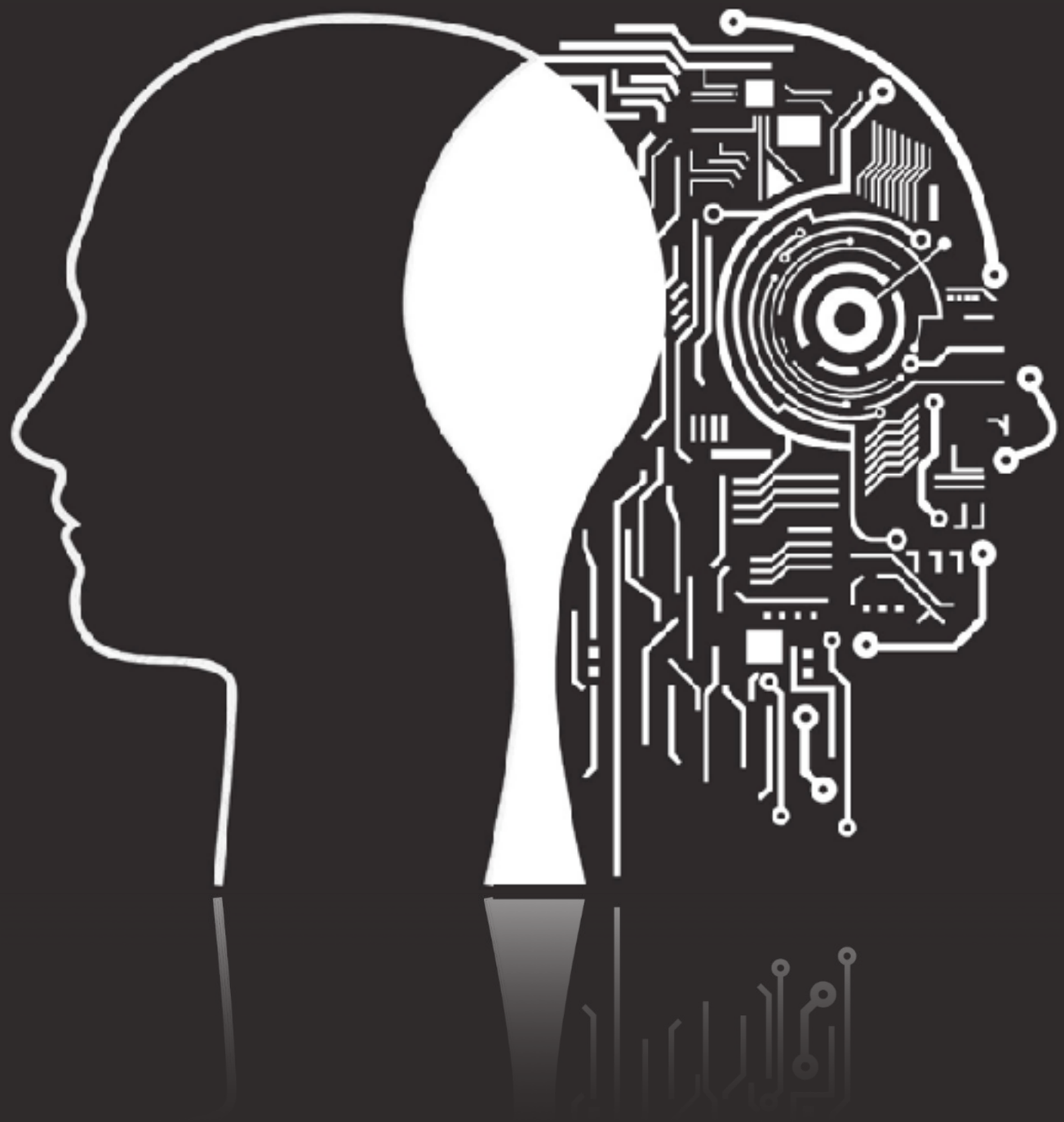
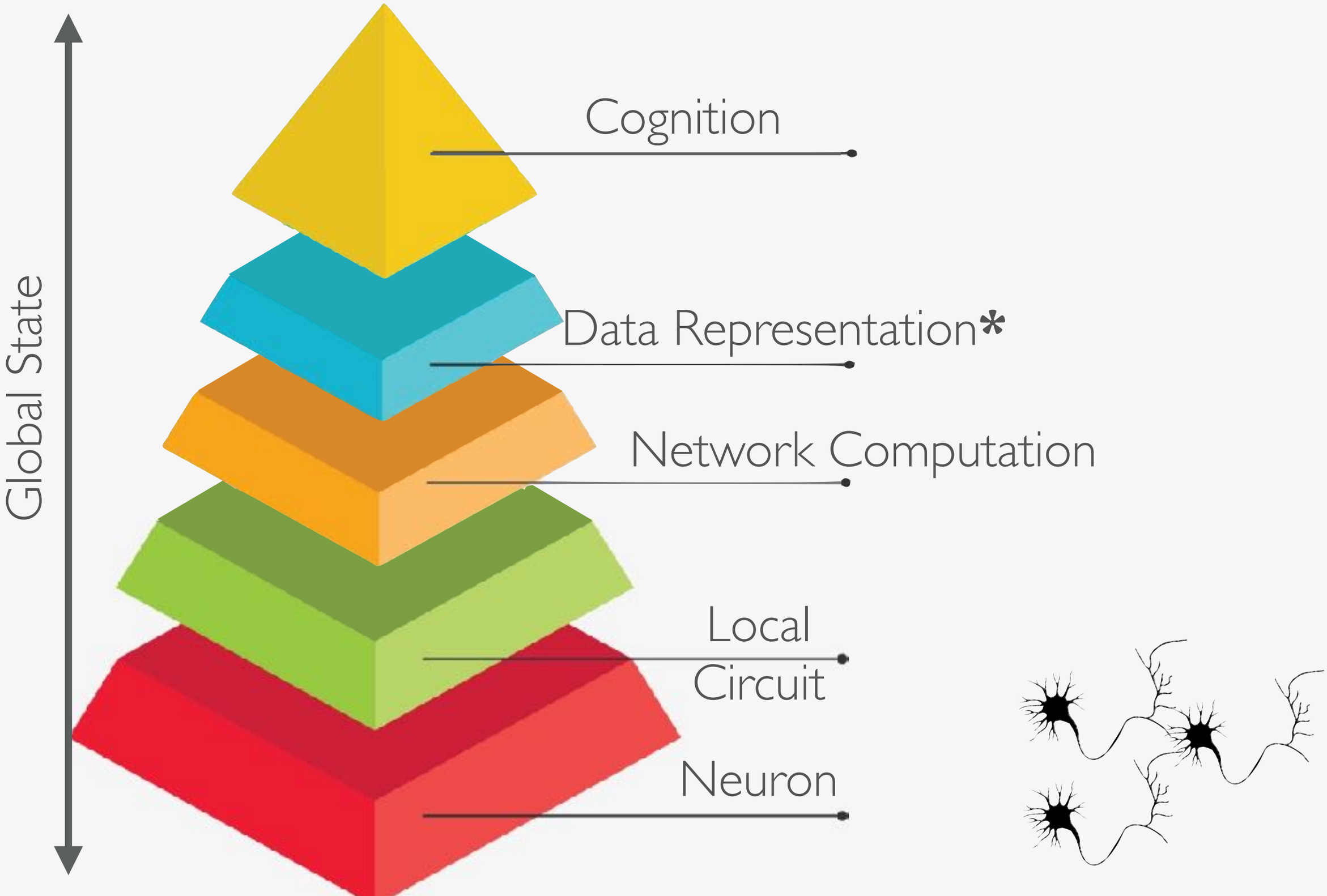
LEARNING POSITION AND OBJECT IDENTITY AS A MODEL OF VISUAL PROCESSING



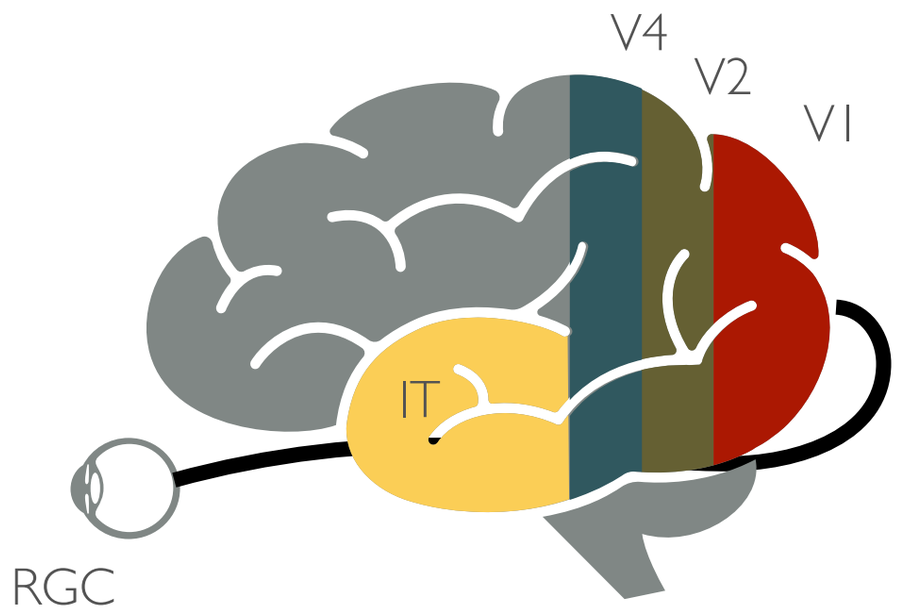
Elijah Christensen - 2020 Feb 5

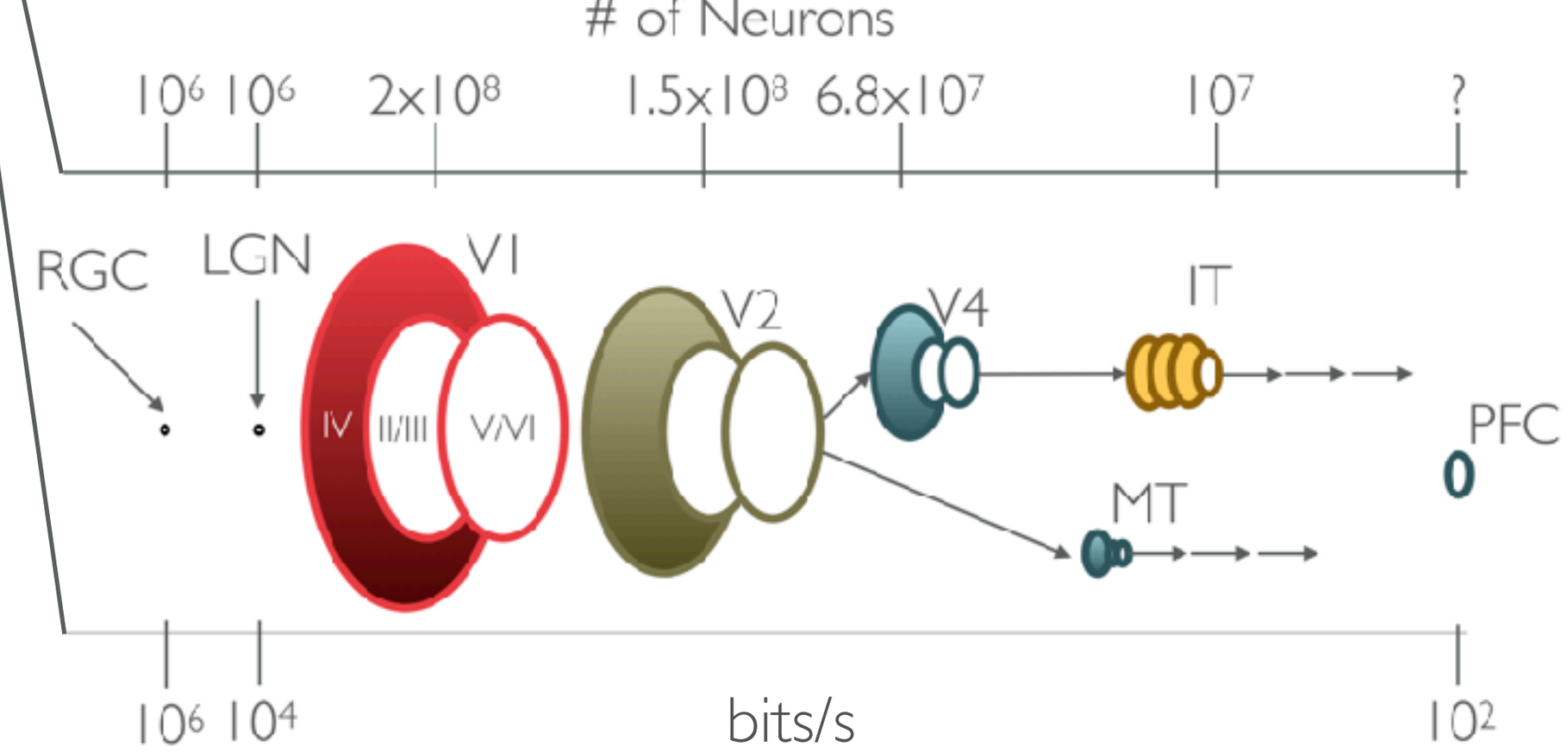
HEIRARCHICAL STRUCTURE OF NEURONAL CIRCUITS IN THE BRAIN



COMPRESSED REPRESENTATIONS ARE IMPORTANT

Sense	Bitrate
Vision	10 Mbps
Touch	1 Mbps
Hearing	100 Kbps
Smell	100 Kbps
Taste	1 Kbps
Total	11 Mbps



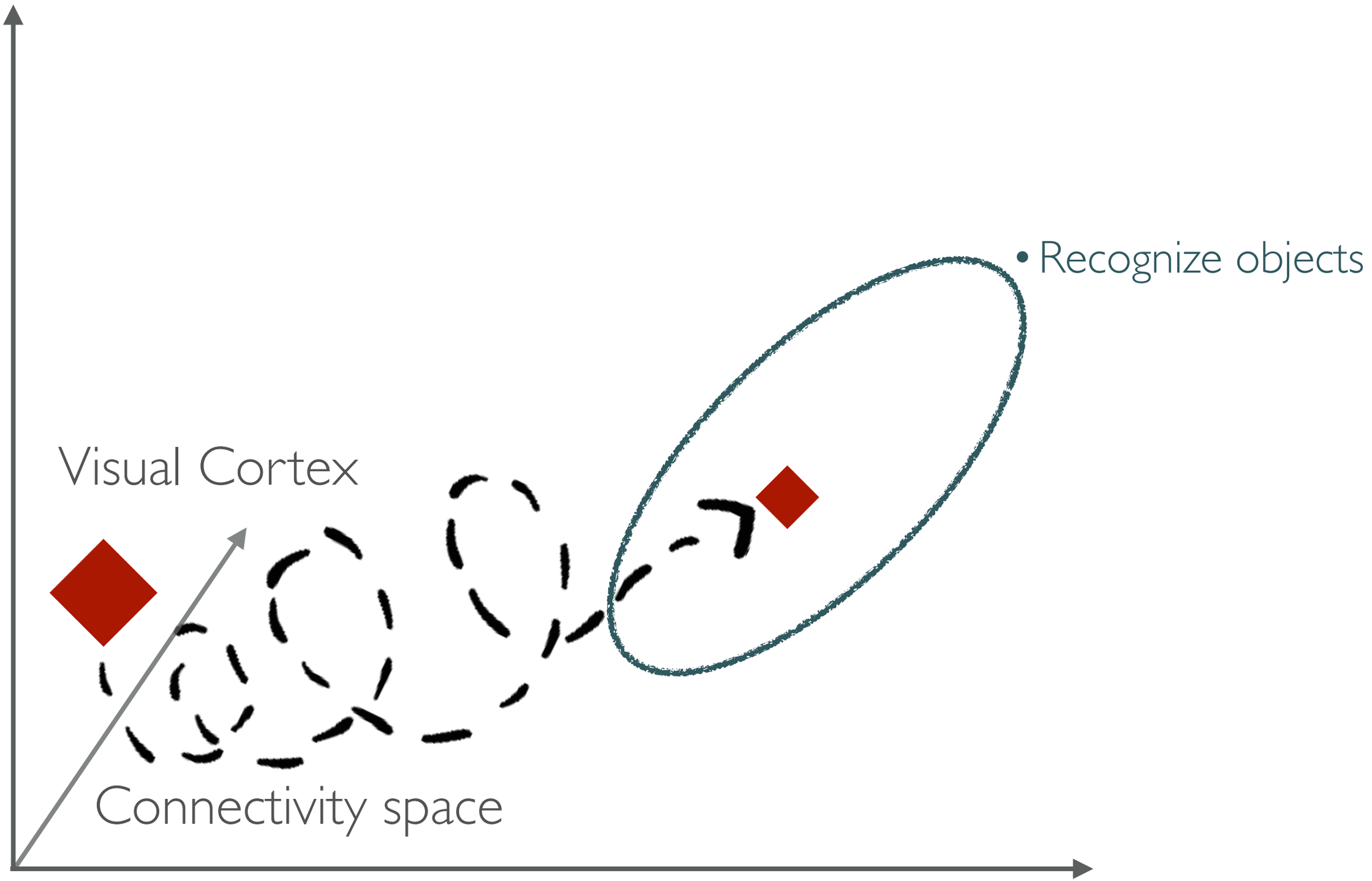


Brainwide Connectivity
10^{15} bits

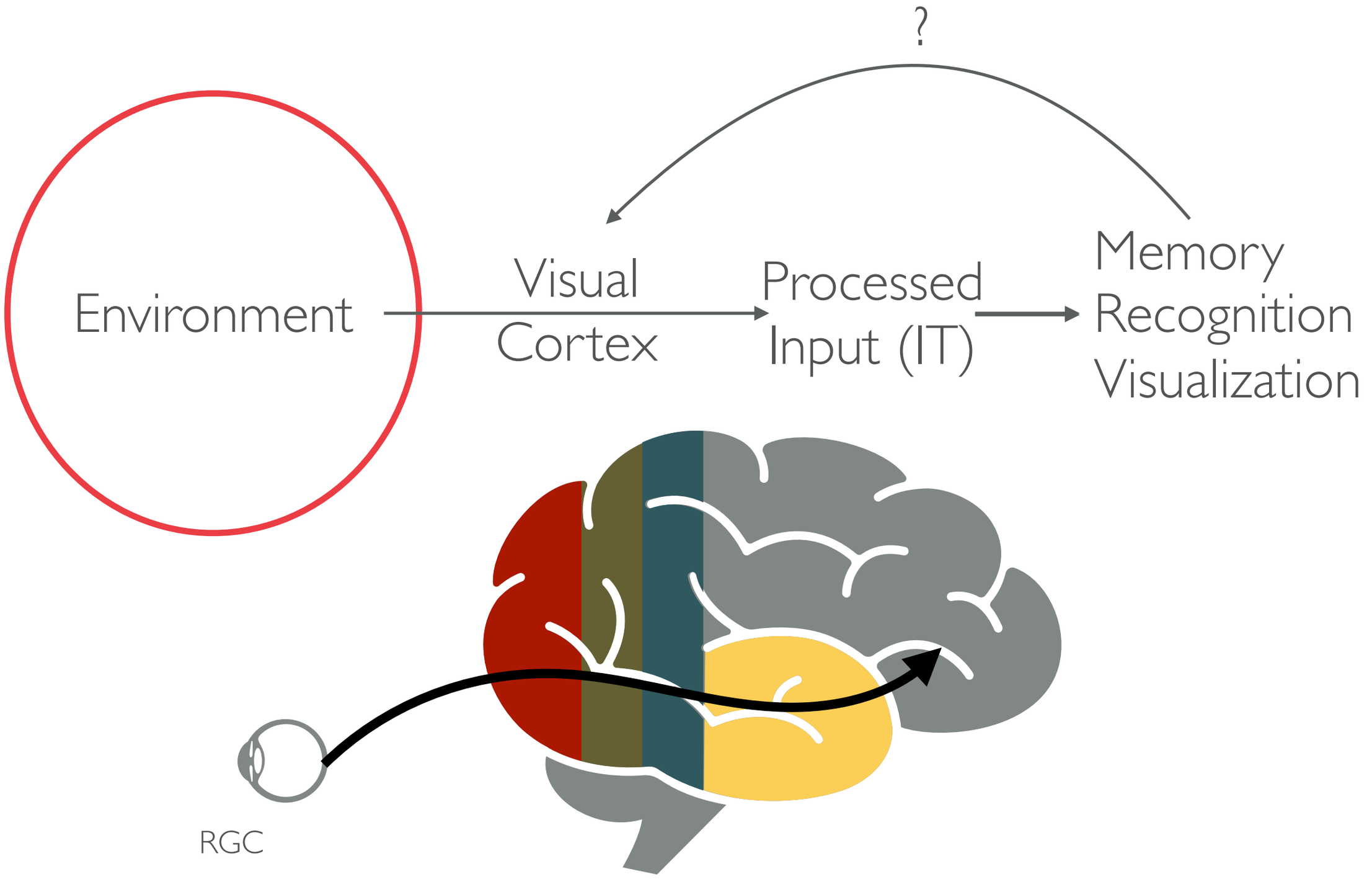
Genomic Capacity
10^{9} bits

Encyclopedia Brittanica

FRAMEWORK FOR VISUAL LEARNING

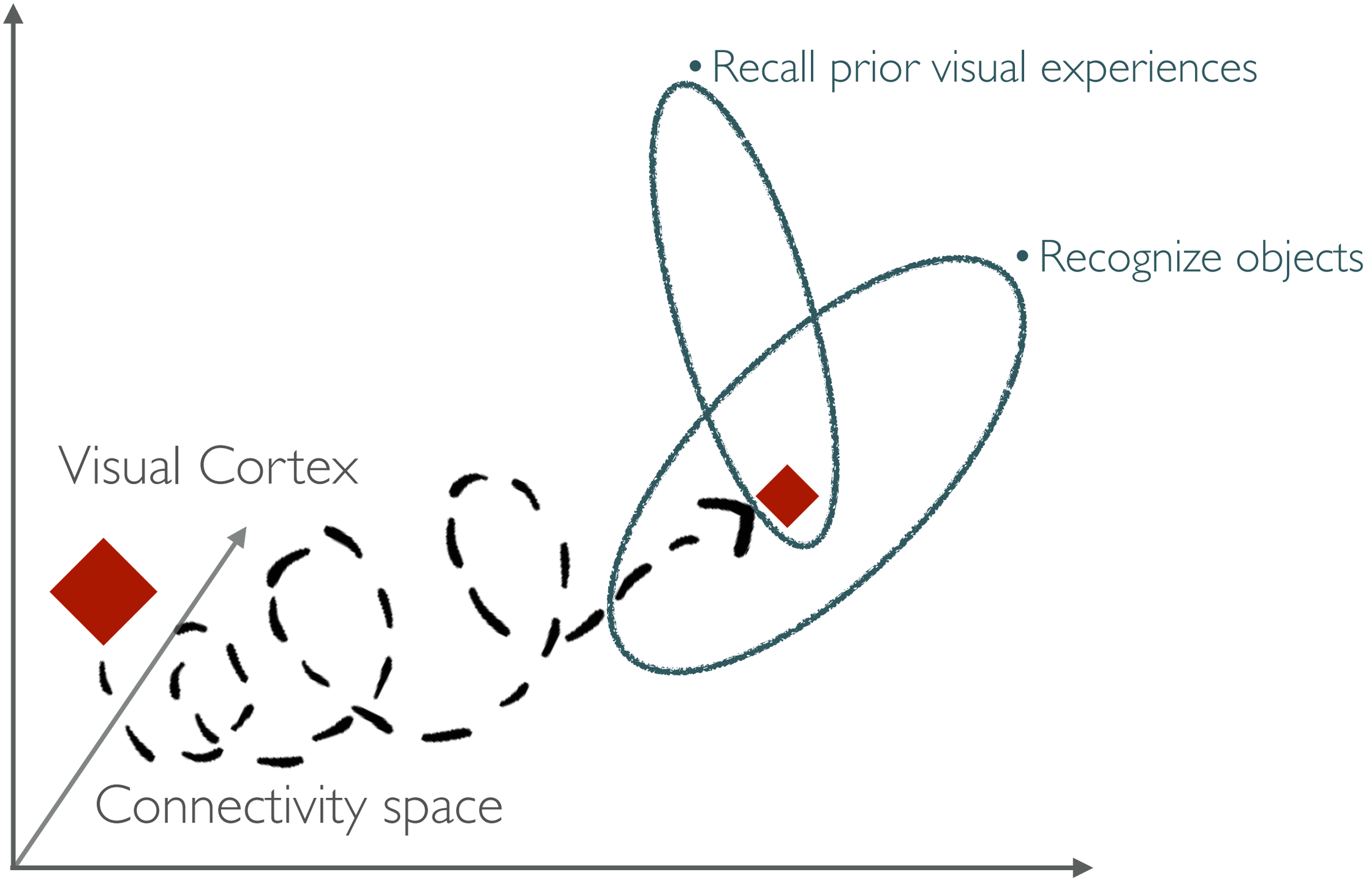


HOW DOES THE VISUAL CORTEX EXTRACT THE RIGHT INFORMATION

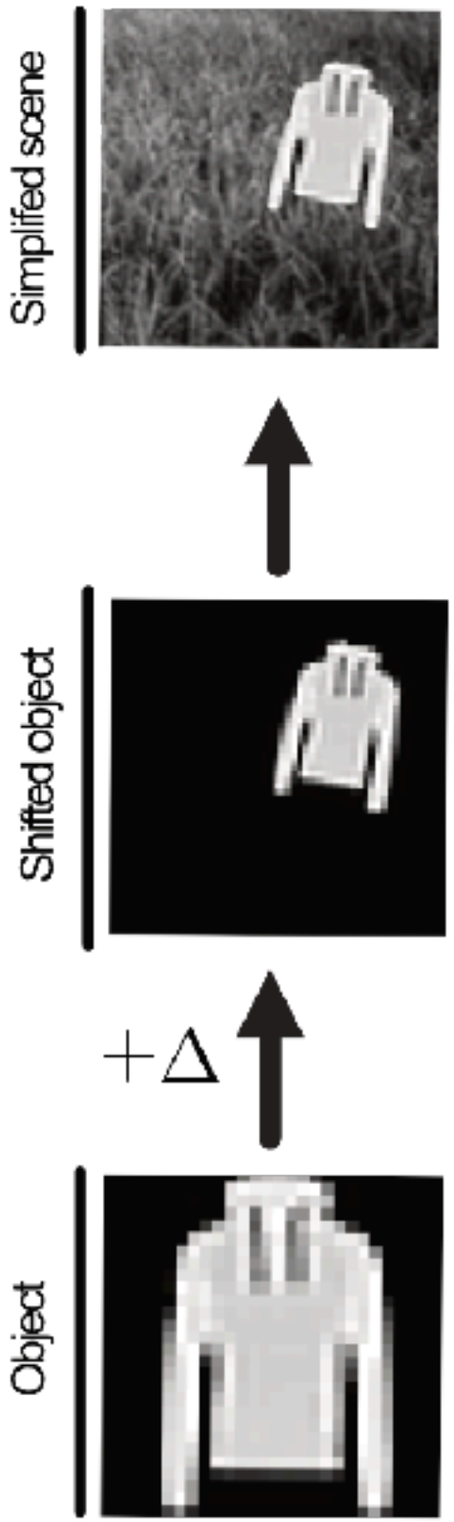


Stokes, M., Thompson, R., Cusack, R. & Duncan, J. *J. Neurosci.* **29**, 1565–1572 (2009).
O'Craven, K.M. & Kanwisher, N. *J Cogn Neurosci* **12**, 1013–1023 (2000).
Freud, E., Plaut, D.C. & Behrmann, M. *Trends in Cognitive Sciences* **20**, 773–784 (2016).
Sereno, A.B. & Lehky, S.R. *Front Comput Neurosci* **4**, 159 (2011).

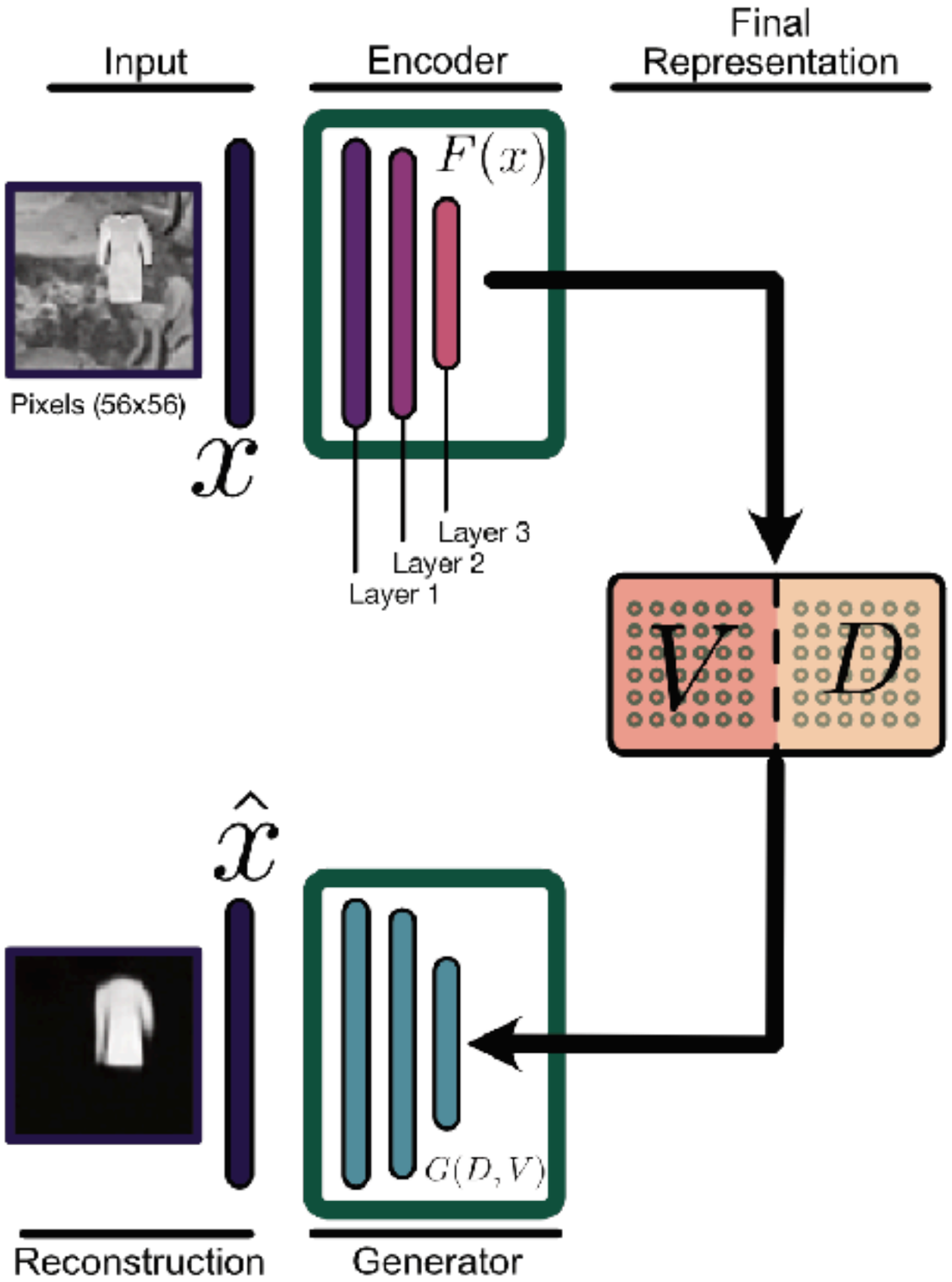
FRAMEWORK FOR VISUAL LEARNING



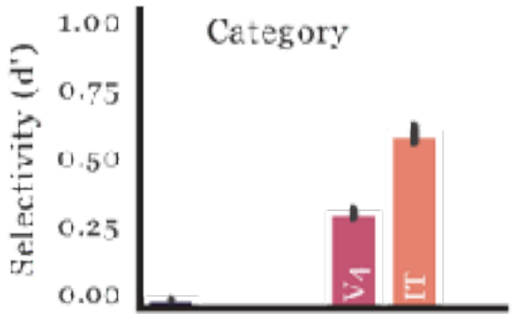
THE MODEL - VISUAL PROCESSING AS AN AUTO ENCODER

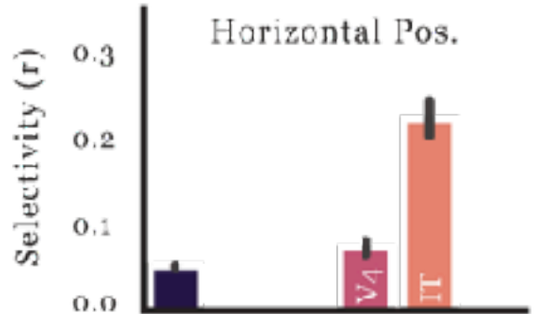


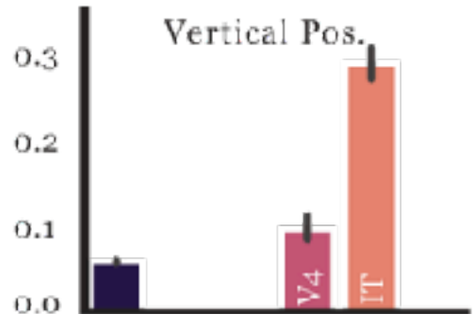
THE MODEL - VISUAL PROCESSING AS AN AUTO ENCODER



SELECTIVITY FOR VISUAL SCENE PROPERTIES







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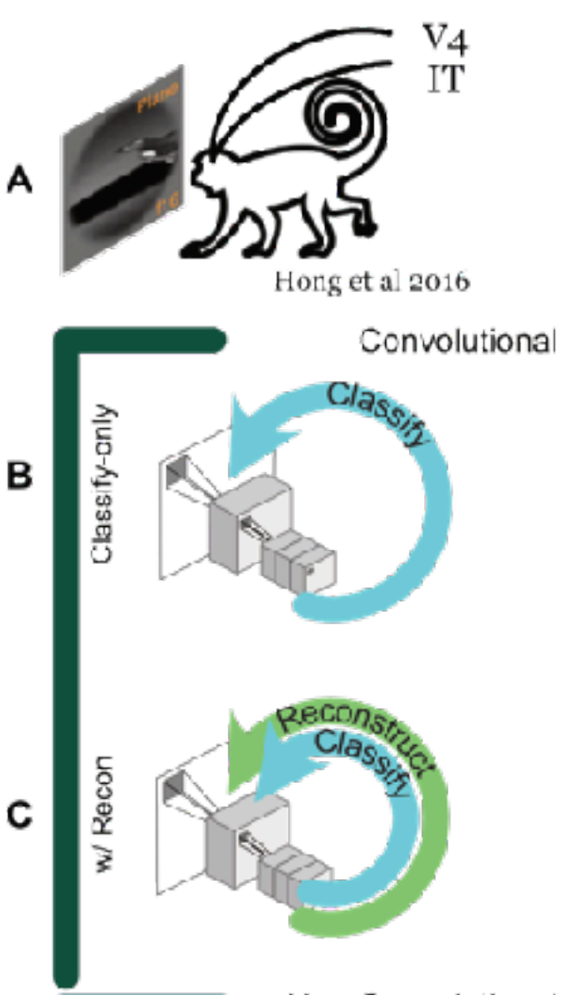

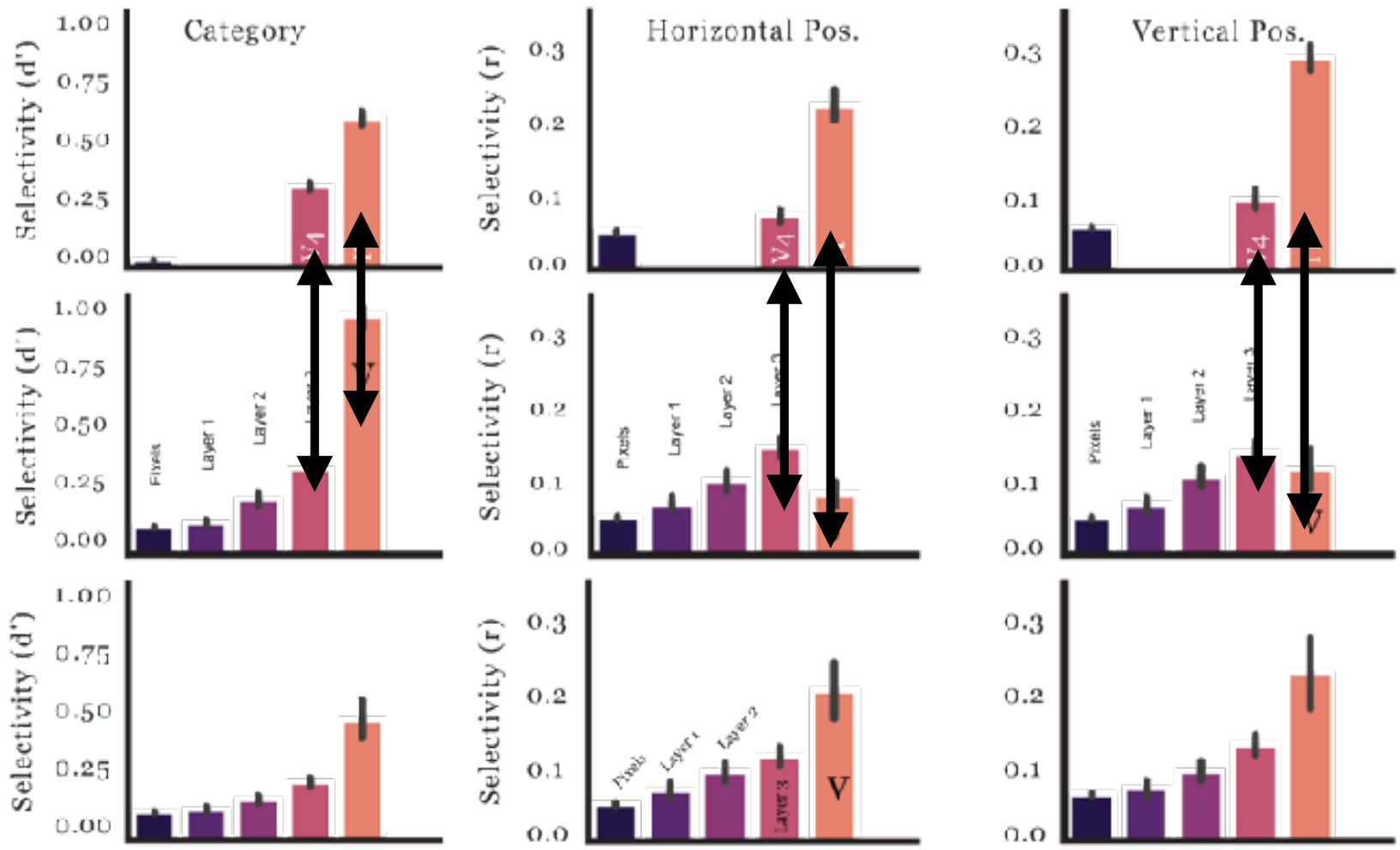

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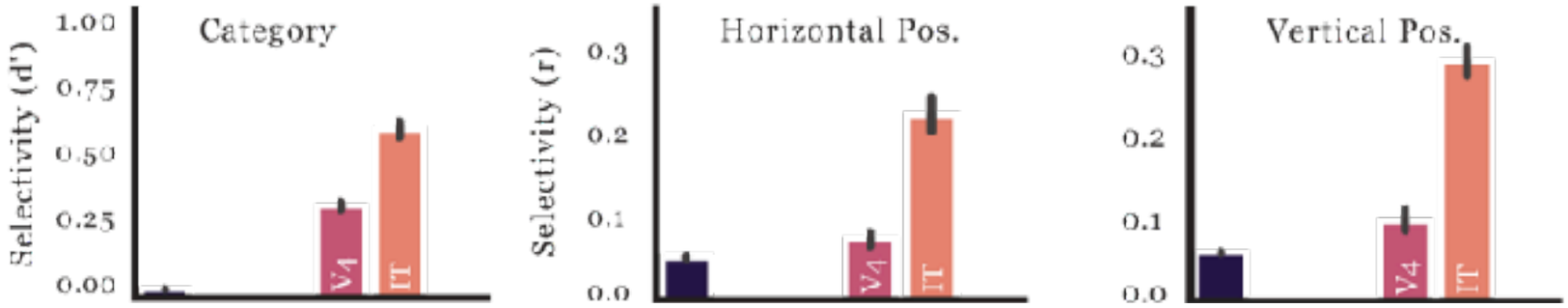
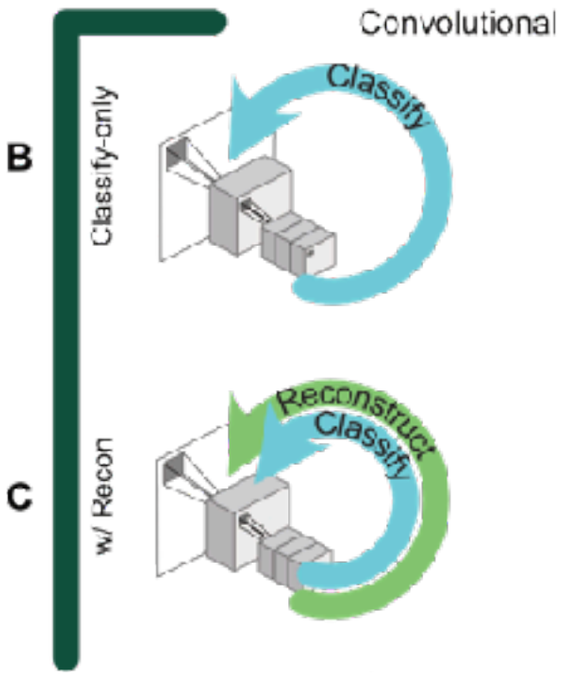
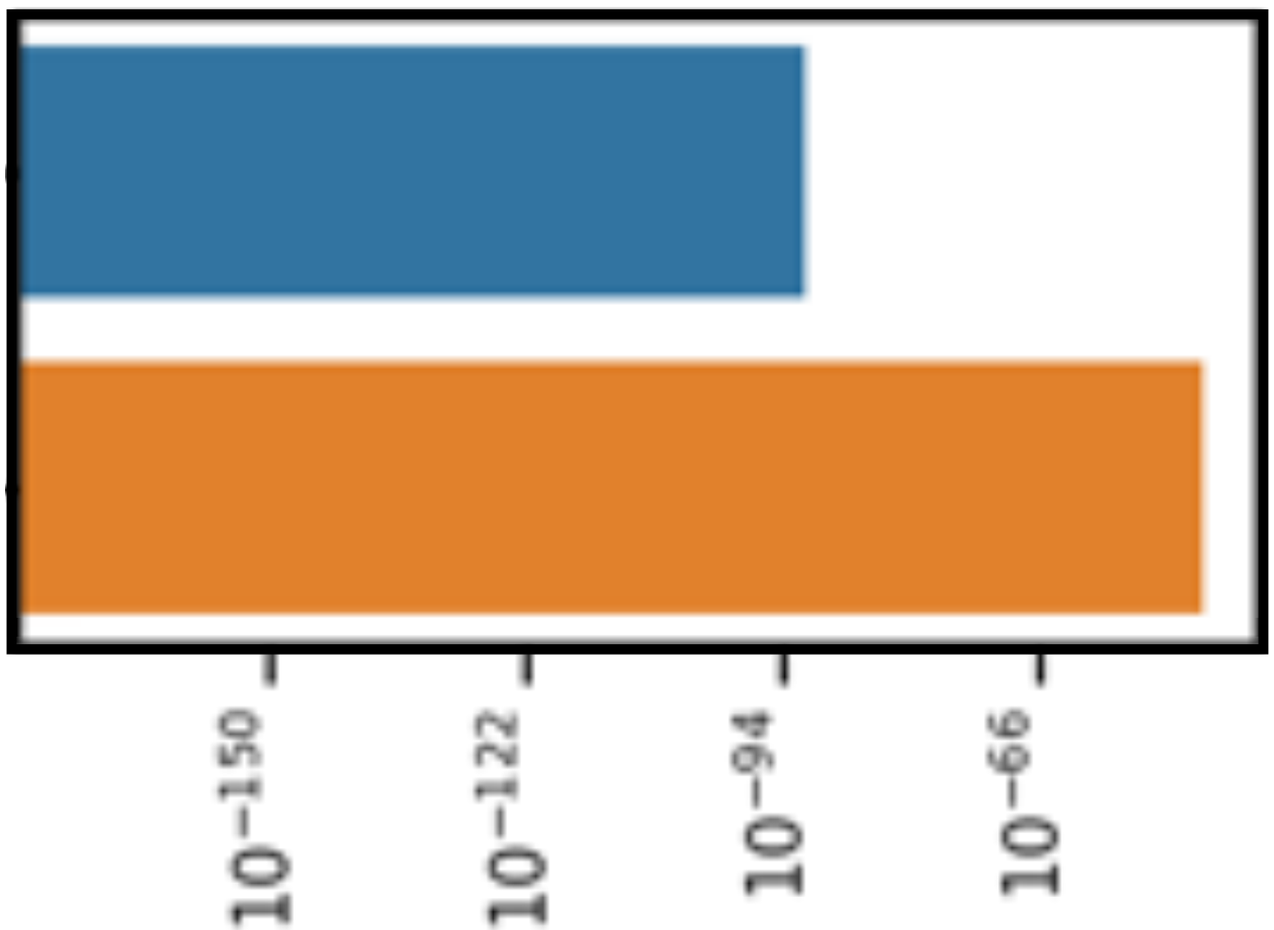
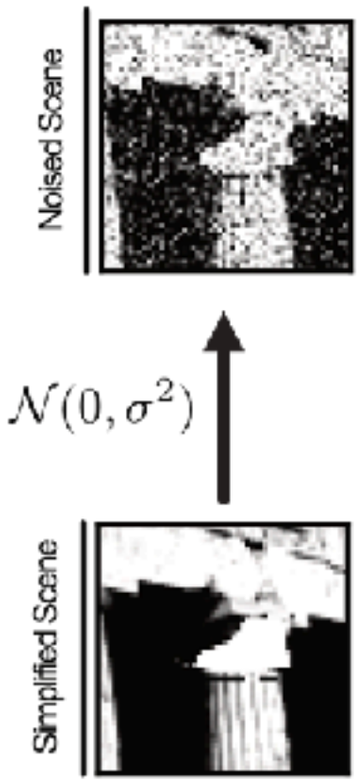




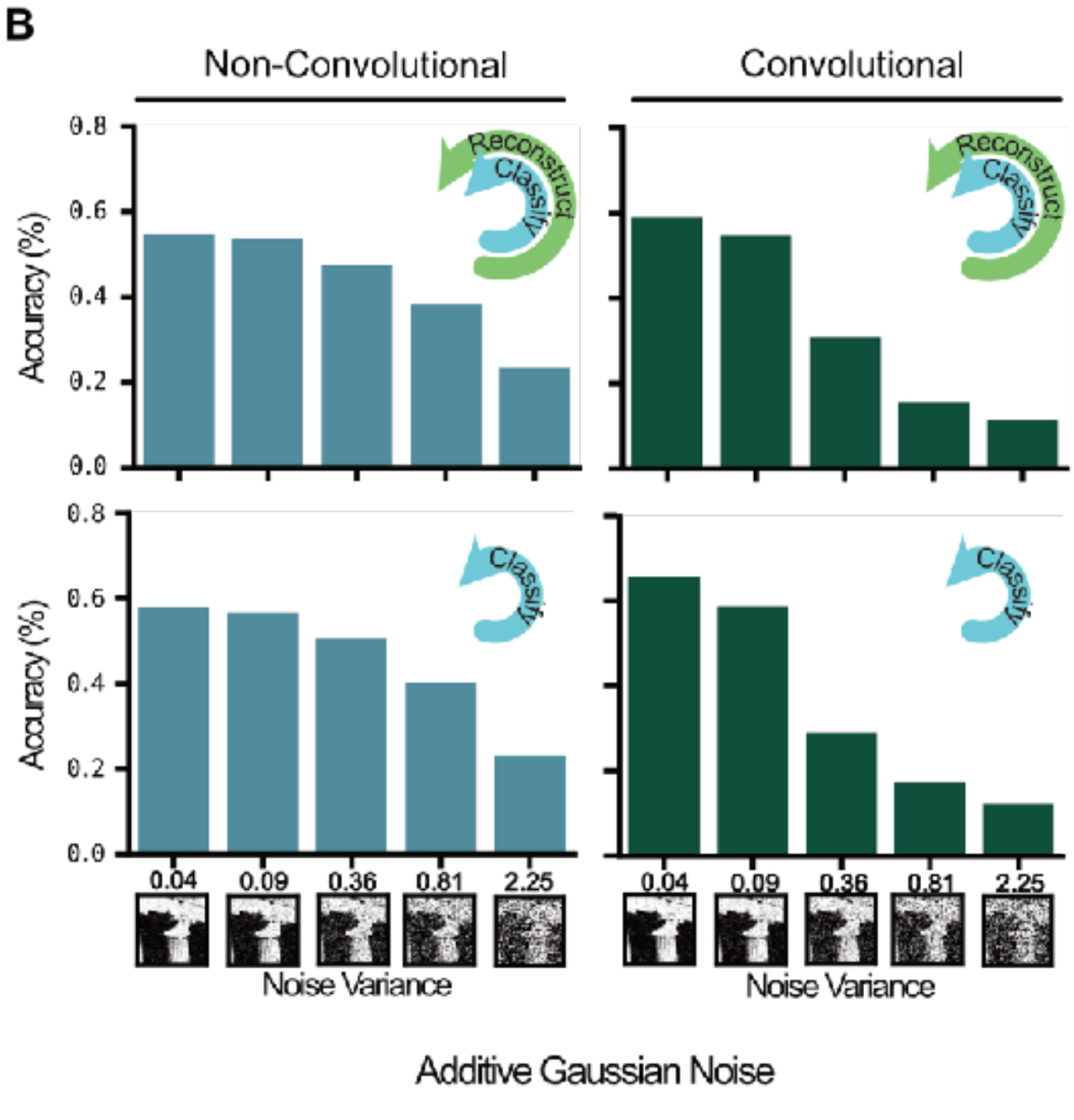


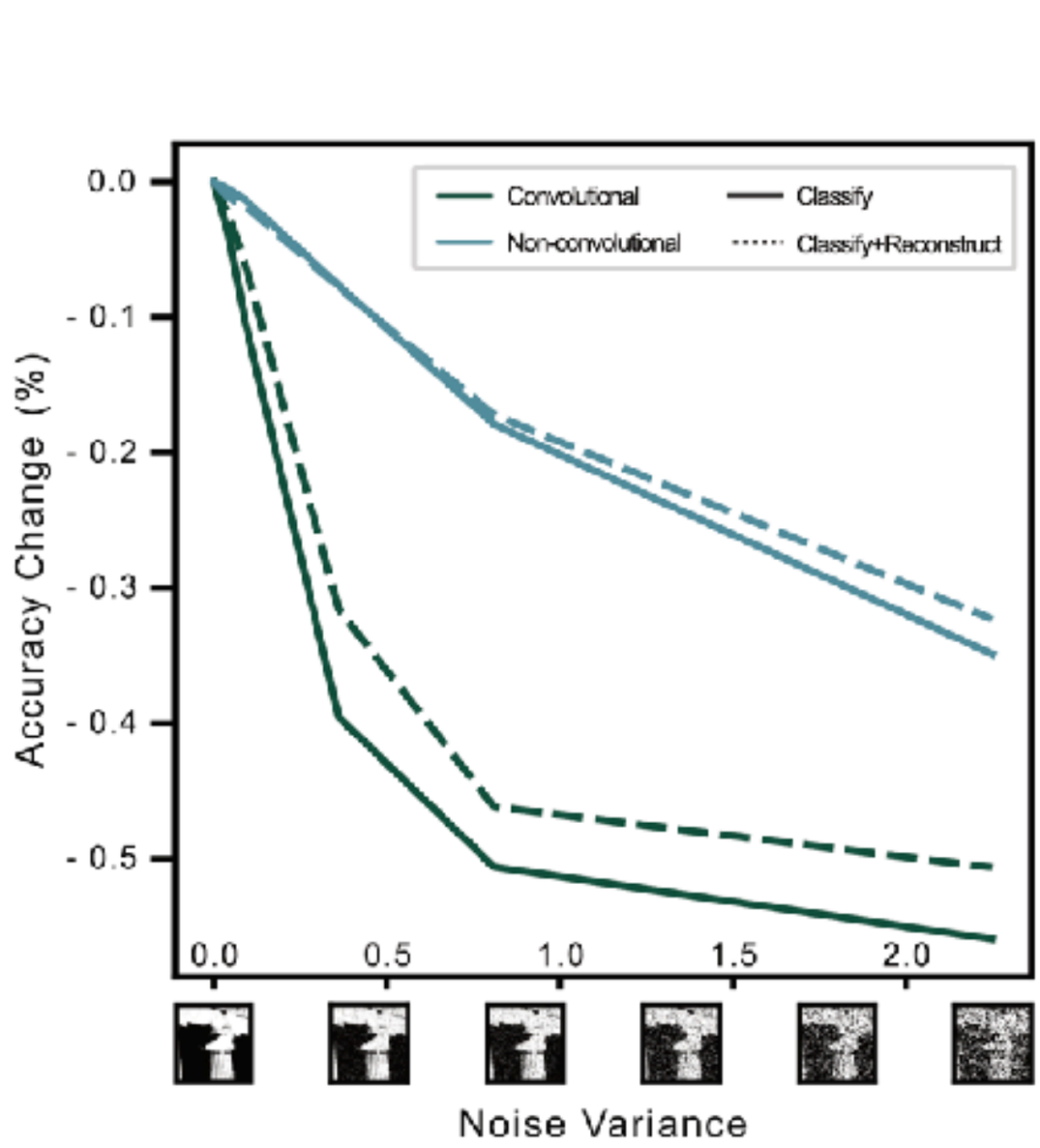
FCT (p-value)

NOISE TOLERANCE

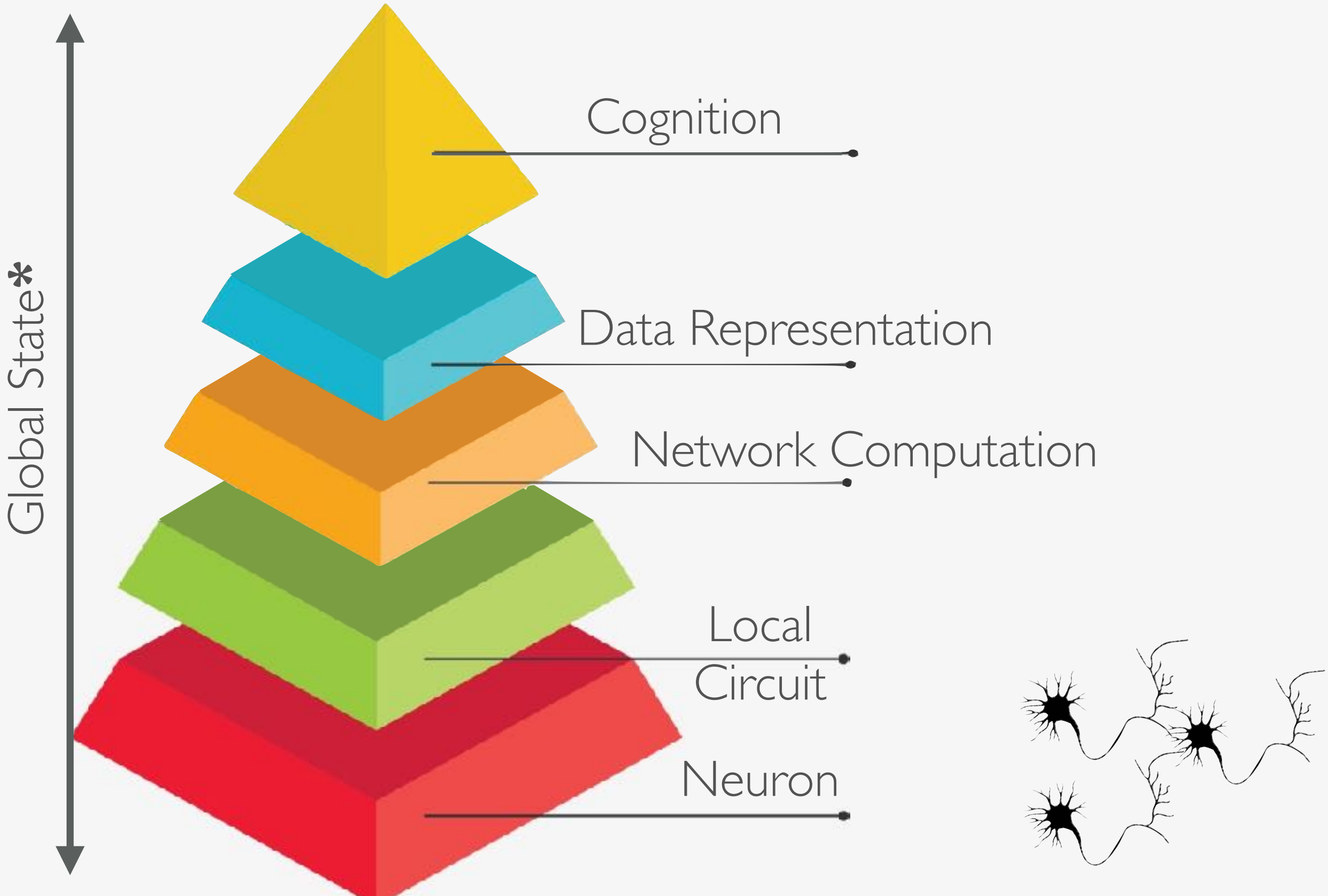


NOISE TOLERANCE

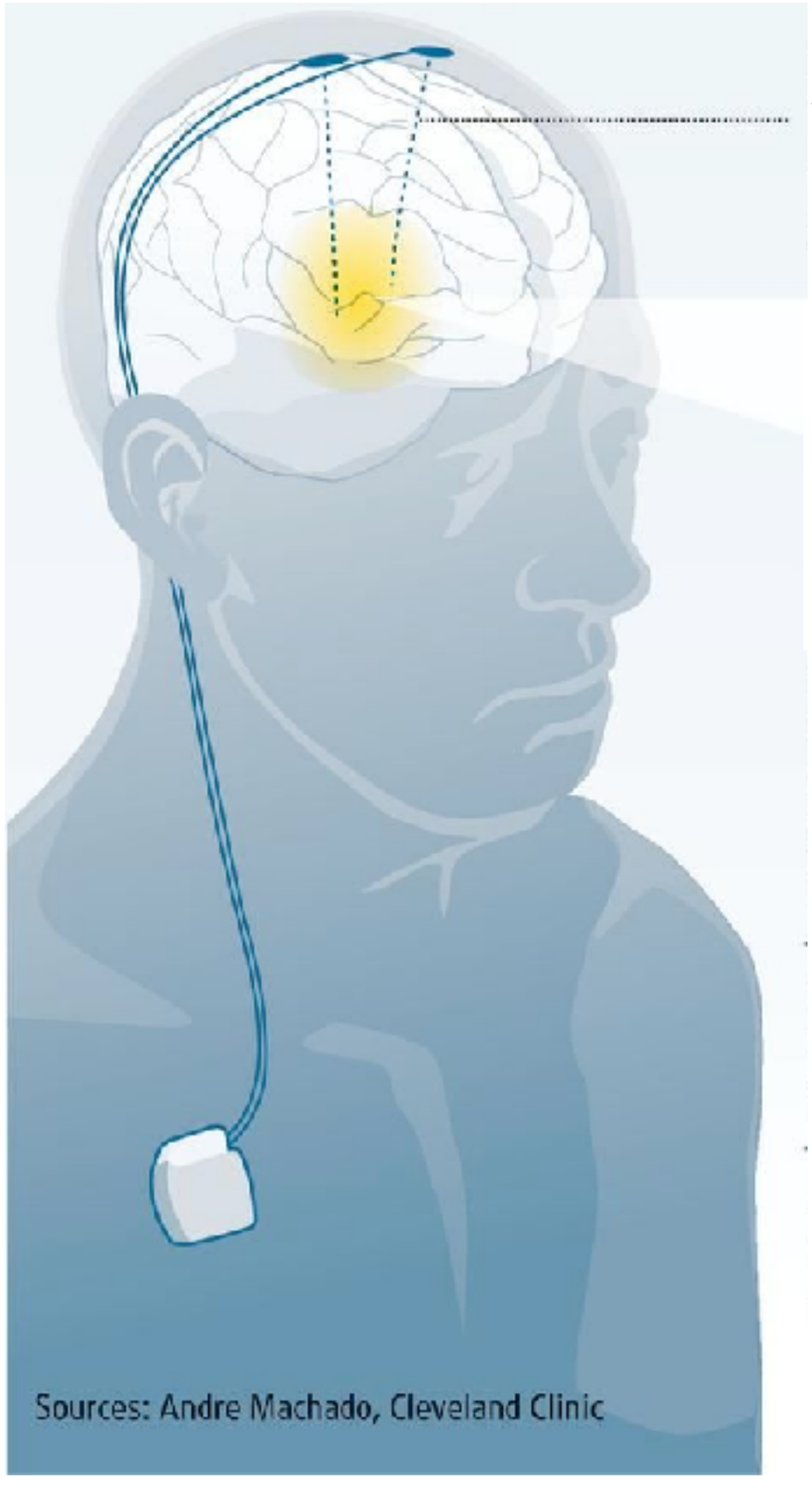




HEIRARCHICAL STRUCTURE OF NEURONAL CIRCUITS IN THE BRAIN



IMPLANTABLE NEUROSTIMULATORS



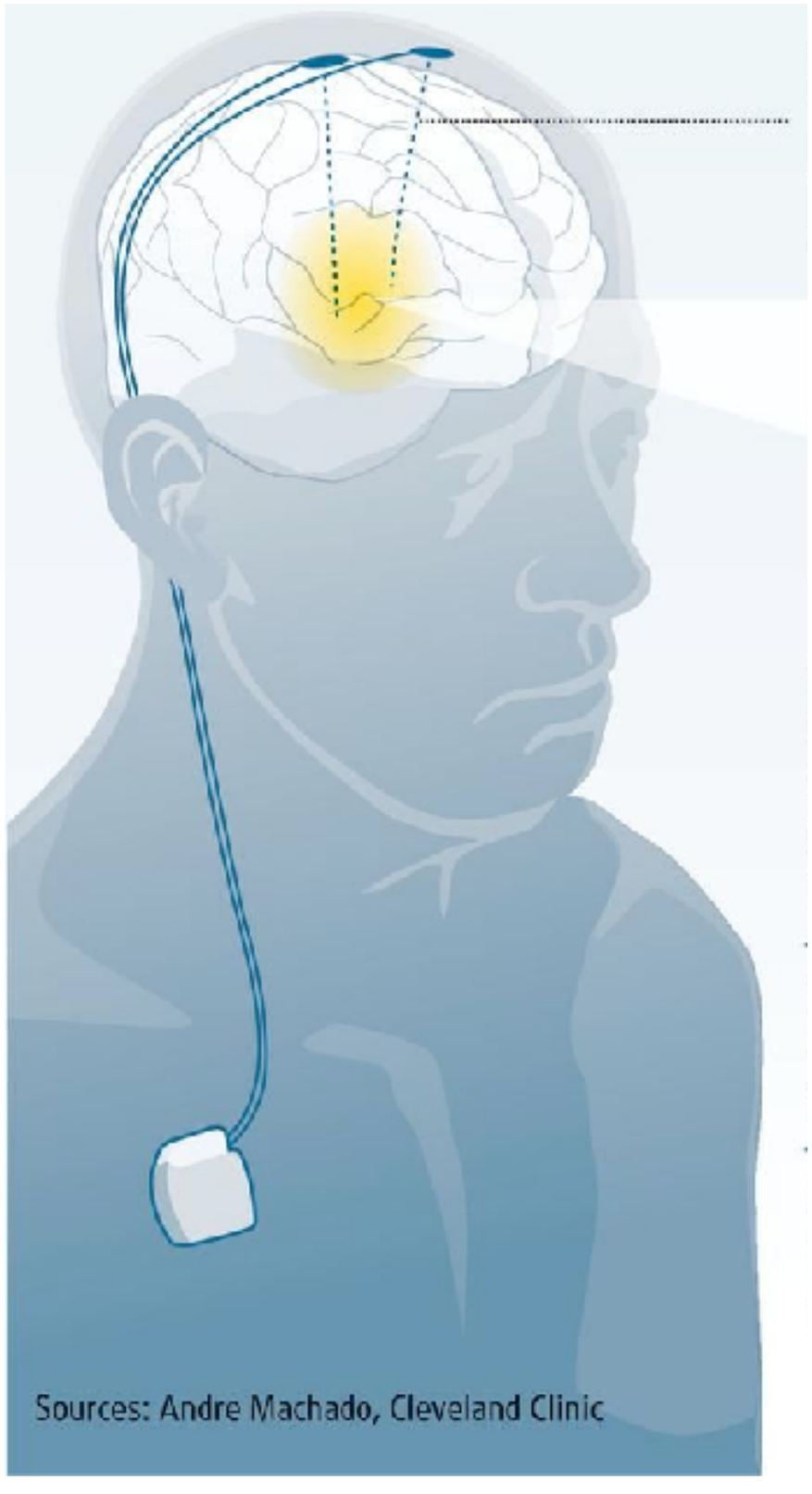
How it works
Thin coated wires carry an electrical current from battery-powered implant to electrodes in the brain.

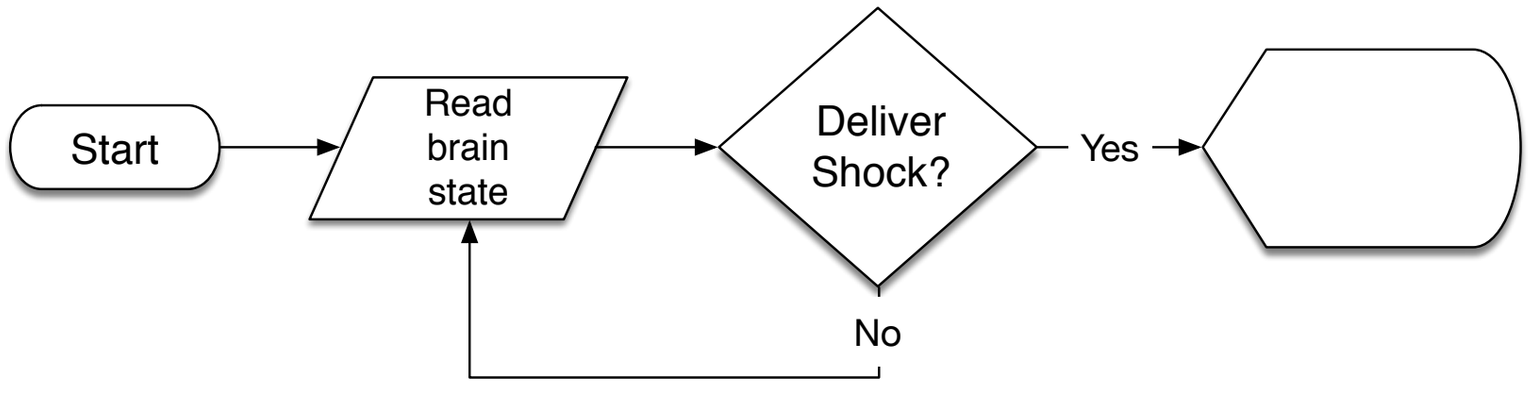
Area targeted in PD:
Subthalamic Nucleus (STN)

Uses (FDA Approval)

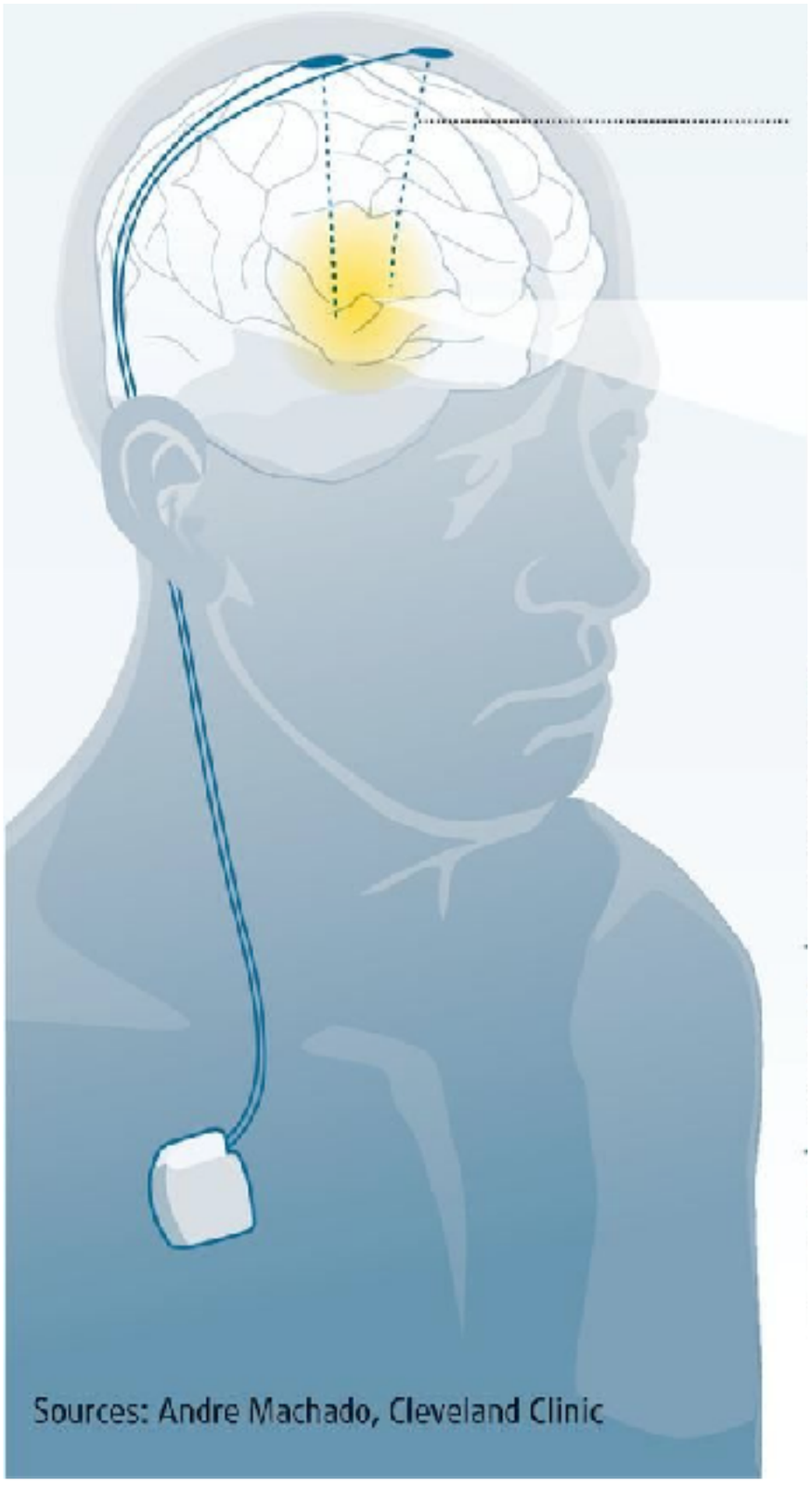
- Chronic Pain (1989)
- ET (1997)
- PD (2002)
- Primary Dystonia (2003)
- OCD (2009)
- Tourette Syndrome
- Refractory Depression
- Epilepsy
- Cluster Headache
- Obesity
- Addiction

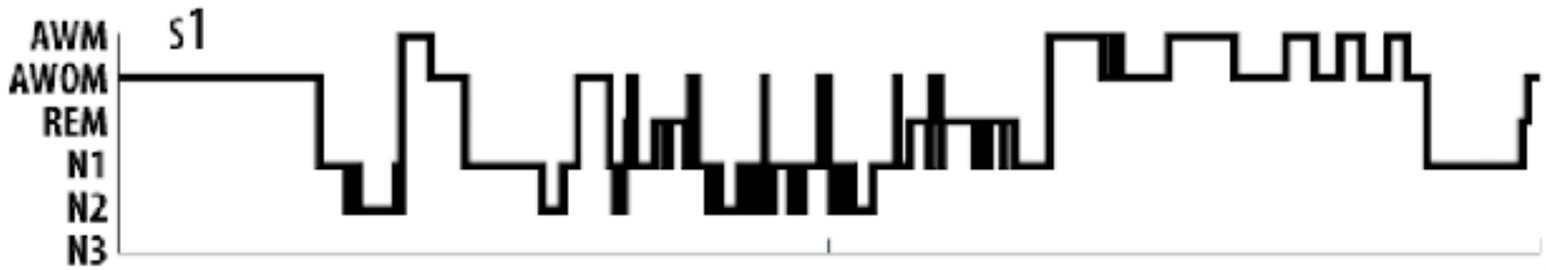
ADAPTIVE NEUROSTIMULATION REQUIRES INSIGHT INTO BRAIN STATE

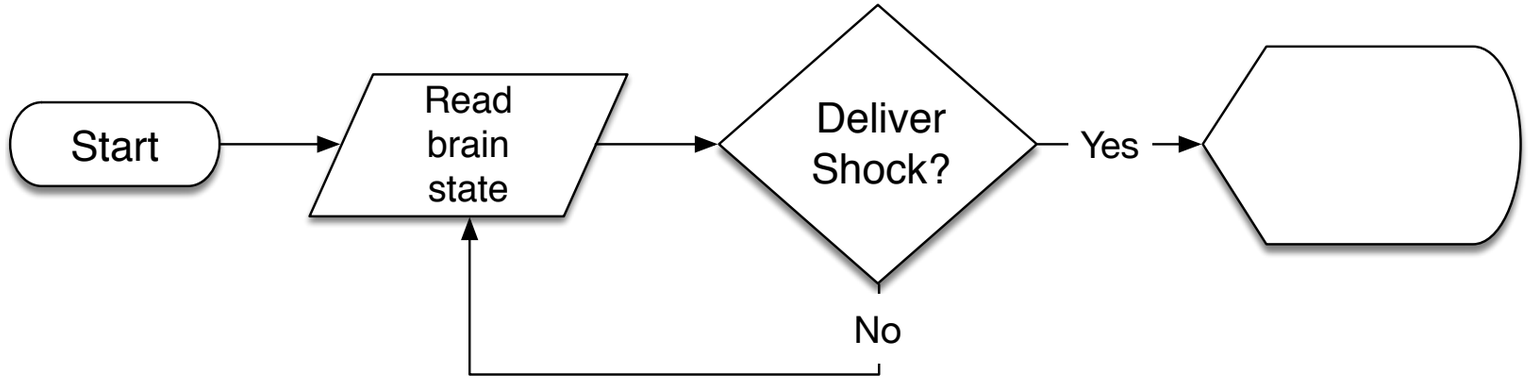




ADAPTIVE NEUROSTIMULATION REQUIRES INSIGHT INTO BRAIN STATE







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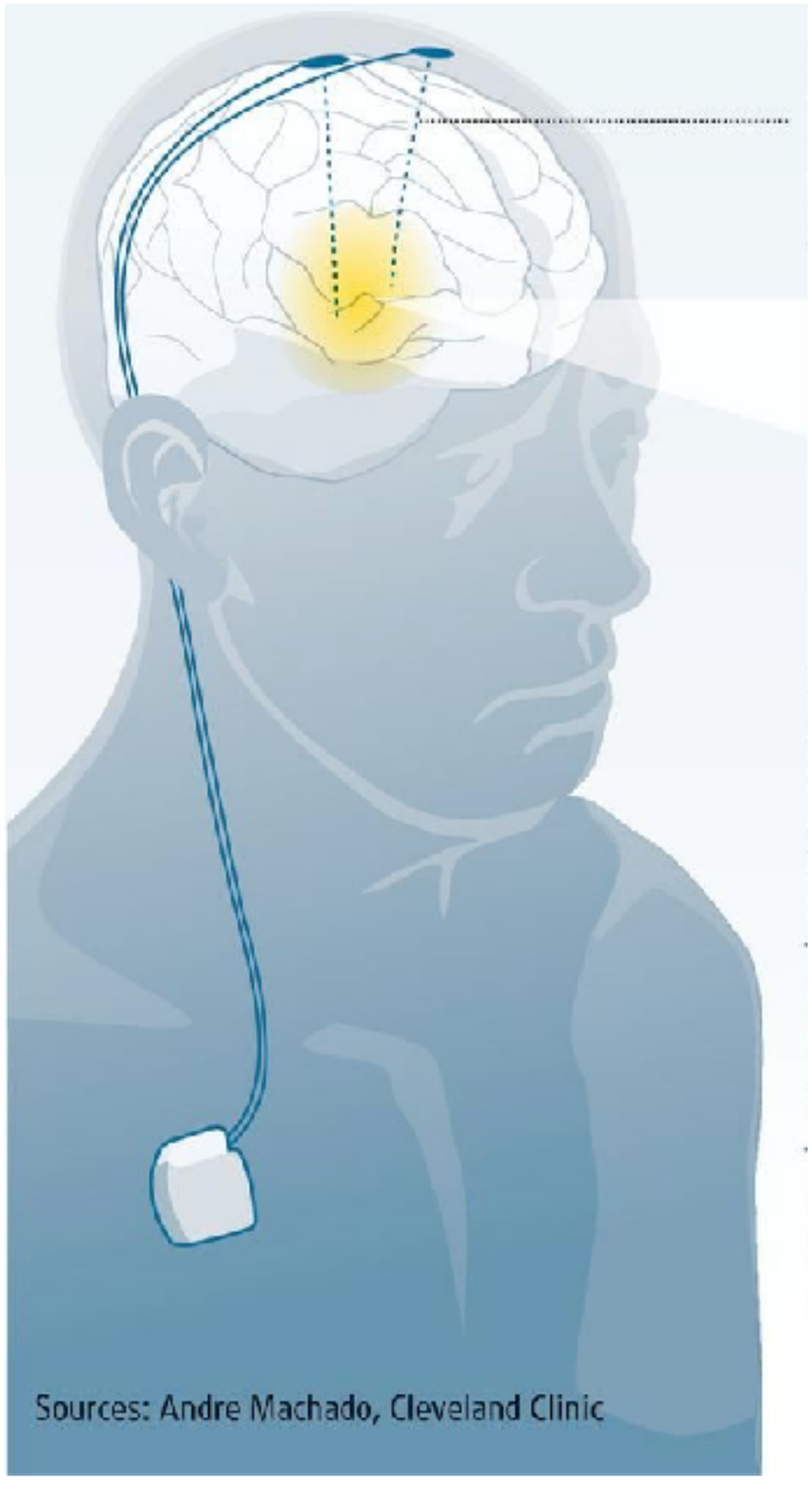
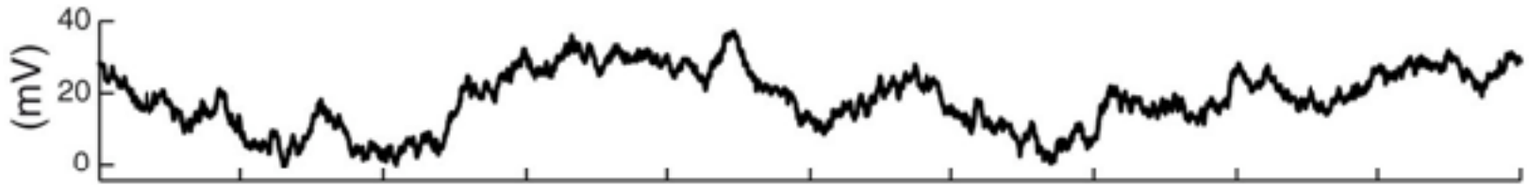
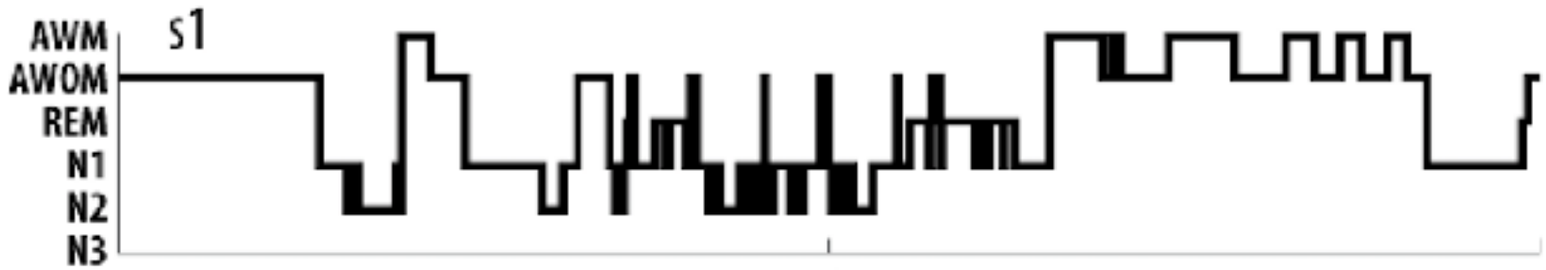
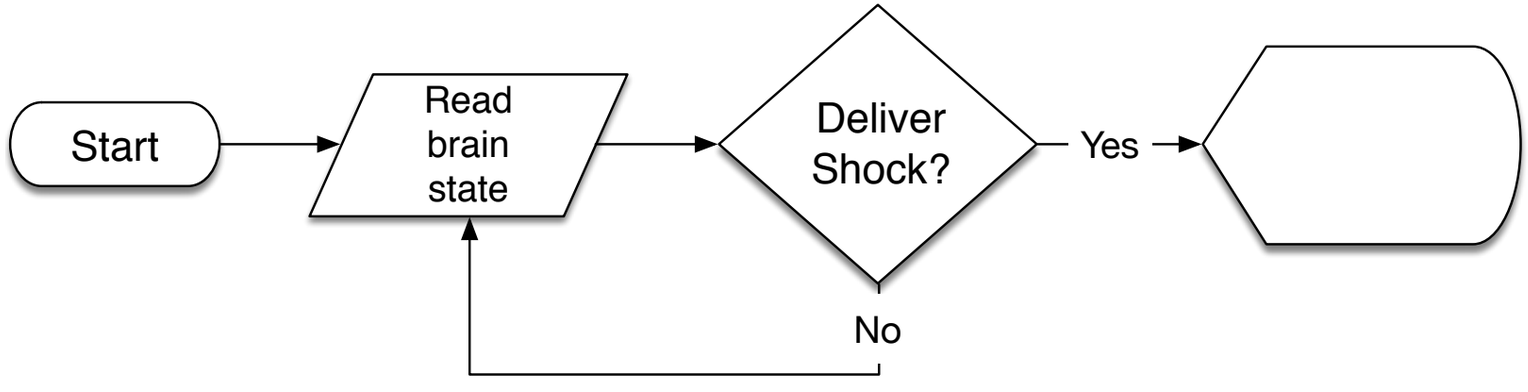


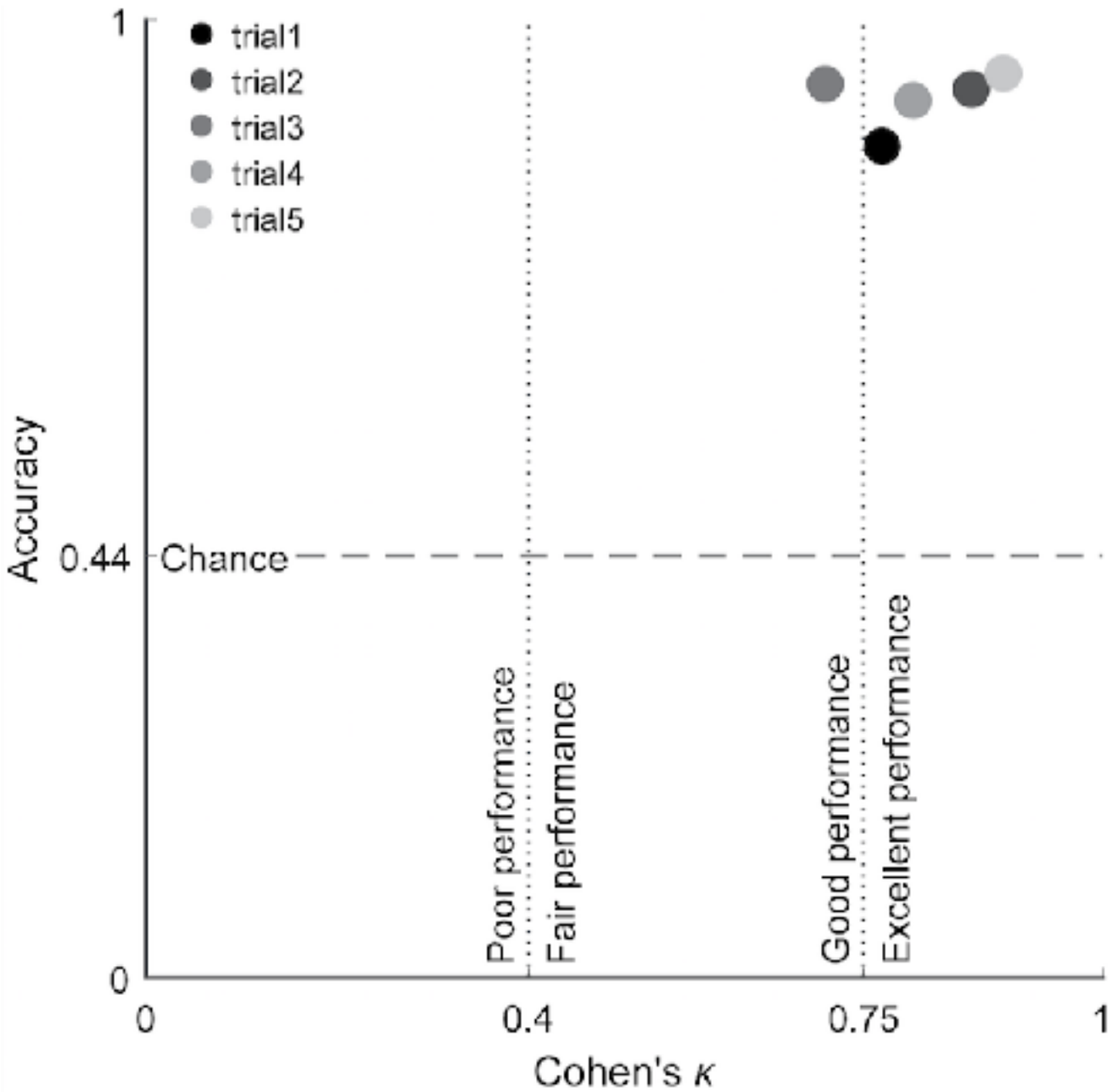




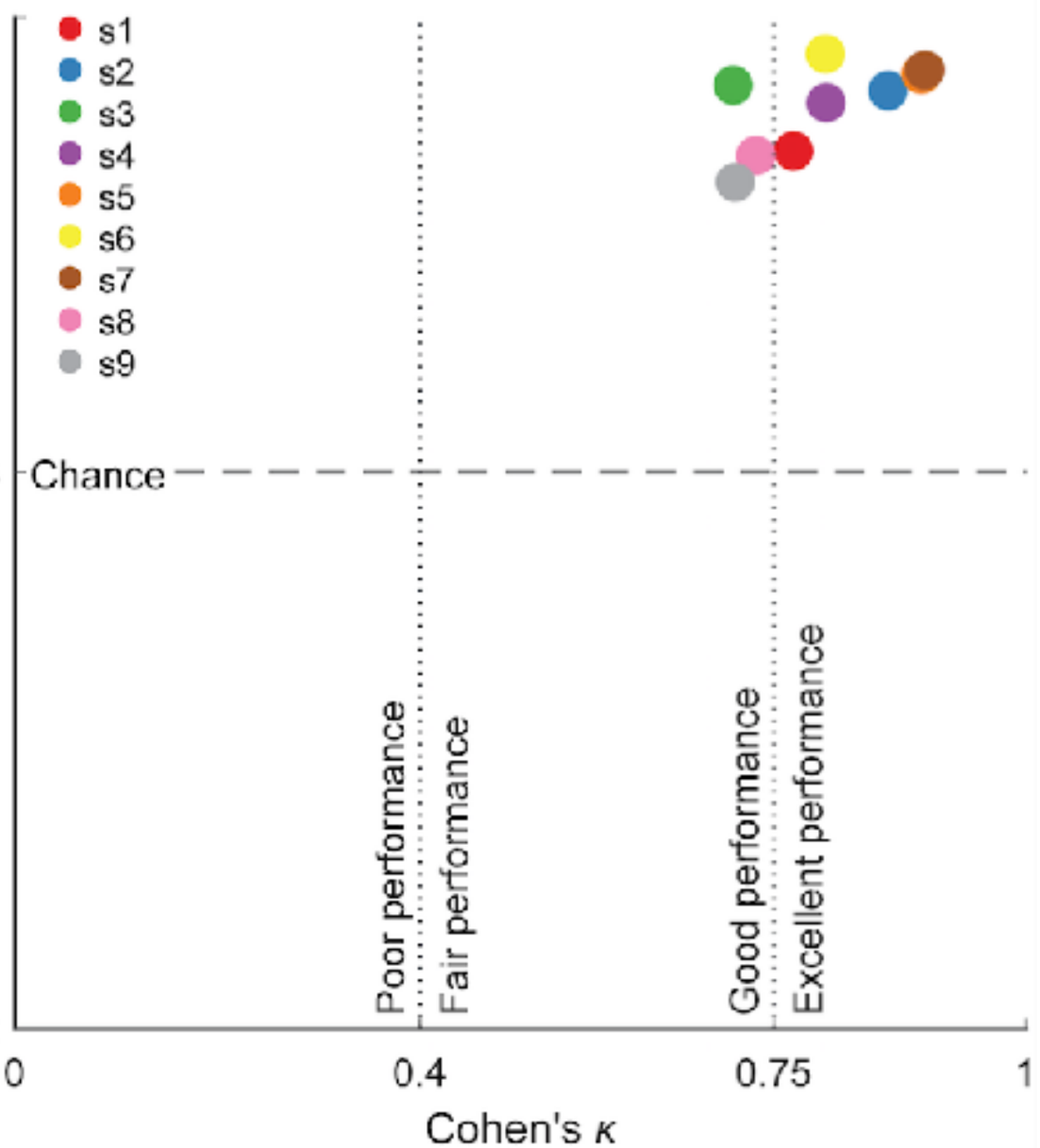


MODEL VALIDATION

K-fold split

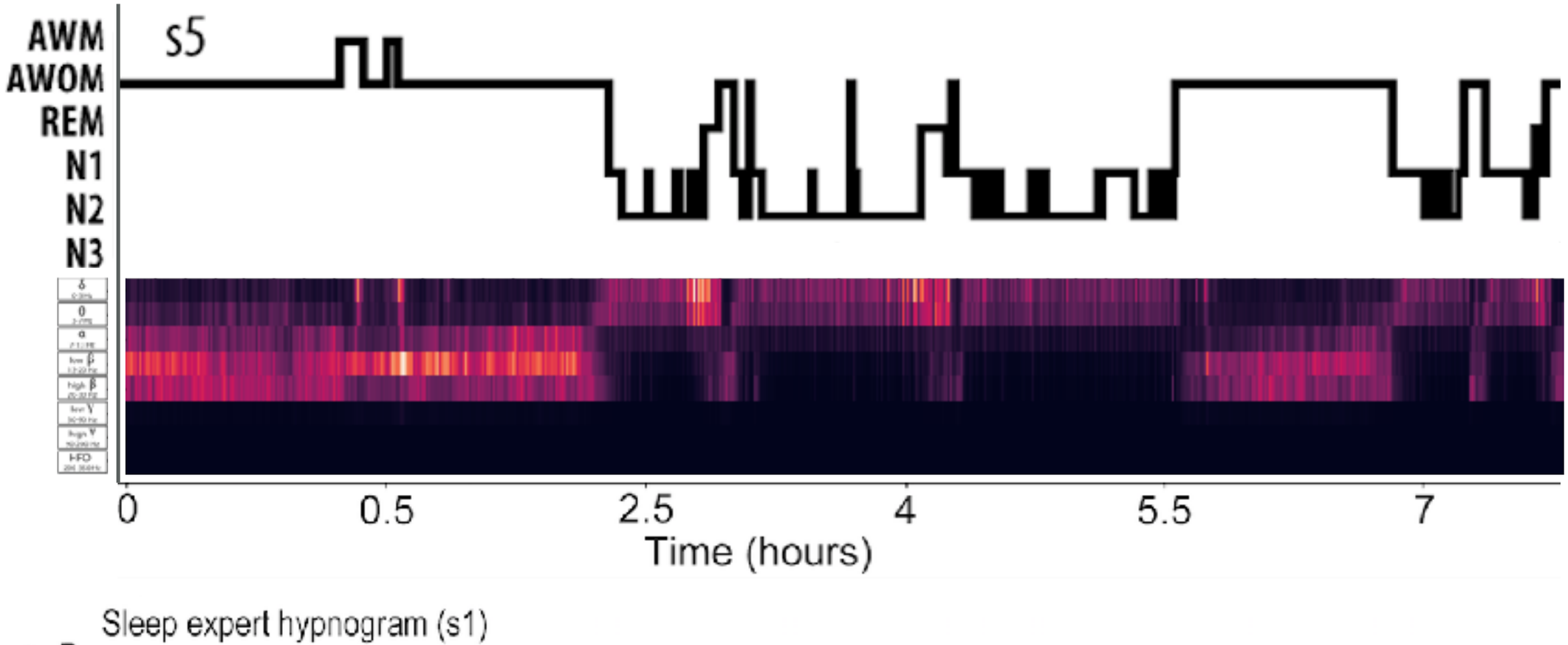


LOGO

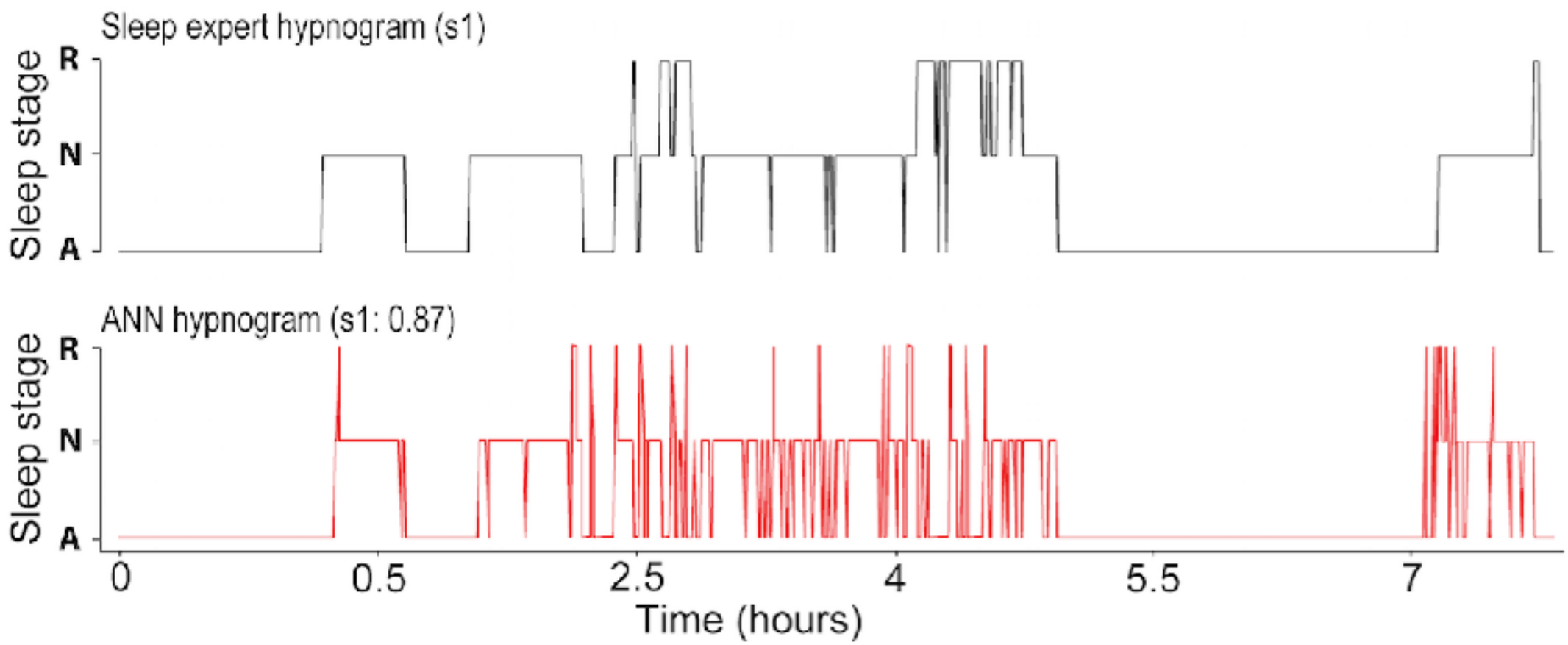


SUMMARY

Train Model

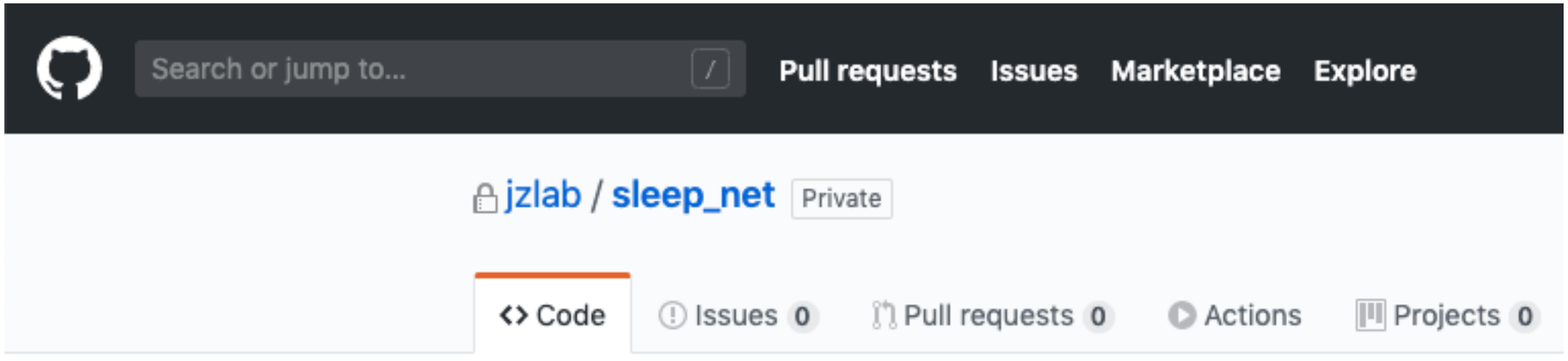


Test on novel pt



RIGOR AND REPRODUCIBILITY

- Publicly available data for replication
- Open source model training code



ACKNOWLEDGEMENTS

SCHOOL OF MEDICINE
Neuroscience Program
UNIVERSITY OF COLORADO **ANSCHUTZ MEDICAL CAMPUS**

SCHOOL OF MEDICINE
Medical Scientist Training Program
UNIVERSITY OF COLORADO **ANSCHUTZ MEDICAL CAMPUS**

- AGH
- Liz
- Ruhiyah

Zylberberg Lab

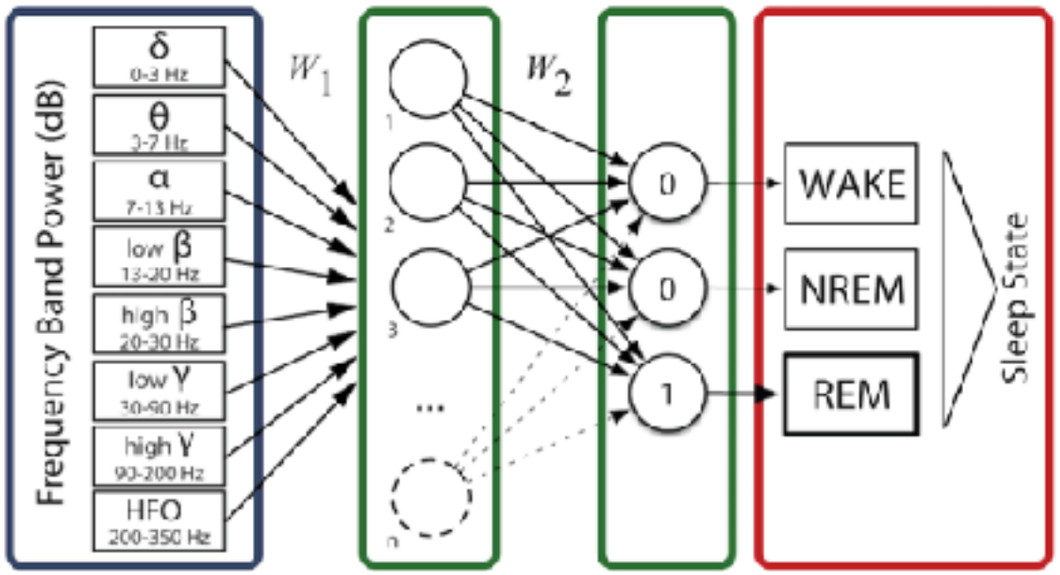
Joel Zylberberg
Callie Federer
Shelly Jones

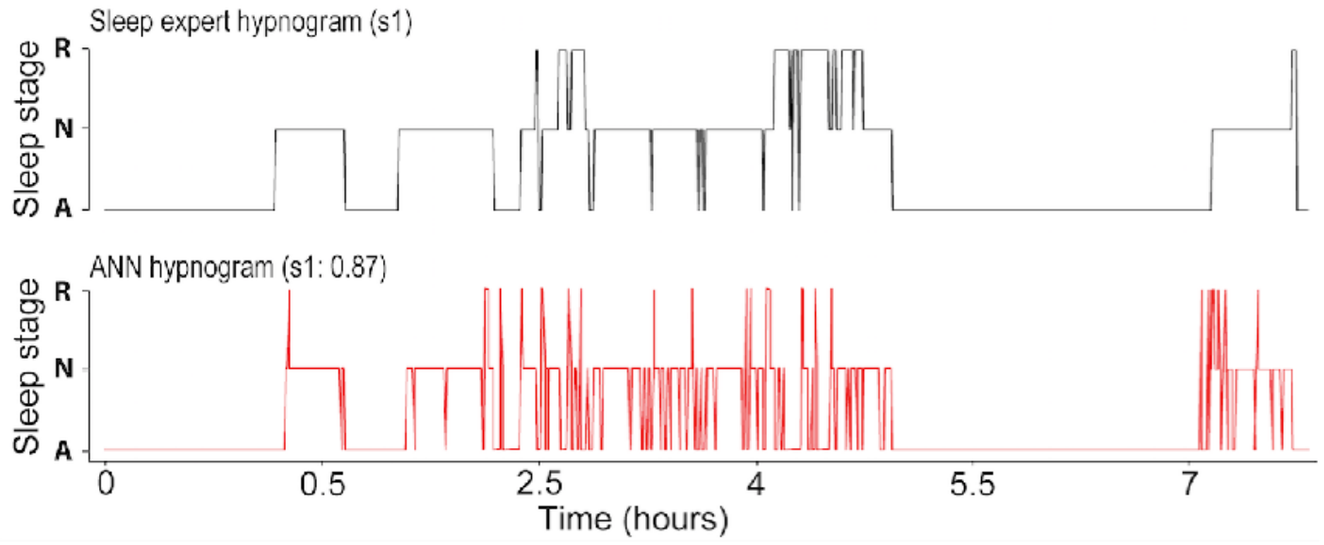
Thompson Lab

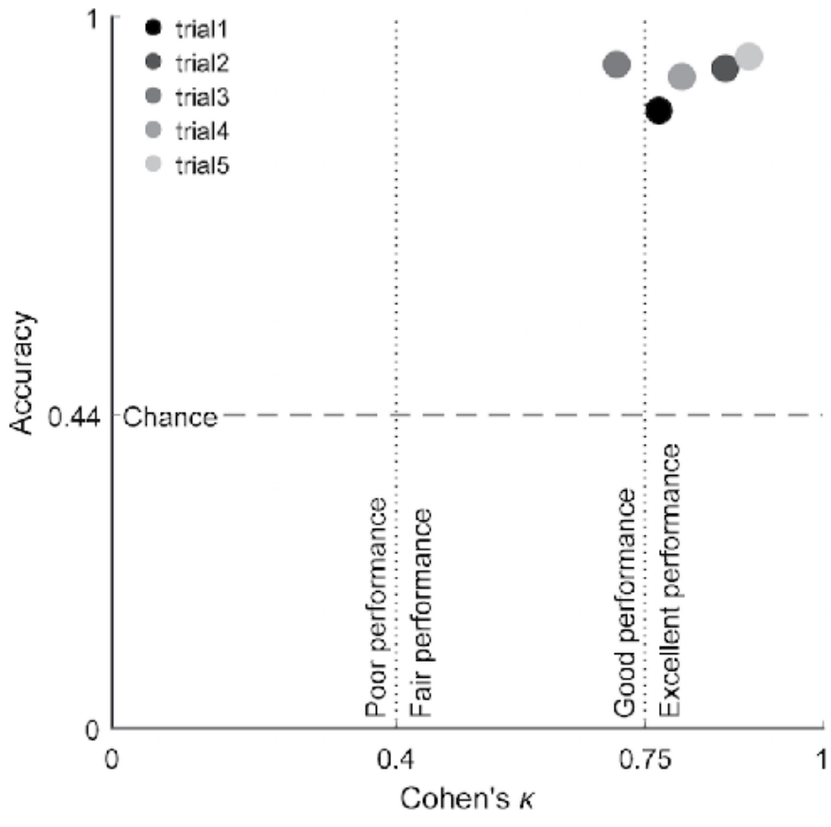
John Thompson
Andy Tekriwal

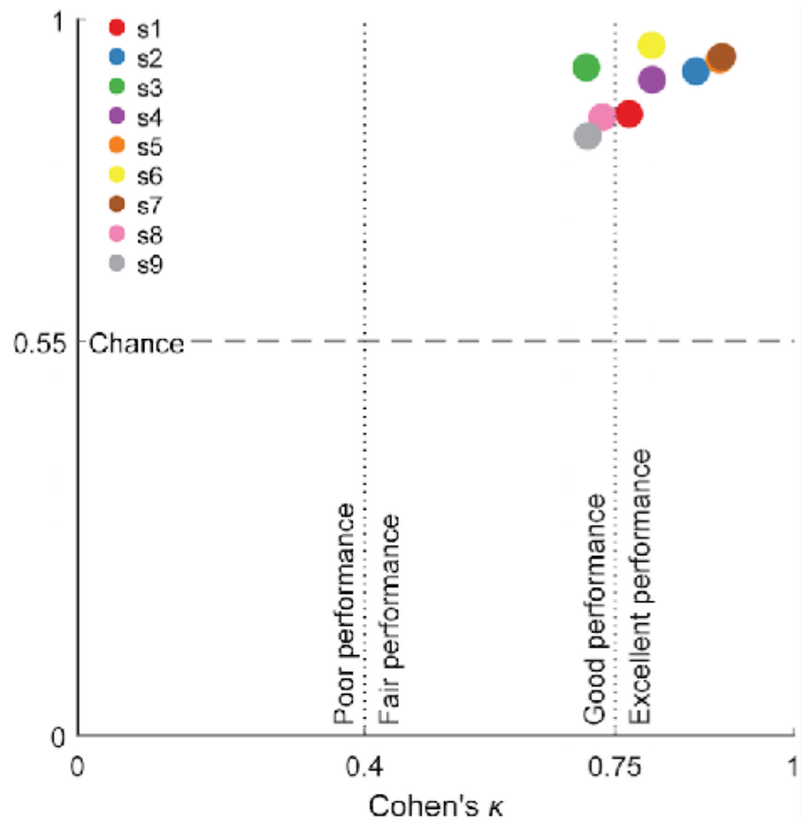
CIFA

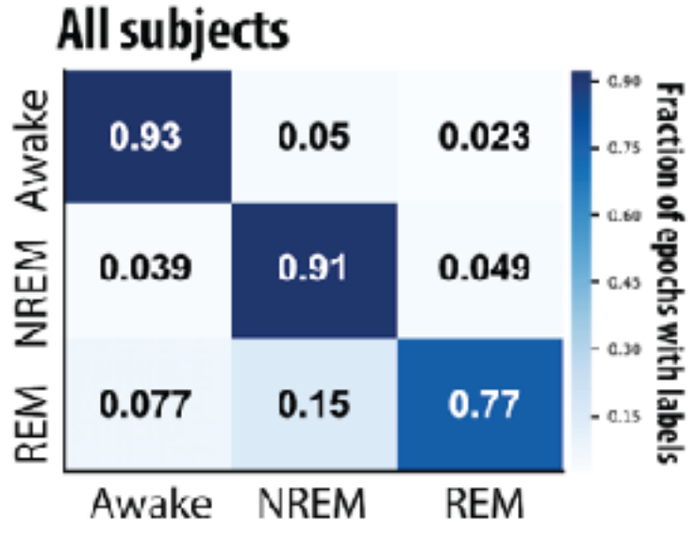
SUMMARY


Frequency Band Power (dB)
δ 0-3 Hz
θ 3-7 Hz
α 7-13 Hz
low β 13-20 Hz
high β 20-30 Hz
low γ 30-90 Hz
high γ 90-200 Hz
HFO 200-350 Hz
W_1
W_2
1
2
3
...
n
0
0
1
WAKE
NREM
REM
Sleep State


Sleep expert hypnogram (s1)
Sleep stage
R
N
A
ANN hypnogram (s1: 0.87)
Sleep stage
R
N
A
0
0.5
2.5
4
5.5
7
Time (hours)


trial1
trial2
trial3
trial4
trial5
Accuracy
1
0.44
Chance
0
Poor performance
Fair performance
Good performance
Excellent performance
0
0.4
0.75
1
Cohen's κ


s1
s2
s3
s4
s5
s6
s7
s8
s9
1
0.55
Chance
0
Poor performance
Fair performance
Good performance
Excellent performance
0
0.4
0.75
1
Cohen's κ


All subjects
Awake
NREM
REM
0.93
0.05
0.023
0.039
0.91
0.049
0.077
0.15
0.77
Awake
NREM
REM
Fraction of epochs with labels

SLEEP ARCHITECTURE IN PD