Using EEG to quantify the enhancement of cognitive control deficits in older adults following video game training

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Research Motivation

- Identify alterations in fundamental brain mechanisms that underlie the broad spectrum of cognitive deficits.

- Leverage these mechanisms to enhance deficient cognitive control processes.
Cognitive enhancement

Traditional Education

Pharmaceuticals

Physical exercise

Enriched Environments

Nutrition

Video games

Pharmaceuticals

Meditation

Neurofeedback

Neuromodulation
Carefully-designed interventions using game mechanics can be powerful agents for change.
Basis of the Game

Multitasking Cost: 
\[
\frac{(\text{Single task} - \text{Multitask})}{\text{Single task}} \times 100
\]
Training the ability to resolve interference

First 3 Days in Lab

EEG + Cog Tests

One Month: Home

Training

Final 3 Days in Lab

EEG + Cog Tests
No Cost

Interference Training

Decades of Life

Multi-tasking Index d'

-100%
-80%
-60%
-40%
-20%
0%
20s 30s 40s 50s 60s 70s

Pre Train 1 mo. Later 6 mo. later

Training Study

Anguera et al. Nature 2013

Multi-task train
Single-task train
No-contact control

12 hours
Transfer to other tasks

Note that only the MTT group showed improvement after training for each of these tasks.
Multitasking: Neural Diagnostic

**Neuroracer**

Electroencephalography (EEG)
Interference Training

Frontal Theta Power

Decades of Life

Anguera et al. Nature 2013
Long-Range Theta Coherence

PLV (% Coherence)

1  5  10

Older

NeuroRacer  Active Control  No Contact
General Conclusions

- Improvements were associated with changes in early sensory processing and engagement of prefrontal cortex.

- .... So how did we collect and analyze these data?
IEEE Dataport for the Brain Data Bank Challenges
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**Data Pre-processing Procedures**

1. High-pass filter at 1Hz
2. ICA to remove blinks
3. Segmentation (-1000 to +1000)
4. Artifact Rejection (-100uV to +100uV)

**ERSP Processing**

1. Baseline Corrected (-900 to -700)
2. Morlet Wavelets

**Phase Coherence**

1. Hilbert Transform
2. Baseline Corrected

★ All done in MATLAB

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Please please use this data set!

* One of the best known cognitive training data sets with EEG

* Possibly only cognitive training set with unique EEG features to interrogate

* Will gladly provide the original scripts for processing to help!
MANY MANY THANKS ...

• Adam Gazzaley
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Extra Slides
Move it out of the lab