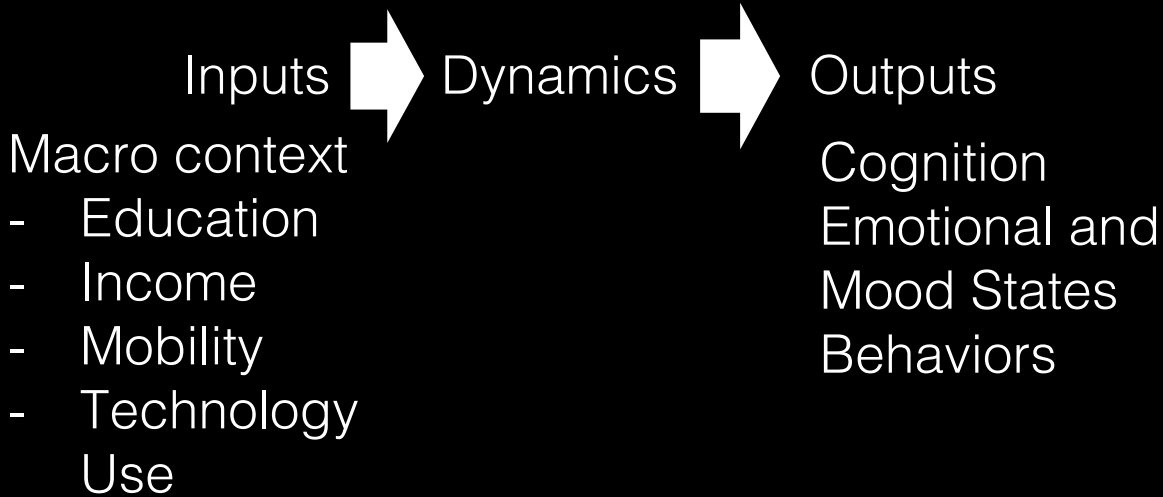


1700s
200 fold range of incomes
Mobility constrained by horse speed
No telecommunications
Limited energy use (wood, horsepower)



percent of world population







MODERNIZATION AND THE HUMAN BRAIN



The India Study

500 people across
48 settlements (populations of 300 to 6 million, 20,000x)

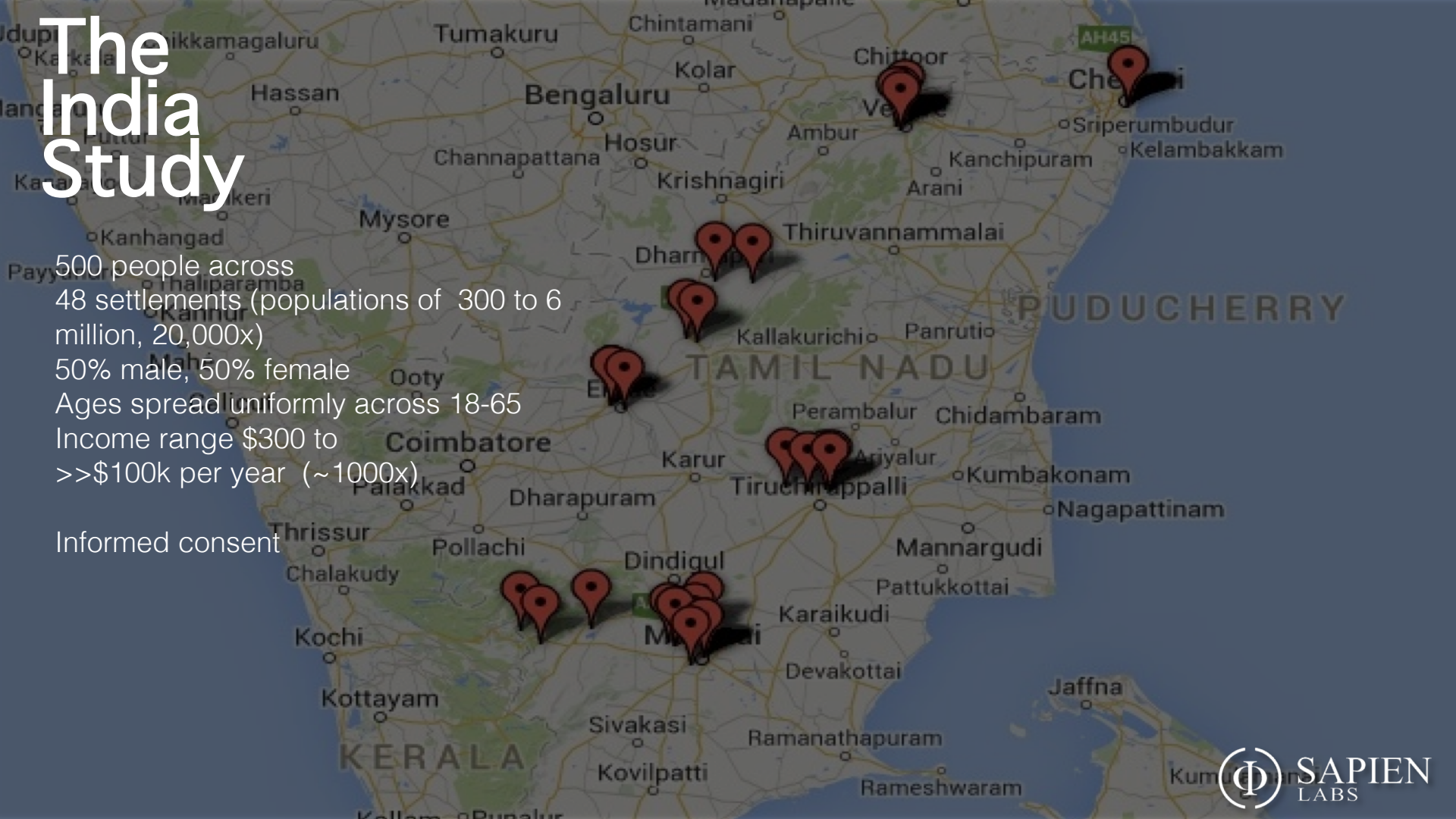
50% male, 50% female

Ages spread uniformly across 18-65

Income range \$300 to

>>\$100k per year (~1000x)

Informed consent



Recording Life Experience

Income
Education
Communication
Mobility
Energy Use
[Diet]

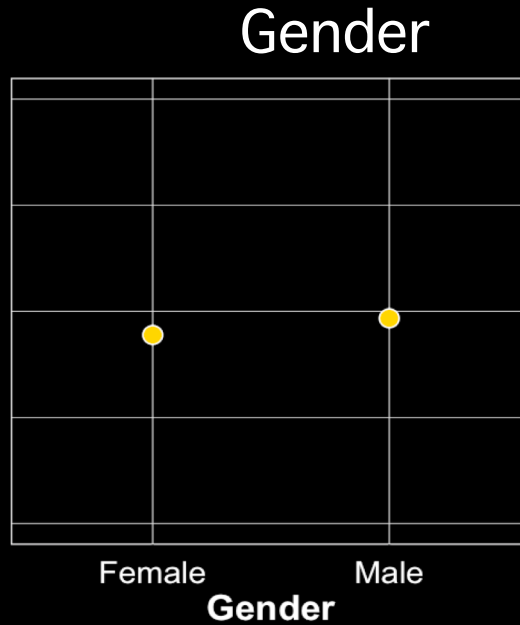
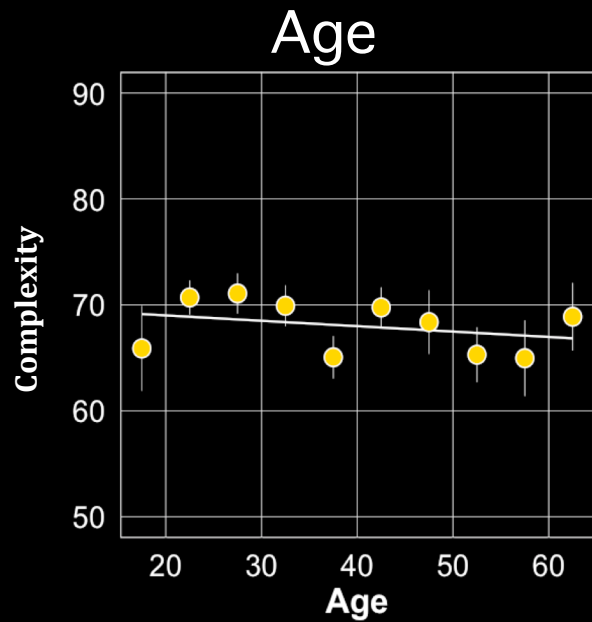


The Experimental Paradigm

3 minutes of spontaneous activity when the participant
was still with their eyes closed
Using the Emotiv Epoc



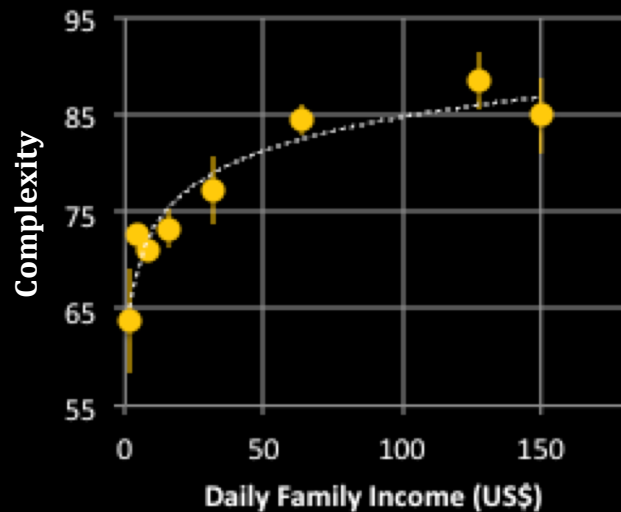
Complexity



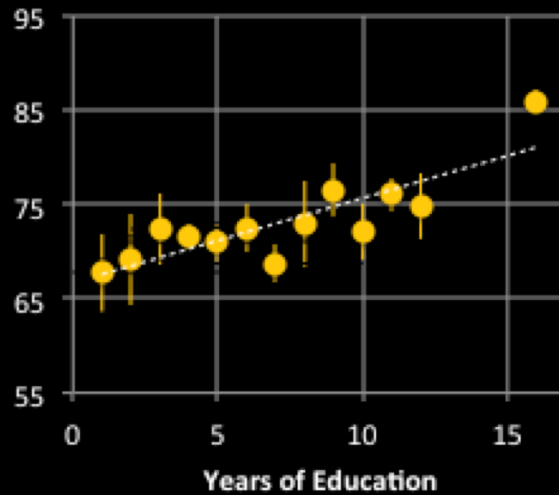
mean +/- SEM

Complexity

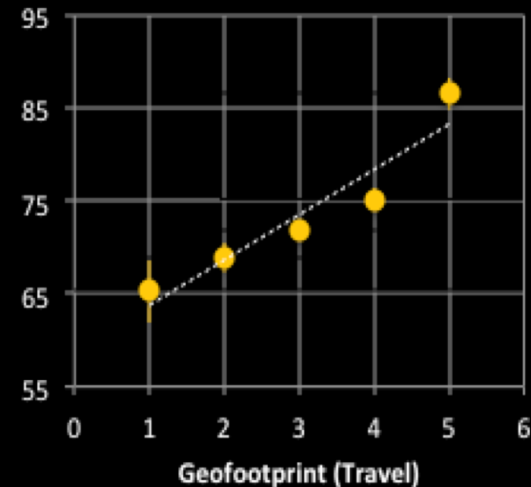
Income



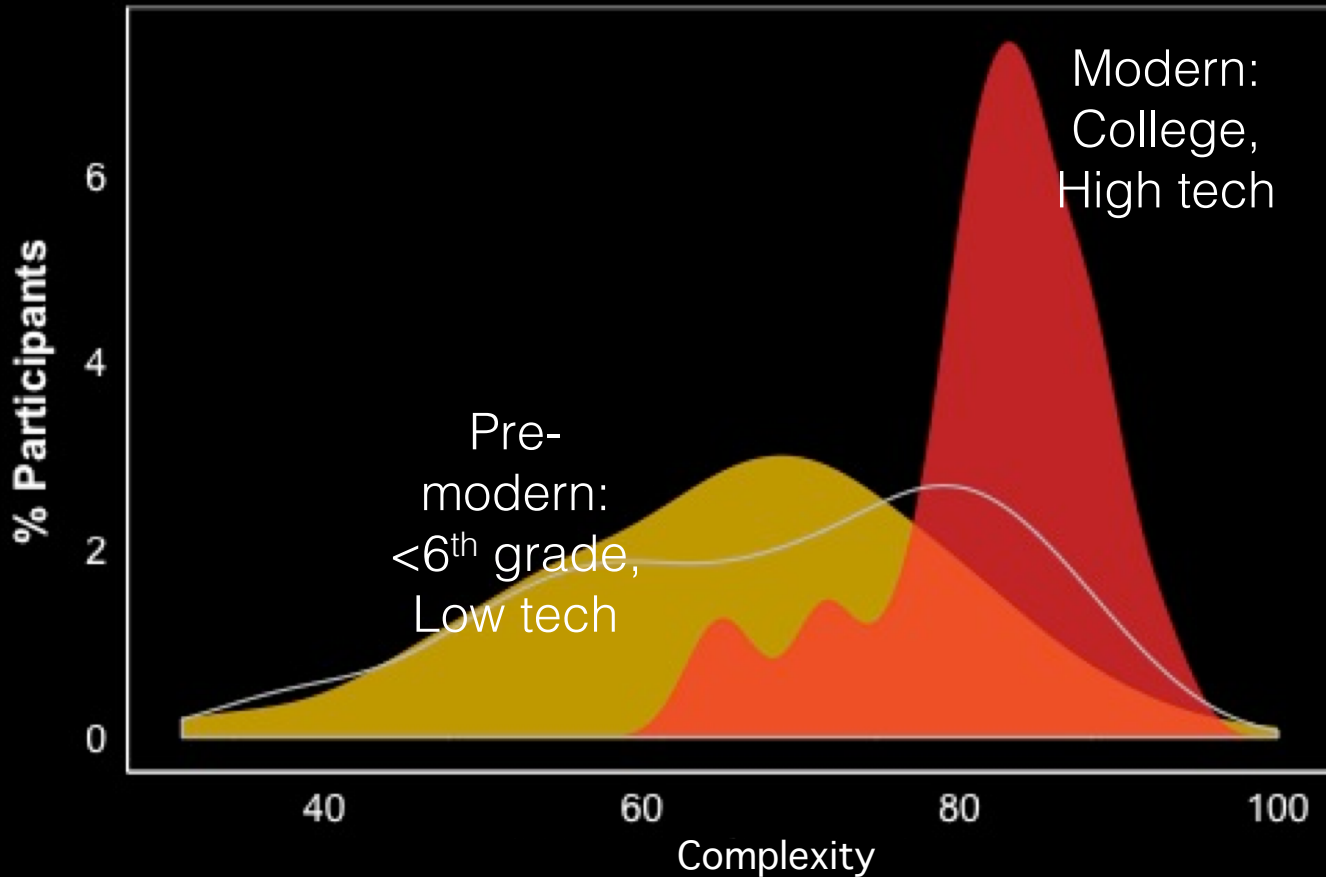
Education



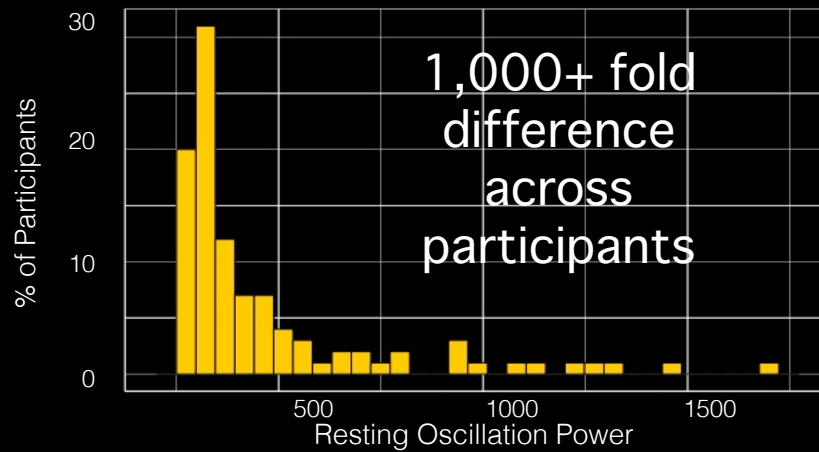
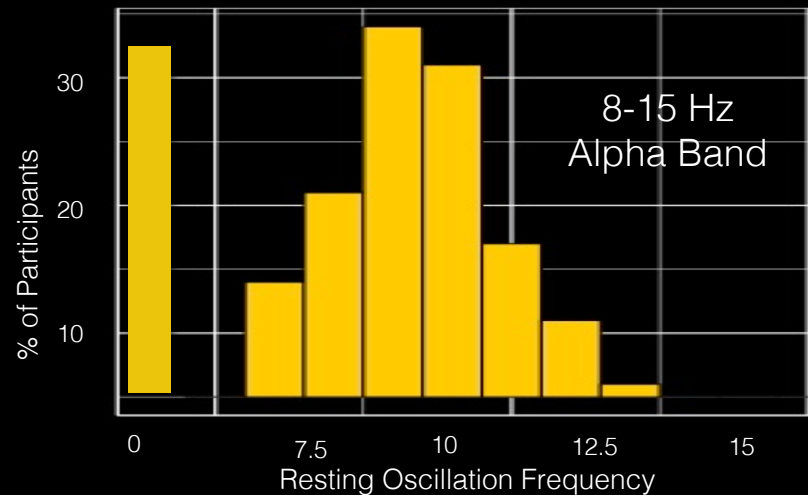
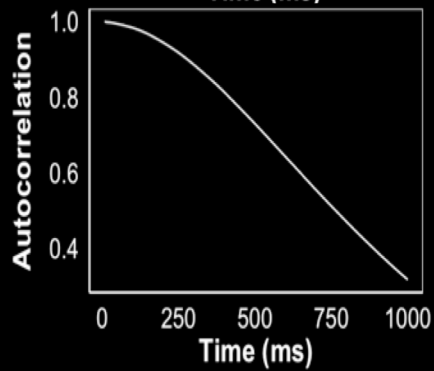
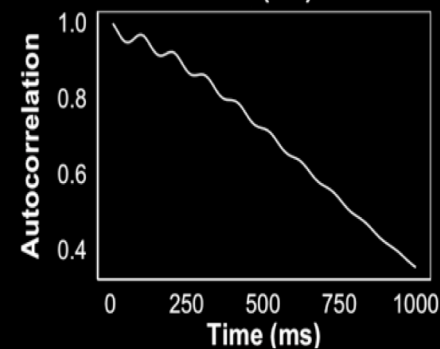
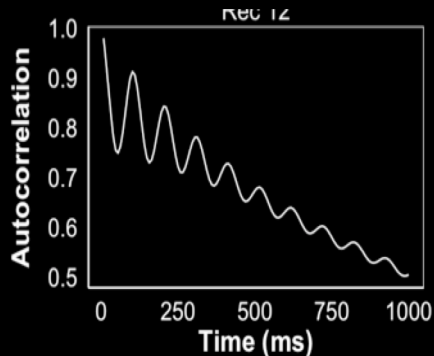
Geofootprint



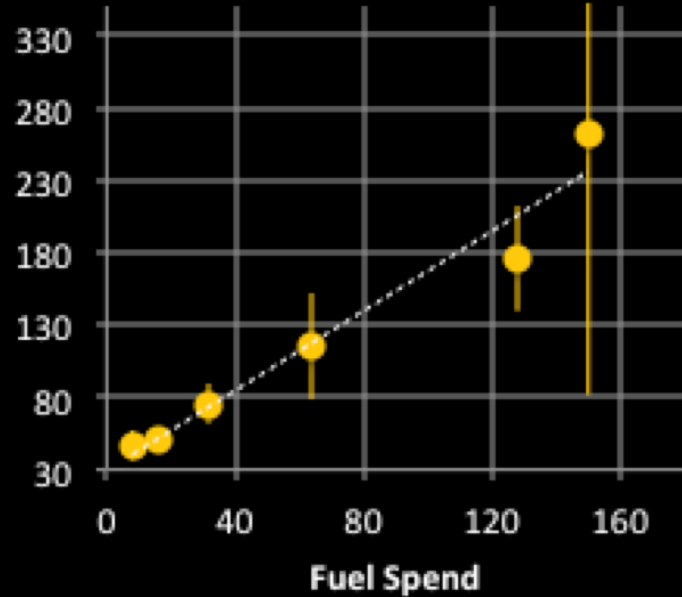
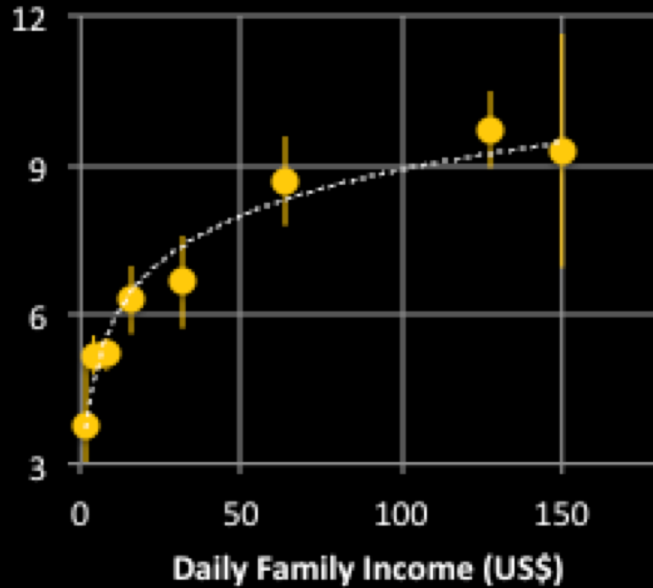
Complexity



Alpha Oscillation



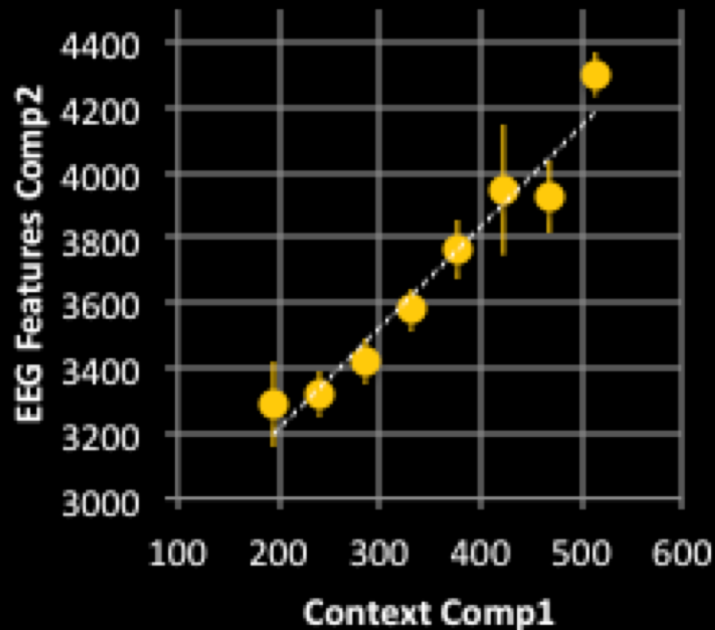
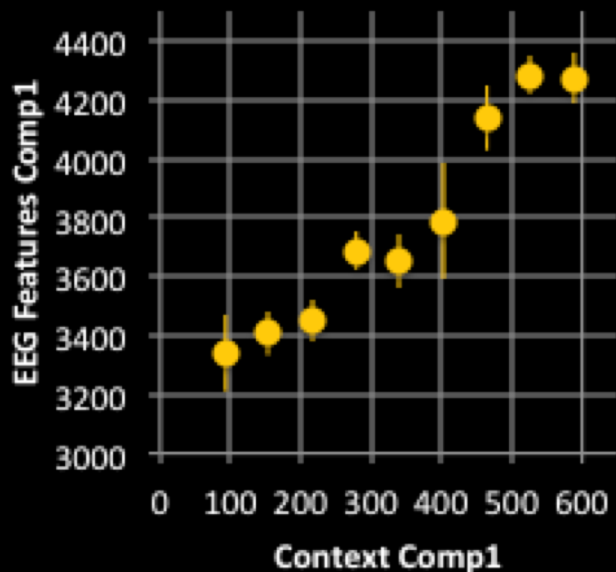
Alpha Oscillation



mean +/- SEM

EEG Scales with Life Context

Principal Component Analysis





WHAT IS NORMAL? IS THERE SUCH A THING AS 'NORMAL'?

What does it mean when an organ's function
diverges so profoundly within the same species?

Sathish

Dhanya

Aravind
Govind

Management and staff of
Madura Microfinance
SciSphere team



THANK YOU



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