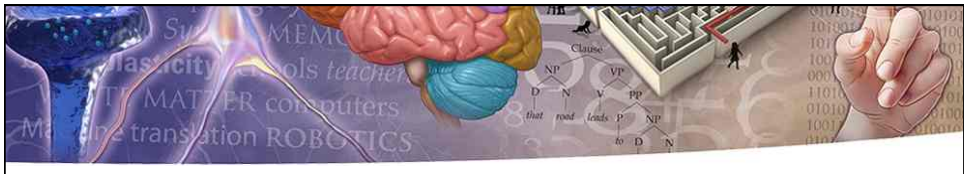


Johns Hopkins University
Science of Learning Institute's

# Belgian Beer Event!

Scientists sharing their work on the science of learning.

1

# Neural Systems of Human Working Memory Representations and Cognitive Control

Susan Courtney
Department of Psychological and Brain Sciences
Krieger School of Arts and Sciences

2

# Why Is Thinking Hard?

Jonathan Flombaum
Department of Psychological and Brain Sciences
Krieger School of Arts and Sciences

3

# Sensitivity to Prediction Error During Learning

Reza Shadmehr
Department of Biomedical Engineering
and Neuroscience
School of Medicine

4

# A Rat Learns to Imagine

David Foster
Department of Neuroscience
School of Medicine

5

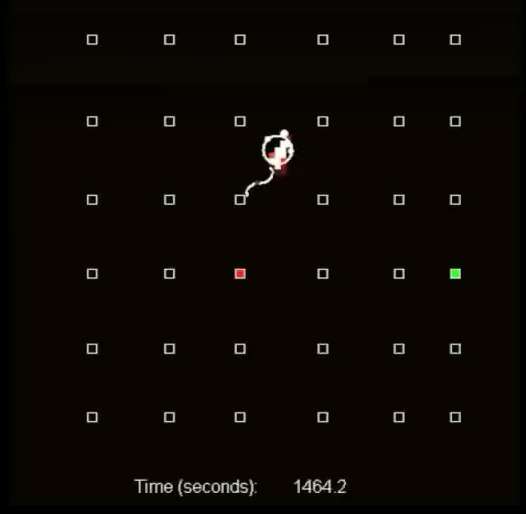
## How the hippocampus plans routes

9.12.13

Brad Pfeiffer and David Foster, Johns Hopkins Neuroscience

The Solomon H. Snyder Department of Neuroscience THE JOHNS HOPKINS UNIVERSITY

BSi




**During movement, current location is represented**

6

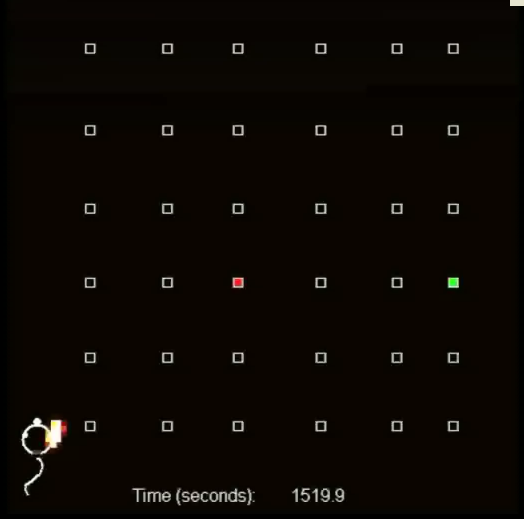
## How the hippocampus plans routes

9.12.13

Brad Pfeiffer and David Foster, Johns Hopkins Neuroscience

The Solomon H. Snyder Department of Neuroscience THE JOHNS HOPKINS UNIVERSITY

BSi




**During pause, plans are made then followed**

7

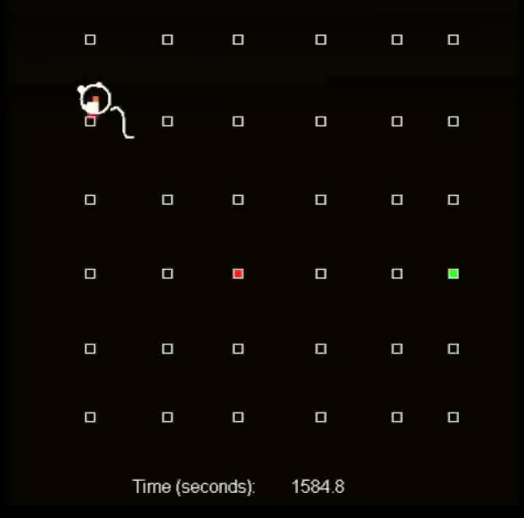
## How the hippocampus plans routes

9.12.13

Brad Pfeiffer and David Foster, Johns Hopkins Neuroscience

The Solomon H. Snyder Department of Neuroscience THE JOHNS HOPKINS UNIVERSITY

BSi




**Continually planning and doing**

8

# tDCS in PPA: Preliminary Results & Challenges

Kyrana Tsapkini
Department of Neurology
School of Medicine

9

## Effects of tDCS in primary progressive aphasia (PPA)

**PI: Kyrana Tsapkini**
**Co-Investigators: Argye Hillis, Brenda Rapp, Peter Barker, Richard Edden, John Desmond, Martin Lindquist, Constantine Frangakis**

- PPA: a devastating neurodegenarative syndrome affecting people 50-60 yrs old, primarily their language abilities.
- tDCS: a novel non-invasive technique of neuromodulation supposedly altering the synaptic potential.

Questions addressed:

- Does tDCS plus language therapy (spelling) induce more improvement than language therapy alone (sham)? Do effects generalize in untrained items?
- Do behavioral effects correlate with concentrations of GABA, a neuropeptide particuraly important for learning, at the site of stimulation?
- Are intervention gains sustainable over time and do improvements generalize to other language and cognitive tasks?

10

# Using Brain Stimulation to Understand and Augment Motor Learning

Pablo Celnik

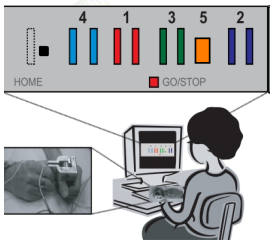
Department of Physical Medicine and Rehabilitation

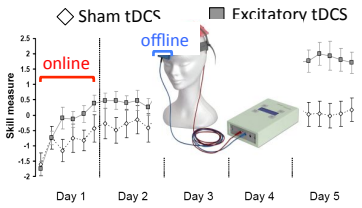
School of Medicine

11

Augmenting Motor Learning with Non-Invasive Brain Stimulation
Pablo Celnik, MD

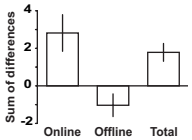
Transcranial Magnetic Stimulation (TMS) – Transcranial Direct Current Stimulation



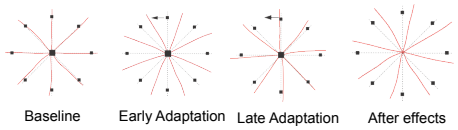




Anodal tDCS over M1 enhances skill retention

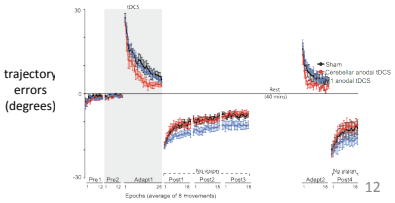
Cerebellar tDCS enhances motor acquisition




CB tDCS /M1 tDCS/ Sham




Reis et al. PNAS 2009




Galea et al. Cereb Cortex 2011

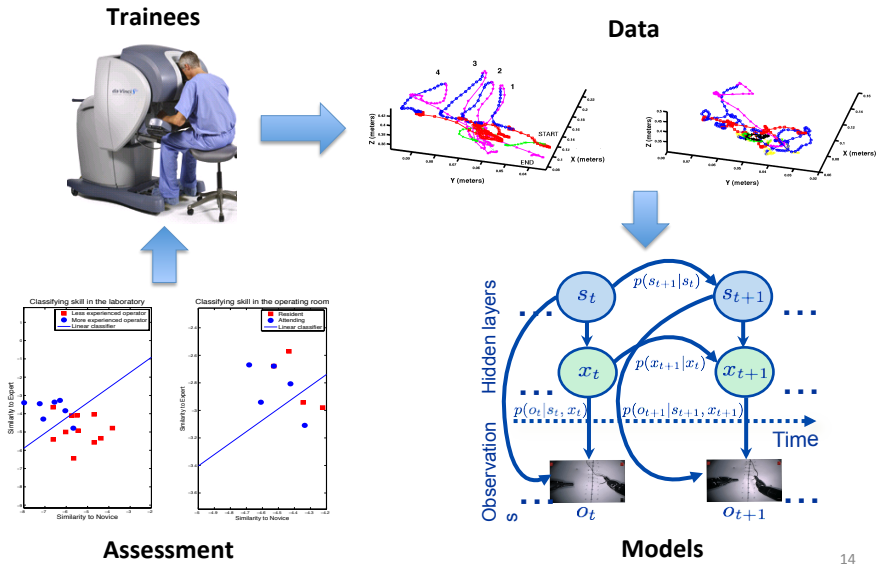
12

# Automated Skill Assessment for Individualized Training in Robotic Surgery

Greg Hager
Department of Computer Science
Whiting School of Engineering

13

Automated Skill Assessment for
Individualized Training in Robotic Surgery
Greg Hager (CS), Gyusung Lee (Surgery)




14

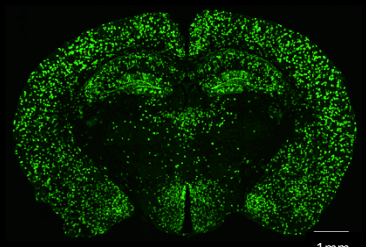
# In vivo Engagement of Astrocyte Networks

Dwight Bergles
Department of Neuroscience
School of Medicine

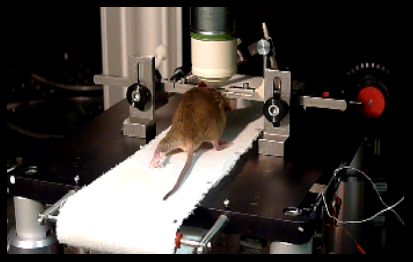
15

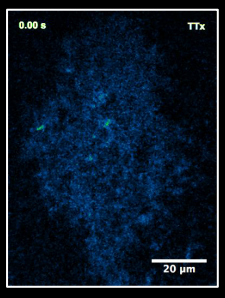
## In vivo engagement of astrocyte networks

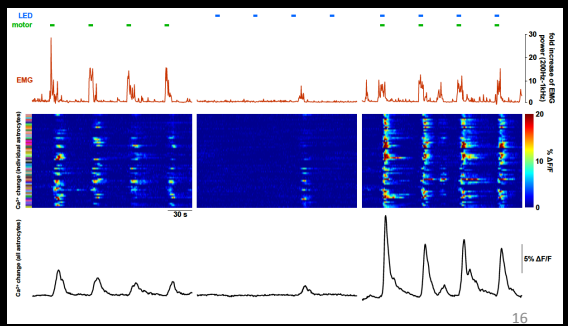
*GLAST-CreER;R26-lsl-GCaMP3*




GCaMP3





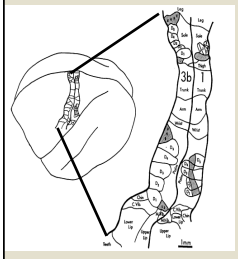

16

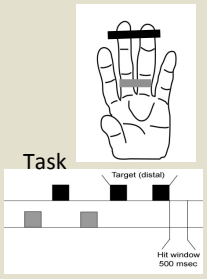
# Plasticity and Learning in Somatosensory Cortex

Steven Hsiao
Department of Neuroscience
School of Medicine

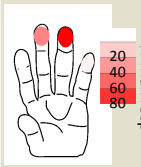
17

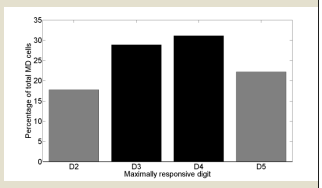
## Attention and Learning





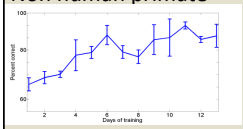

Cells with Multidigit Receptive fields emerge on trained digits.



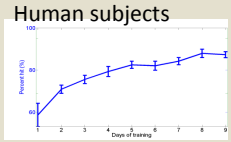




Learning is rapid in both humans and non-human primates

Non human primate




Human subjects

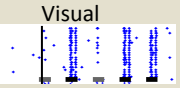


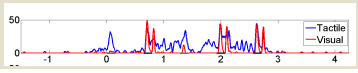

Natalie Trzcinski

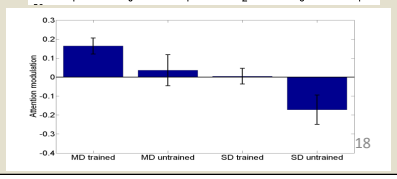
Attention targets trained digits

Tactile

Visual






18

# Defining The Genetic Basis For Individual Differences In Learning

Mengnan Tian

Department of Neuroscience

School of Medicine

19

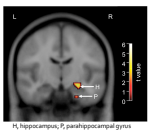
## Defining The Genetic Basis For Individual Differences In Learning

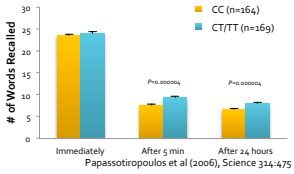
Mengnan Tian

www.sciencemag.org SCIENCE VOL 314 20 OCTOBER 2006

### Common *Kibra* Alleles Are Associated with Human Memory Performance

Andreas Papassotiropoulos,[1,2]† Dietrich A. Stephan,[3]† Matthew J. Huentelman,[3] Frederic J. Hoerndli,[1] David W. Craig,[3] John V. Pearson,[3] Kim-Dung Huynh,[1] Fabienne Brunner,[1] Jason Corneveaux,[3] David Osborne,[4] M. Axel Wollmer,[1] Amanda Aerni,[1] Daniel Coluccia,[1] Jürgen Hänggi,[1] Christian R. A. Mondadori,[1] Andreas Buchmann,[1] Eric M. Reiman,[3,6] Richard J. Caselli,[5] Katharina Henke,[1] Dominique J.-F. de Quervain[1,2]






Papassotiropoulos et al (2006), Science 314:475

ELSEVIER

Neurobiology of Aging 31 (2010) 901–909

NEUROBIOLOGY OF AGING

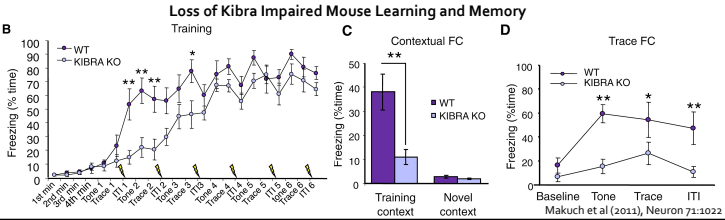
www.elsevier.com/locate/neuaging

Evidence for an association between *KIBRA* and late-onset Alzheimer's disease

- *KIBRA* was significantly over-expressed in AD-affected hippocampal, posterior cingulate and temporal cortex regions.
- T carrier had higher glucose metabolism than did carriers in posterior cingulate and precuneus brain regions.
- Non-carriers of the *KIBRA* rs17070145 T-allele had increased risk of late-onset AD in association studies.

Corneveaux et al (2010), Neurobiology of Aging 31:901

**Loss of Kibra Impaired Mouse Learning and Memory**




Makuch et al (2011), Neuron 71:1022

20

# Virtues of Wonder: A Seedbed for Discovery and Healing

Gail Geller
Department of Medicine and
Berman Institute of Bioethics
School of Medicine

21

## Virtues of Wonder: A Seedbed for Discovery and Healing

*"The most beautiful thing we can experience is the mysterious. It is the source of all true art and all science. He to whom this emotion is a stranger, who can no longer pause to wonder…, is as good as dead; his eyes are closed."* *Albert Einstein*

**Provisional conception of 'wonder'**

An experience of:
- surprise at the unexpected
- attraction to the unknown, and
- an awakening of the imagination in the face of what might be

**Inter-divisional, multi-disciplinary project team**

| | | |
|---|---|---|
| Co-PI: | Gail Geller, ScD, MHS | BI, SOM |
| Co-PI: | Maria Merritt, PhD | BI, BSPH |
| | Charles Limb, MD, PhD | SOM, SOE, Peabody |
| | Barbara Landau, PhD | KSAS, Provost's Off. |
| | Elaine Hansen, PhD | CTY |
| | Susan Magsamen | BSi |
| | Amy Shelton, PhD | CTY, SOE |

**Orienting Concept**
- The "capacity for wonder" underlies several virtues of character - *humility, creativity, curiosity, gratitude, respect, and compassion* – that are integral to discovery and healing.

**Statement of Problem**
- These virtues tend to be extinguished rather than nurtured by the culture and worldview of many educational institutions at every level.

**Goals**
- to advance our understanding (through rigorous, transdisciplinary conceptual and empirical analysis) of the "capacity for wonder" and its relationship to the specific virtues of character.
- to infuse teaching and learning with wonder so as to cultivate these virtues in the leaders of tomorrow.

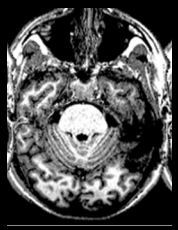
JOHNS HOPKINS BERMAN INSTITUTE of BIOETHICS 22

# Neurobiology of language plasticity

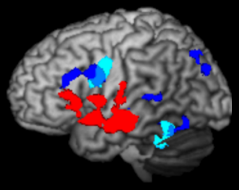
Brenda Rapp
Department of Cognitive Science
Krieger School of Arts and Sciences

23

## Neurobiology of language plasticity



DPT

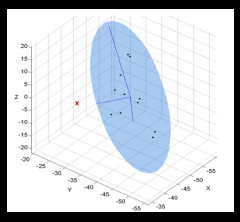


Blue: control group
Red: DPT

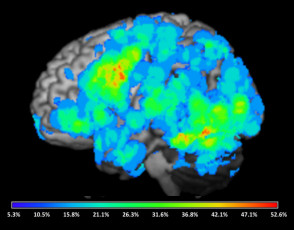
1. To what extent is the normal network recruited?
2. Is there recruitment of novel substrates?

Challenge: normal variability

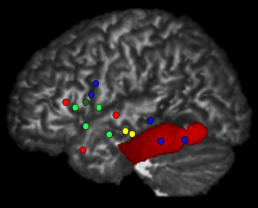
IPPC Analysis



1. Mahalanobis distance



2. Peak probability map (control group)



Blue: control group peaks
Green/yel: DPT normal range
Red: DPT novel recruitment

24

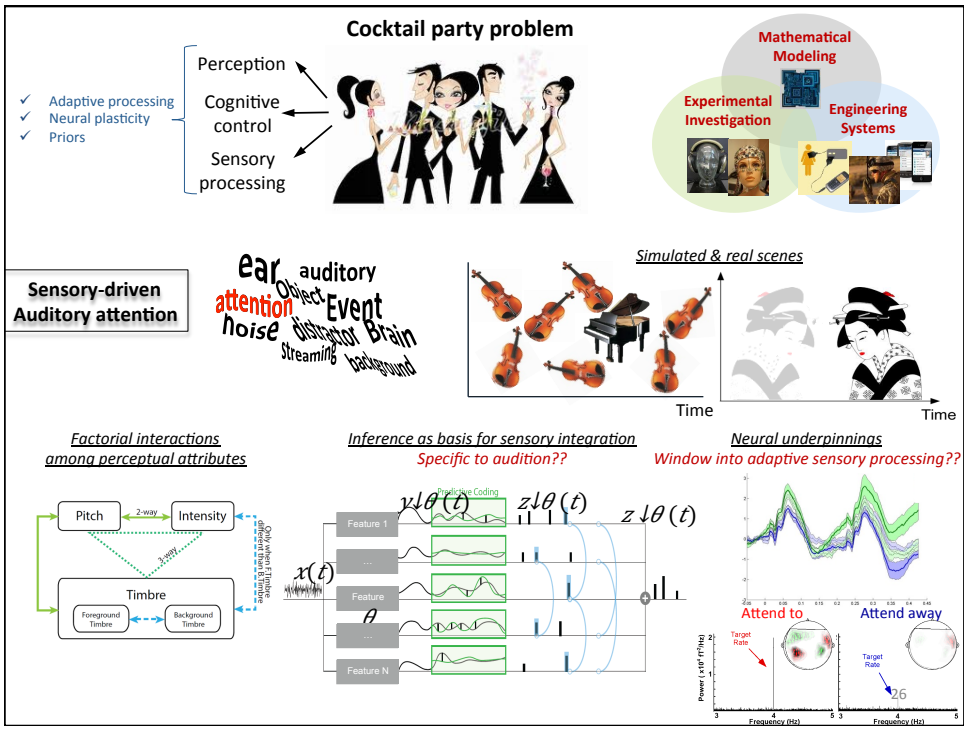
# The Cocktail Party Problem

Mounya Elhilali

Department of Electrical and Computer Engineering

Whiting School of Engineering

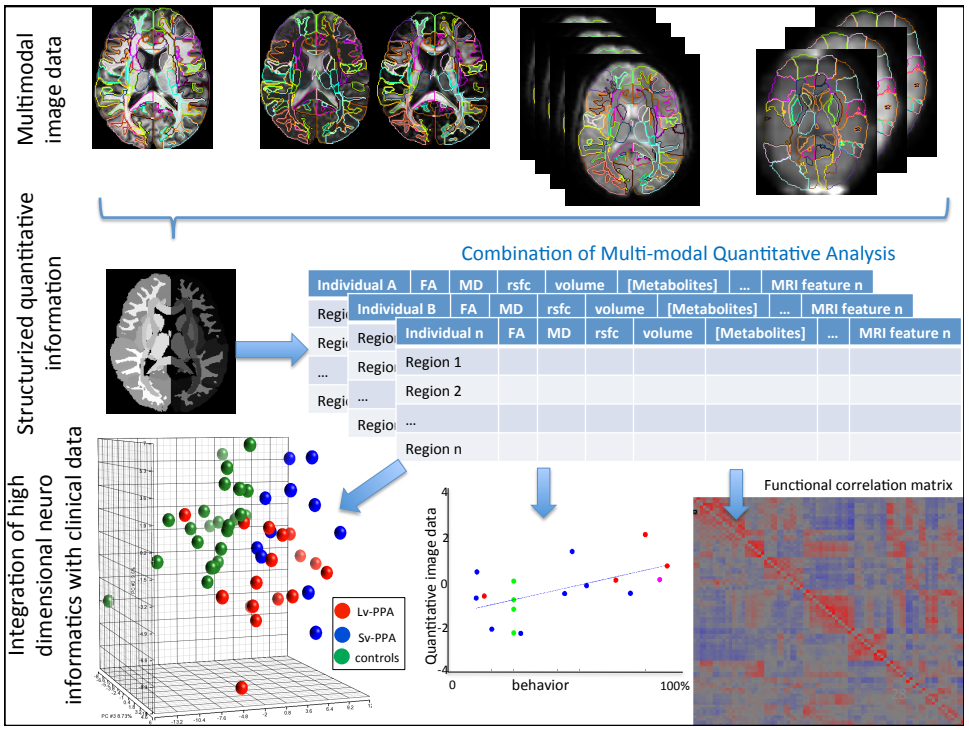
25



# Artificial Intelligence to Simulate Radiologists' Learning and Reasoning

Andreia Faria
Department of Radiology-Magnetic Resonance Research
School of Medicine

27



# Metacognitive Responses to Math Errors

Luke Rinne
Department of Educator Preparation Programs
School of Education

29

## Metacognitive Responses To Math Errors

Luke Rinne, JHU School of Education

10200 ÷ 7 = 1600

Correct or Incorrect? Are you positive?

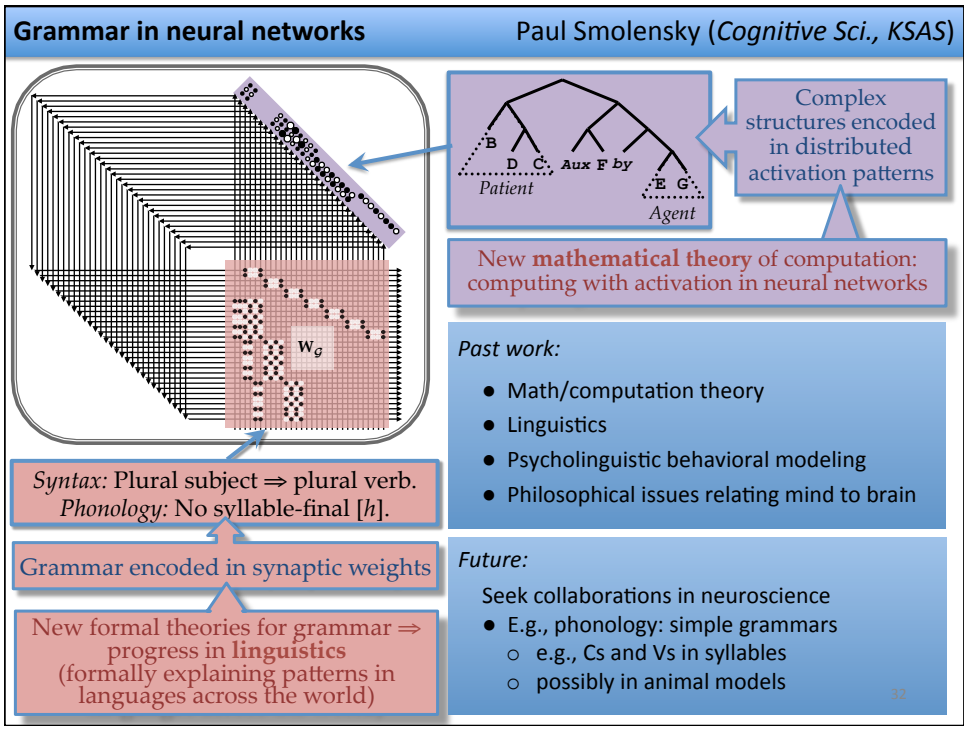
- Is metacognition more than just computation ability?
  - Skill in assigning confidence is still developing during adolescence, well after arithmetic has been acquired.
  - Impairment with MLD, but not low-achievement in general.
- How does metacognition affect learning?
  - What happens *after* errors? Slowing? Improved accuracy?
- What are the biological bases of metacognition?
  - We know about ERN, but *cortisol* may also be important.
  - Cortisol likely aids responses to error (in ways we don't understand well yet), but is also a factor in math anxiety.

30

# Grammar in Neural Networks

Paul Smolensky
Department of Cognitive Science
Krieger School of Arts and Sciences

31



# The Cognitive Timeline

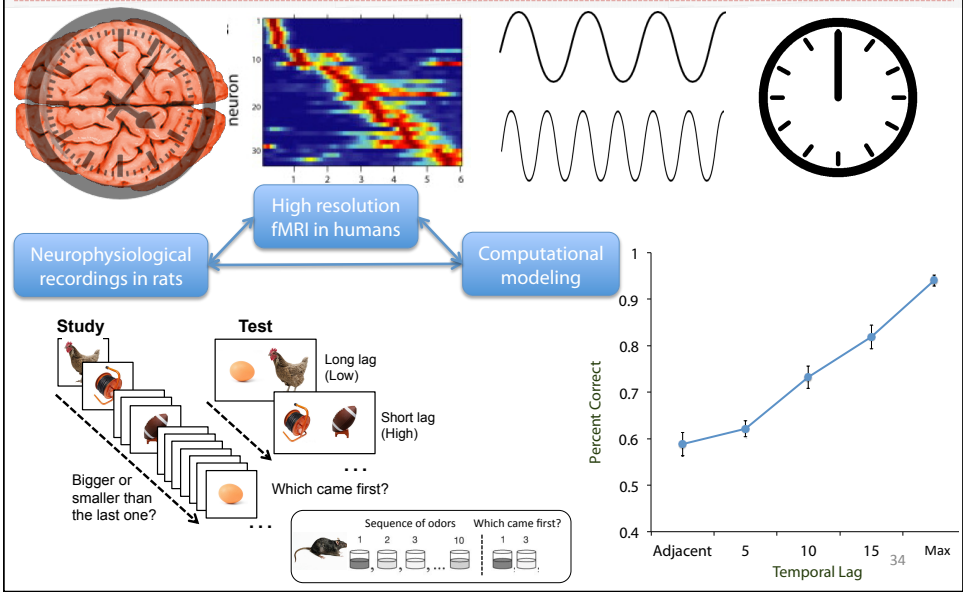
Michael Yassa
Department of Psychological and Brain Sciences
Krieger School of Arts and Sciences

33

## The Cognitive Timeline

*How does the brain process the temporal aspects of episodic memory?*

Investigators: Jim Knierim (Neuroscience), Noah Cowan (Engineering), and Mike Yassa (Psychology)




34

# Reinforcement Learning, Acetylcholine, and Astrocytes

Marshall Shuler
Department of Neuroscience
School of Medicine

35

# The Motor-cognitive Interface, Skill and Gaming

John Krakauer
Department of Neurology
School of Medicine

36

# Fear Conditioning in Humans

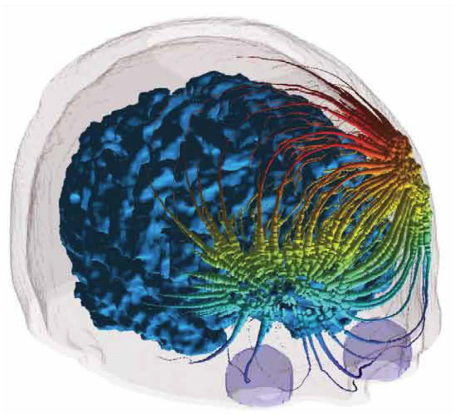
Chang-Chia Liu
Department of Neurological Surgery
School of Medicine

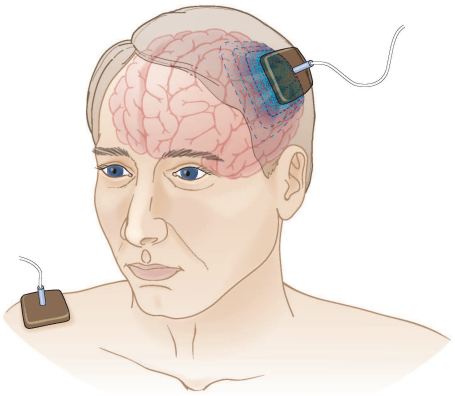
37

# Can Brainpower Be Boosted? (Safely)

Barry Gordon
Department of Neurology and Cognitive Science
School of Medicine

38





39