EEG/ERP: Potential Applications for tDCS

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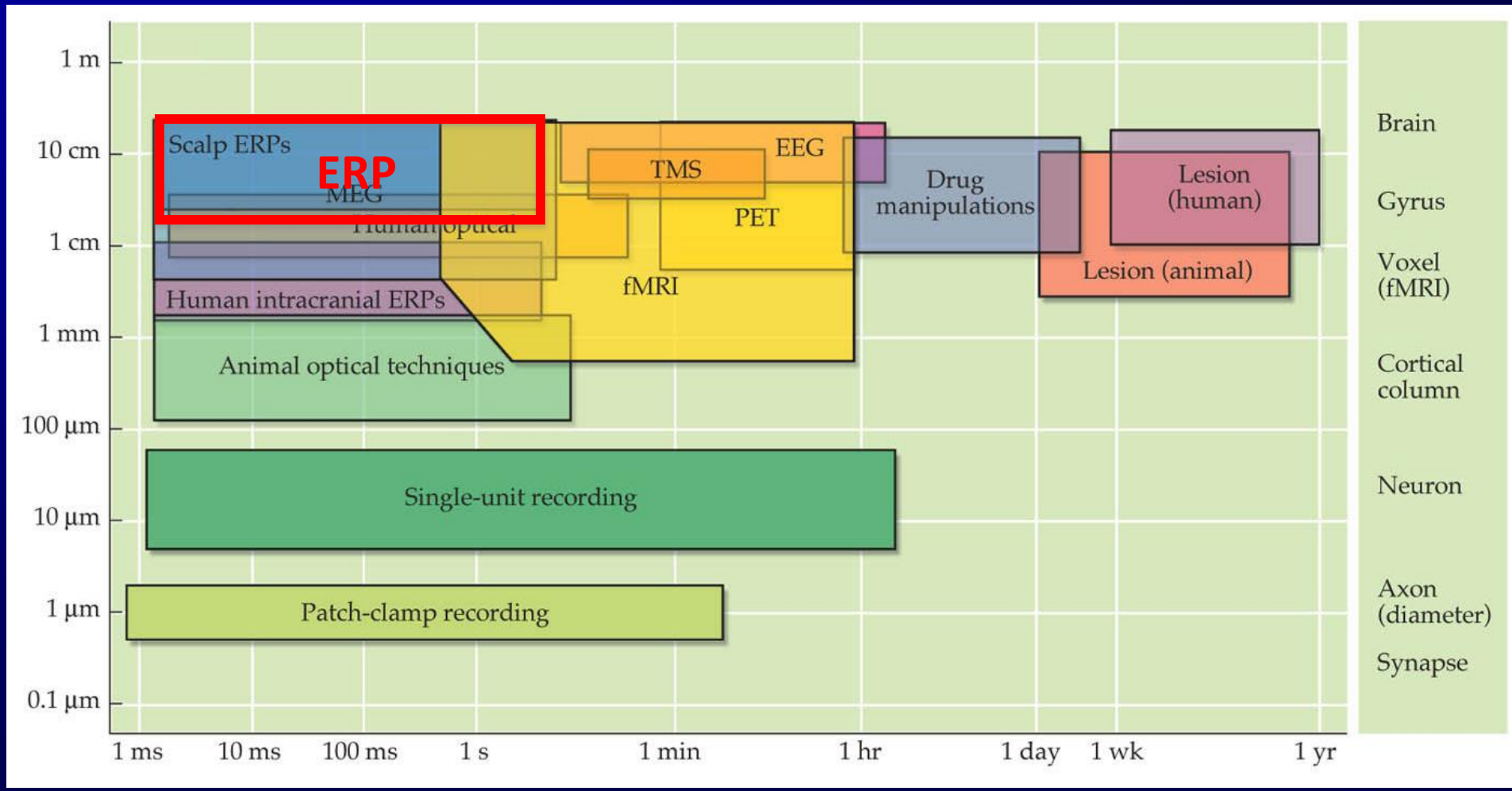
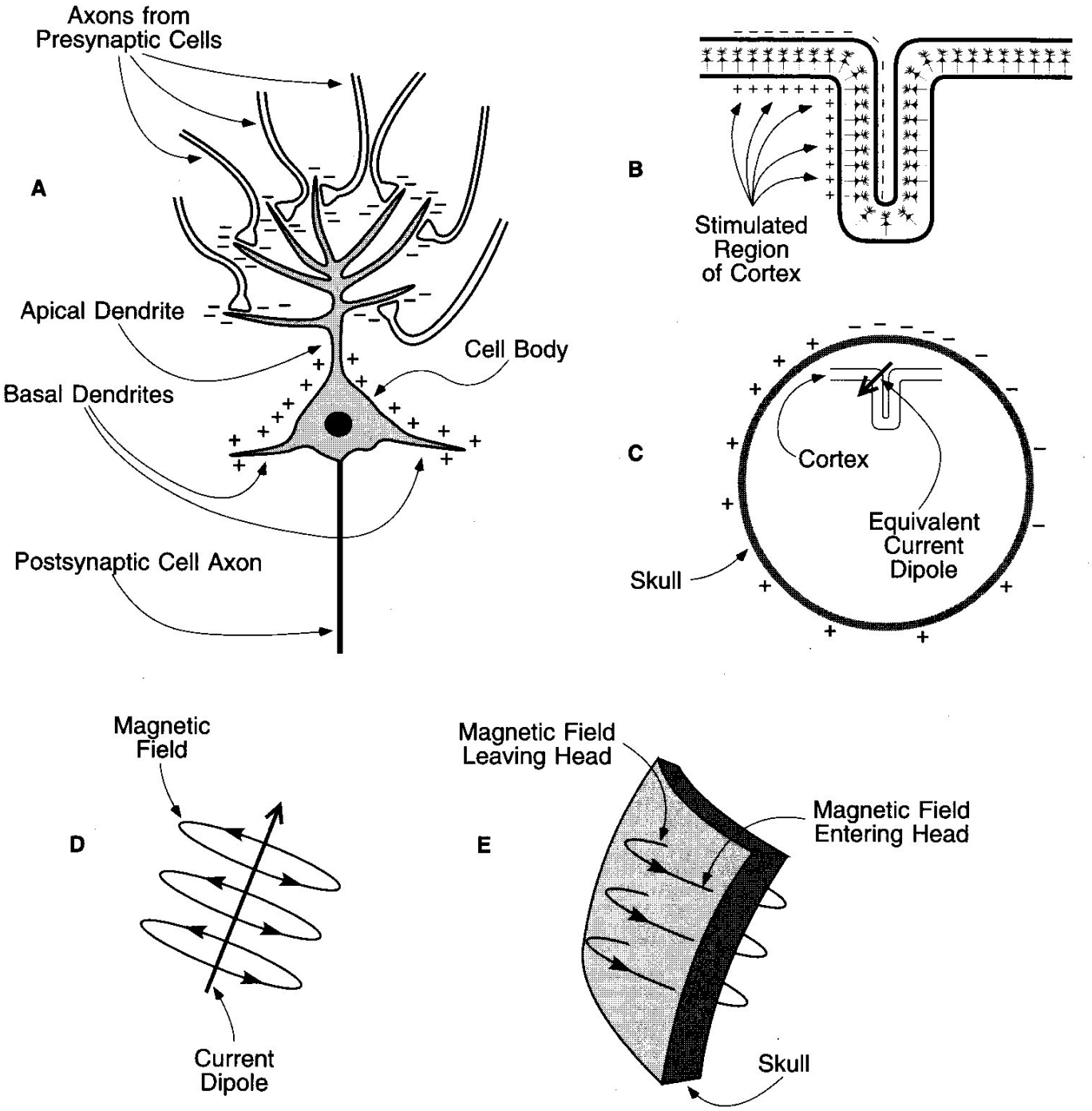
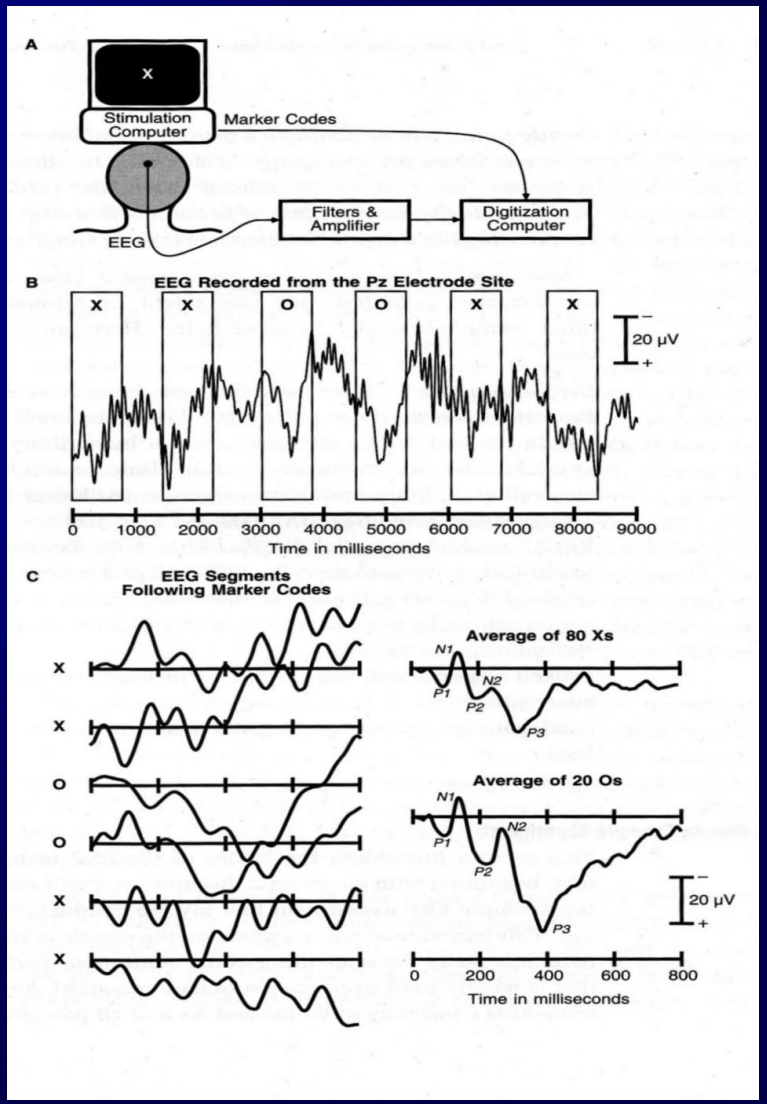


Huettel et al., 2004


Axons from
Presynaptic Cells
A
Apical Dendrite
Cell Body
Basal Dendrites
Postsynaptic Cell Axon
B
Stimulated
Region
of Cortex
C
Cortex
Equivalent
Current
Dipole
Skull
D
Magnetic
Field
Current
Dipole
E
Magnetic Field
Leaving Head
Magnetic Field
Entering Head
Skull

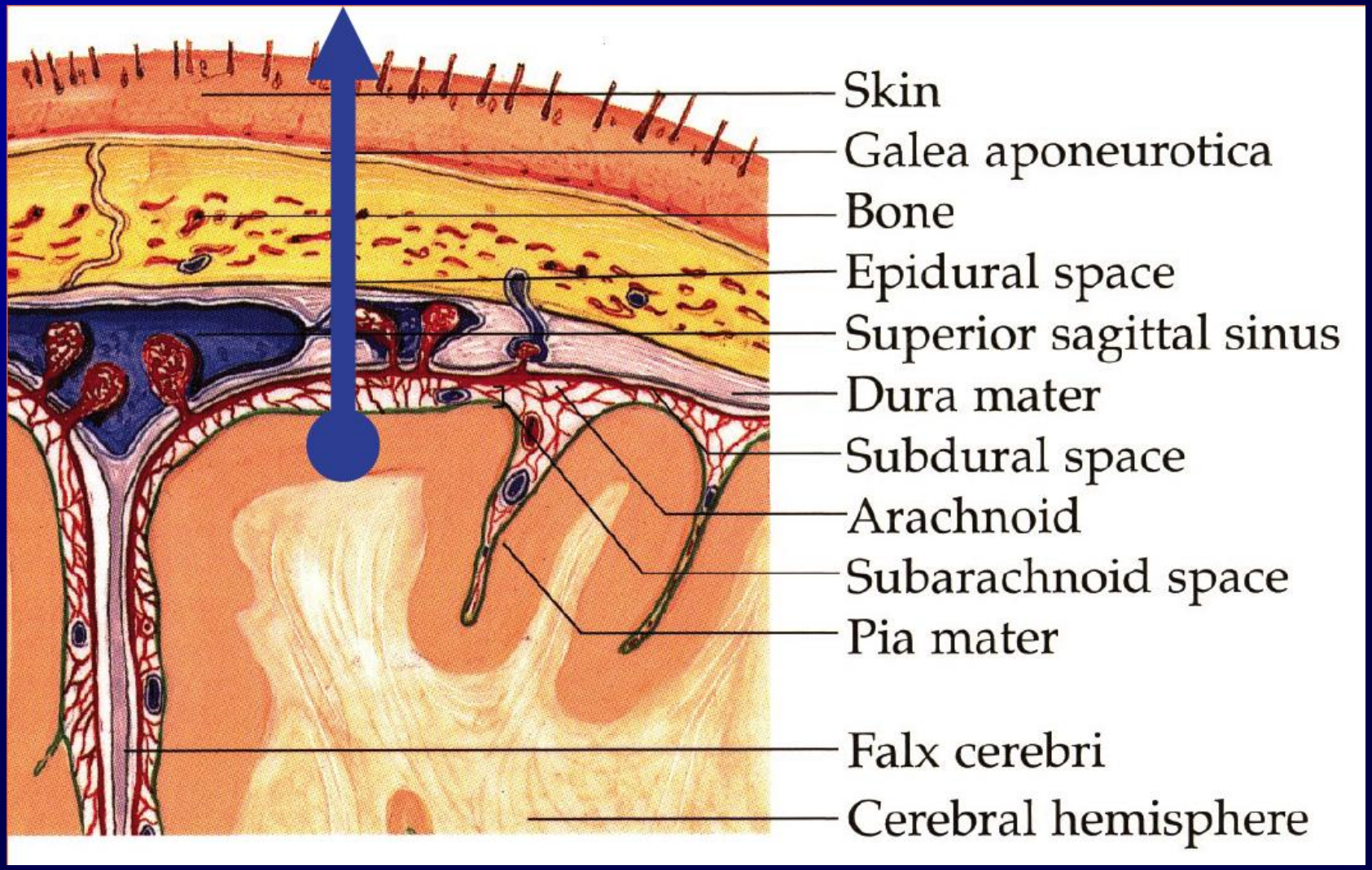
Event-Related Potentials (ERP)

- ERPs time-locked brain-wave recordings to a particular event or response
- Averaging multiple trials to that event (eg. hits) allows for reduction in noise and linking to underlying brain processes

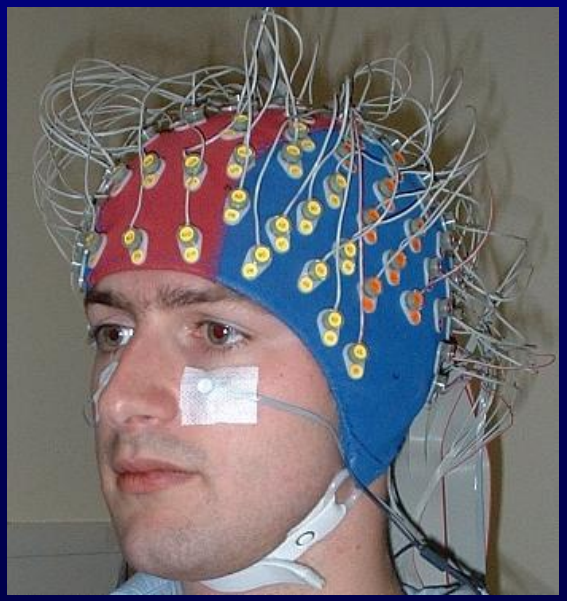


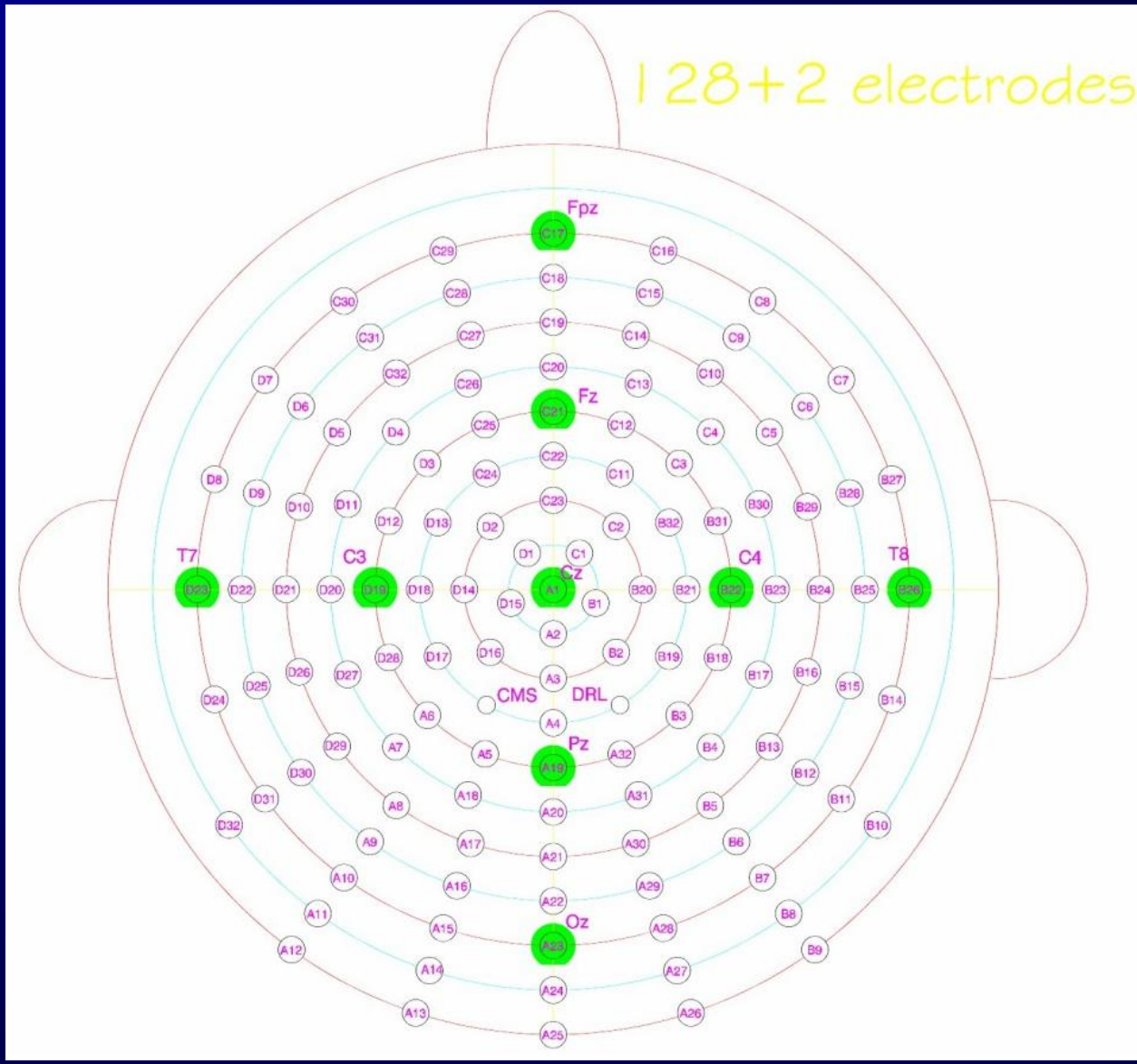
Luck, 2005

Limited Spatial Resolution



Courtesy M. Funke, UU, SLC, UT, Anto Bagic; Modified by DW




128+2 electrodes
Fpz
Fz
T7
C3
Cz
C4
T8
CMS
DRL
Pz
Oz

ERP Components

- Controversial how to define
- Components/waves defined by a peak with a particular
  - Polarity
  - Latency
  - Scalp Distribution
- Many conceive of it as a scalp recording of neural activity generated by a neural assembly in service of an underlying senorimotor or cognitive process

Basic Analytic Approach

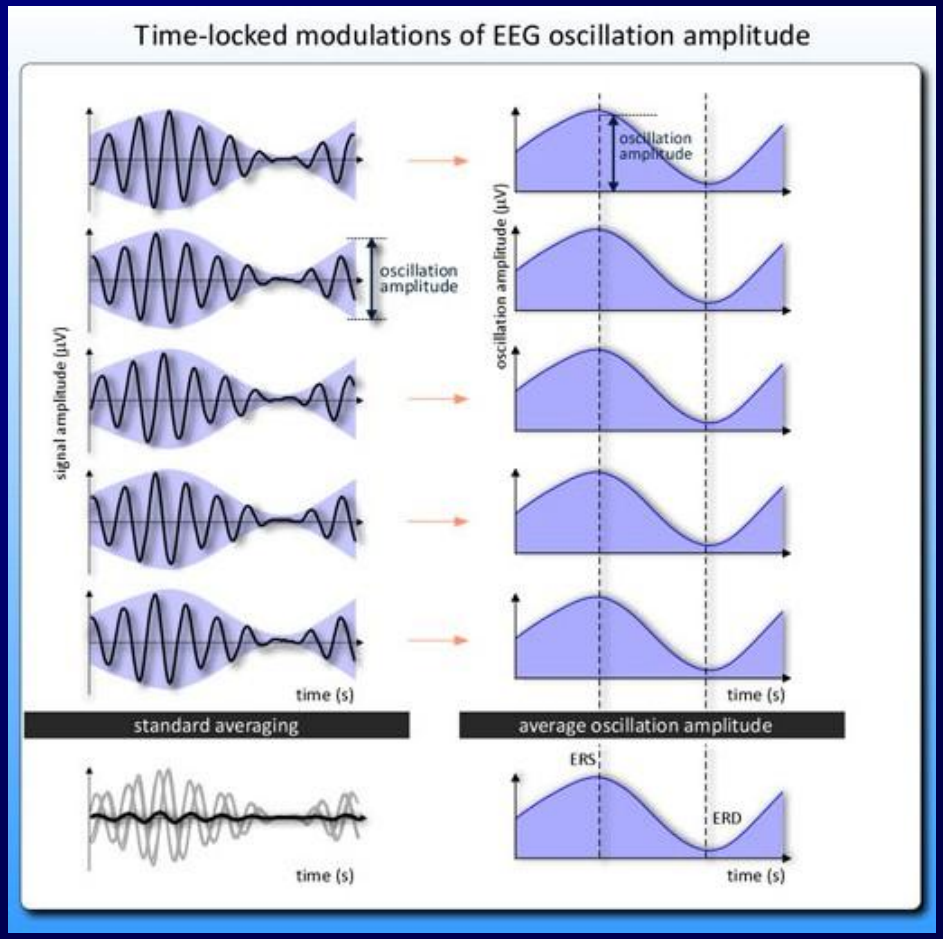
- Low tech approach
  - Examine peak amplitudes, mean amplitudes, latencies, etc across conditions
- Advantage is decades of research
- Many well defined components related
  - Visual
  - Auditory
  - Somatosensory
  - Language
  - Attention
  - Memory

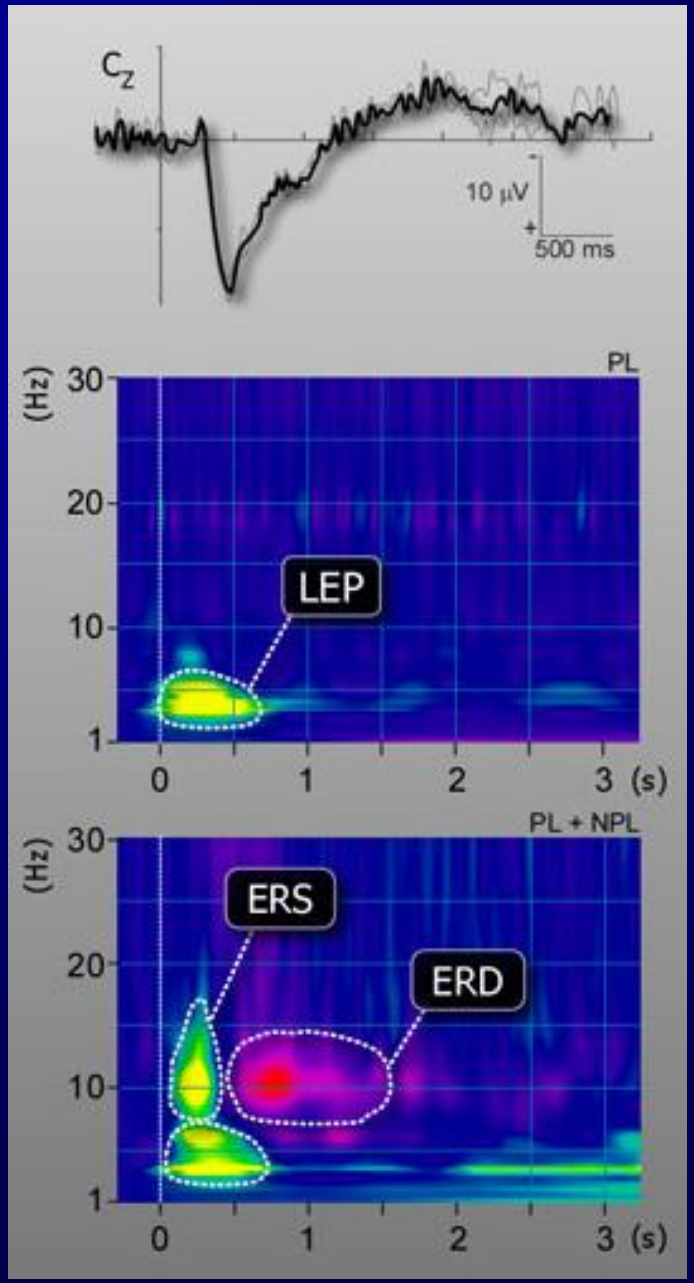
Additional Approaches

- Spectral Analysis
  - Resting or Task-related
- Time-Frequency Analysis
  - Event-related synchronization/desynchronization (ERSD)
- Scalp/source coherence
  - Potential measure of functional connectivity
- Current source density
- Additional source localization techniques

Oscillations

- Spontaneous
  - Not time-locked to stimulus
- Induced
  - Time-locked, but not phase-locked
- Evoked
  - Time- and phase-locked
  - Only activity seen with ERPs



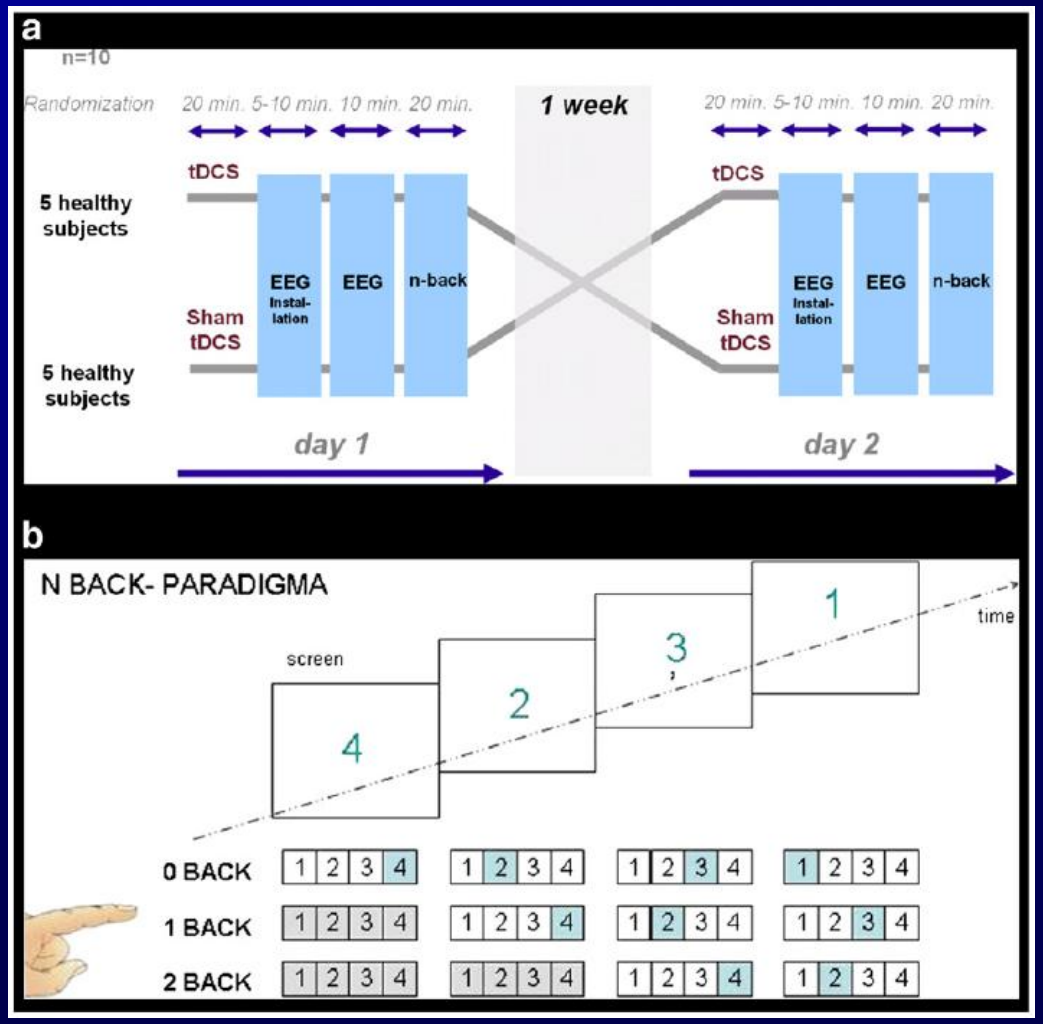


Mouraux et al., *Clinical Neurophysiology*, 2003

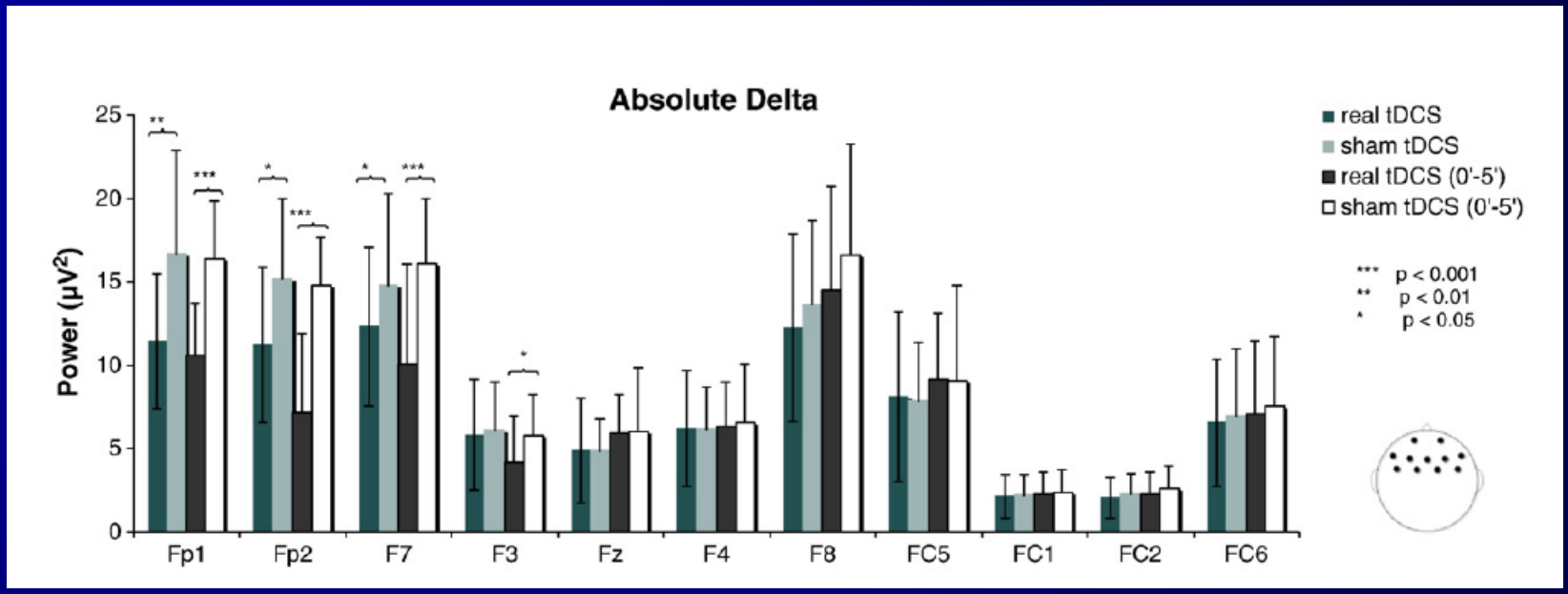
How Might EEG/ERP be Applied to Evaluate Brain Effects of tDCS?

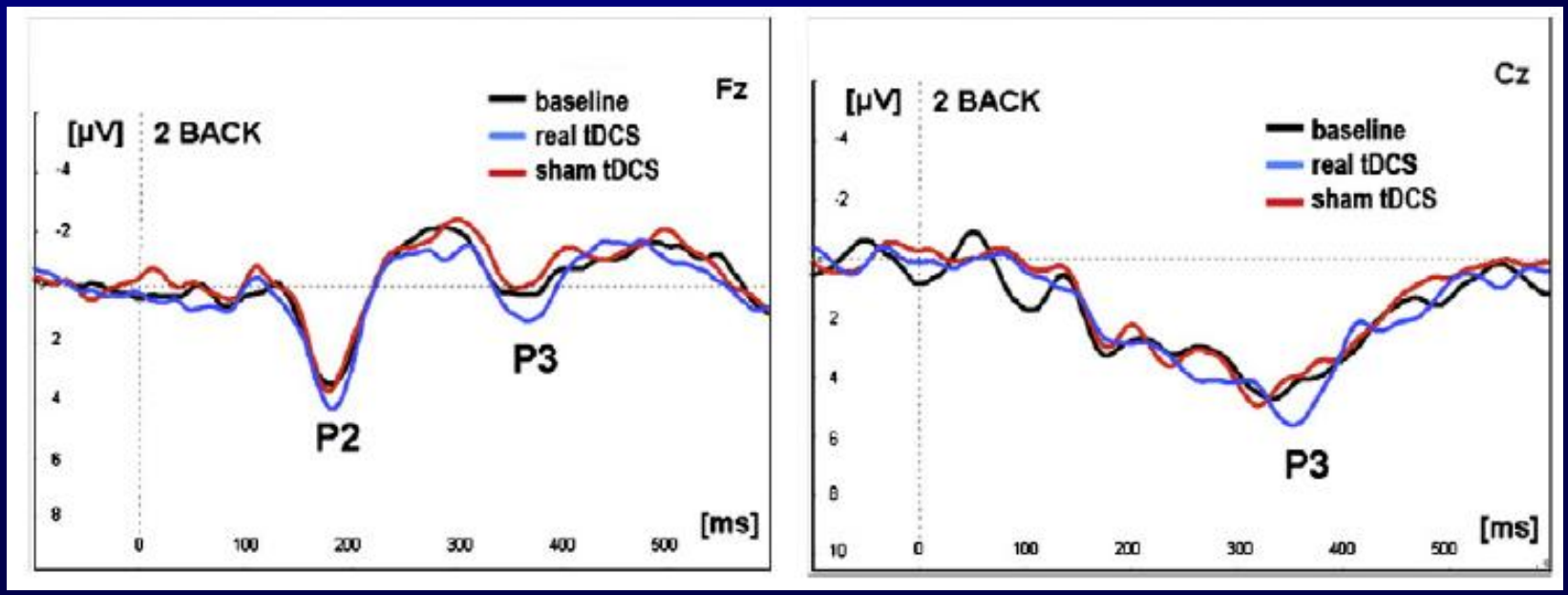
- Few studies of combined tDCS/EEG in literature
- Larger (although still limited) literature of using EEG/ERP to assess rTMS affects
  - Used to assess ‘lasting’ effects of rTMS

Combined tDCS/EEG Study

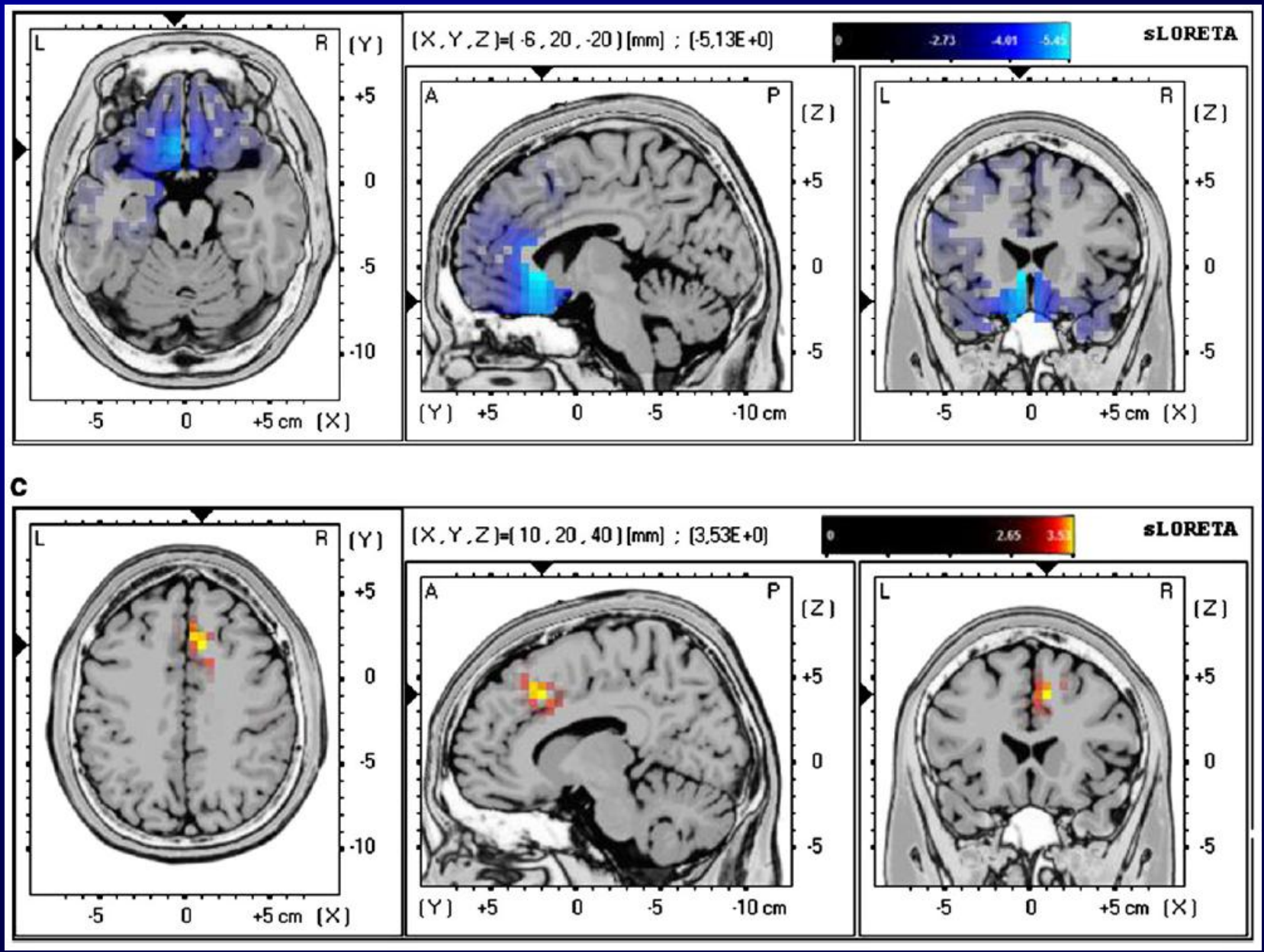


Keeser et al., NeuroImage, 2011



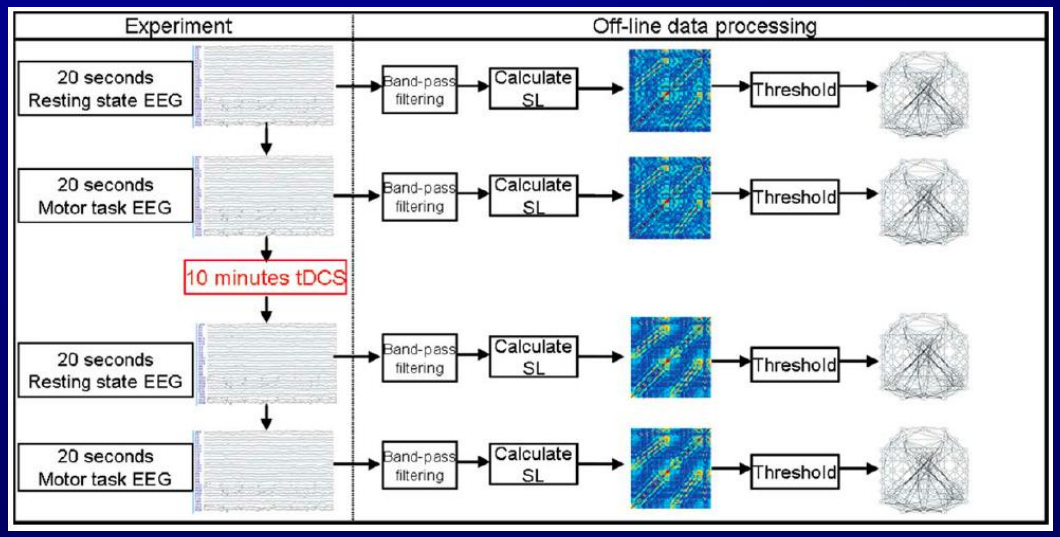


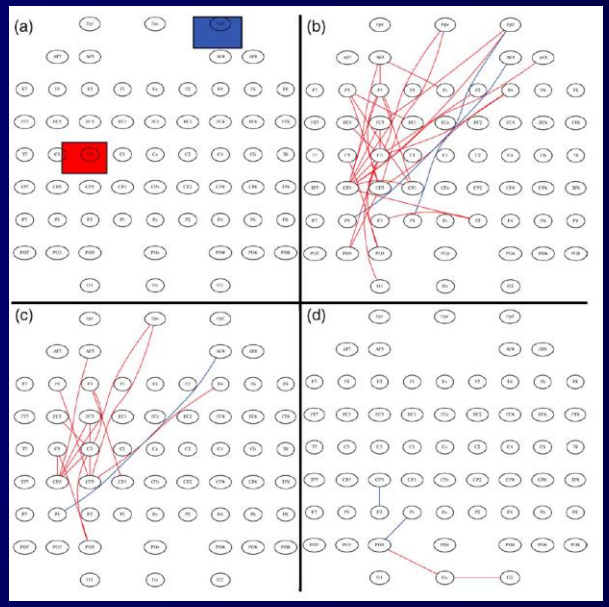
Keeser et al., NeuroImage, 2011



Keeser et al., NeuroImage, 2011

Measuring Functional Connectivity Effects of tDCS

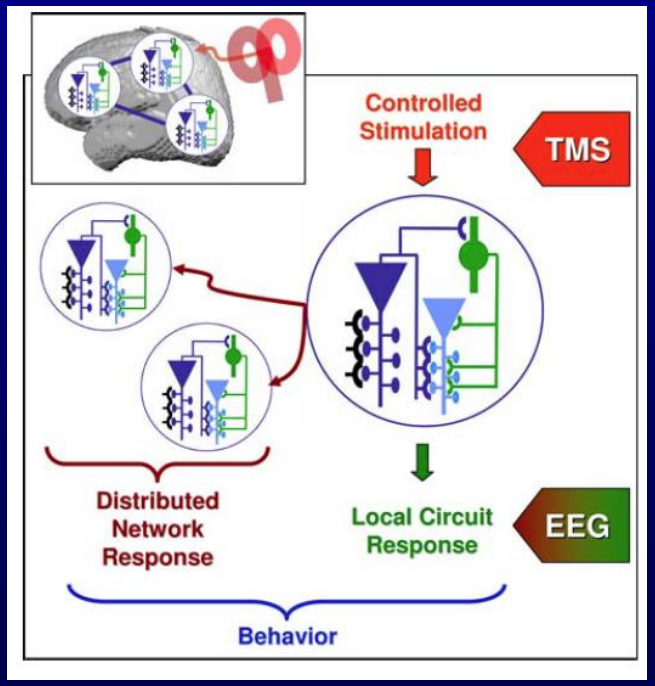




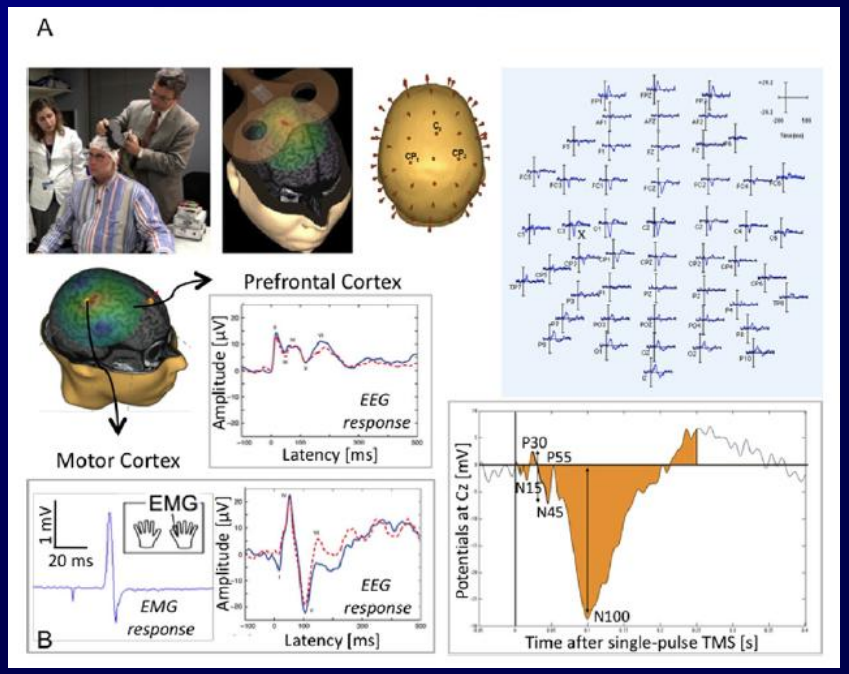
Polania, Nitsche, and Paulus, *HBM*, 2010

TMS-Evoked Potentials

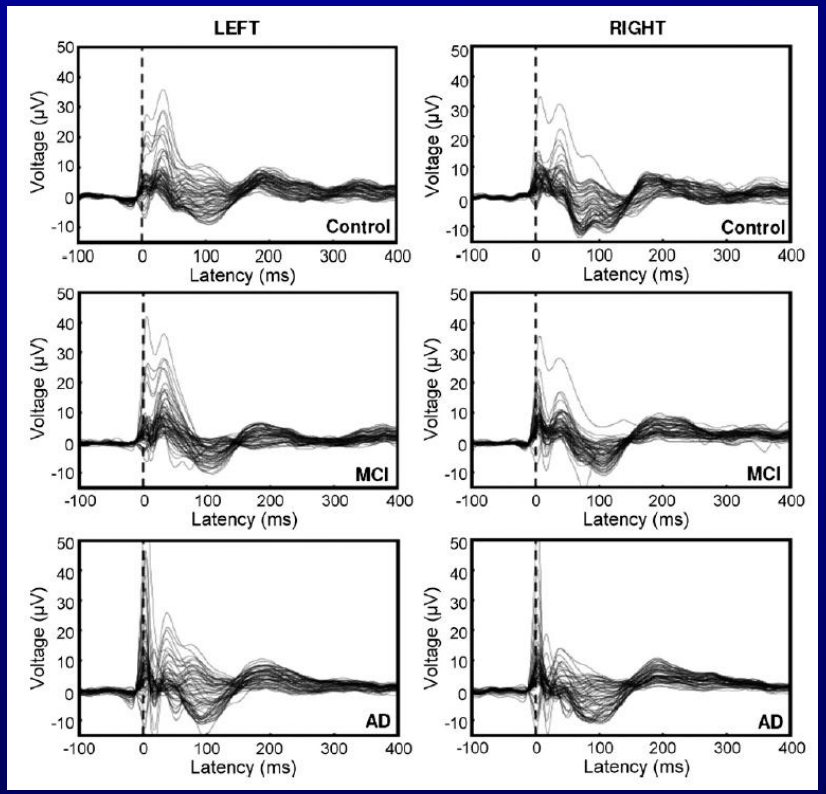
- Primary evidence of tDCS physiologic effect is change in TMS-induced MEP
  - Limited to motor physiology
- TMS-EP's to assess other cortical regions

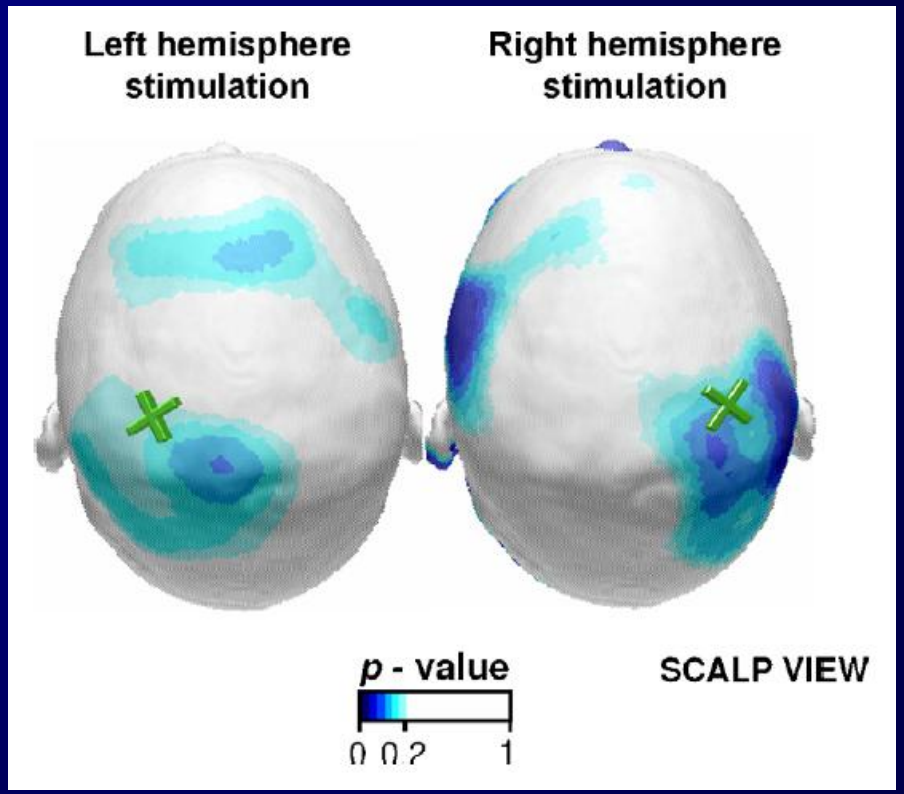


Thut and Pasual-Leone, *Brain Topography*, 2010

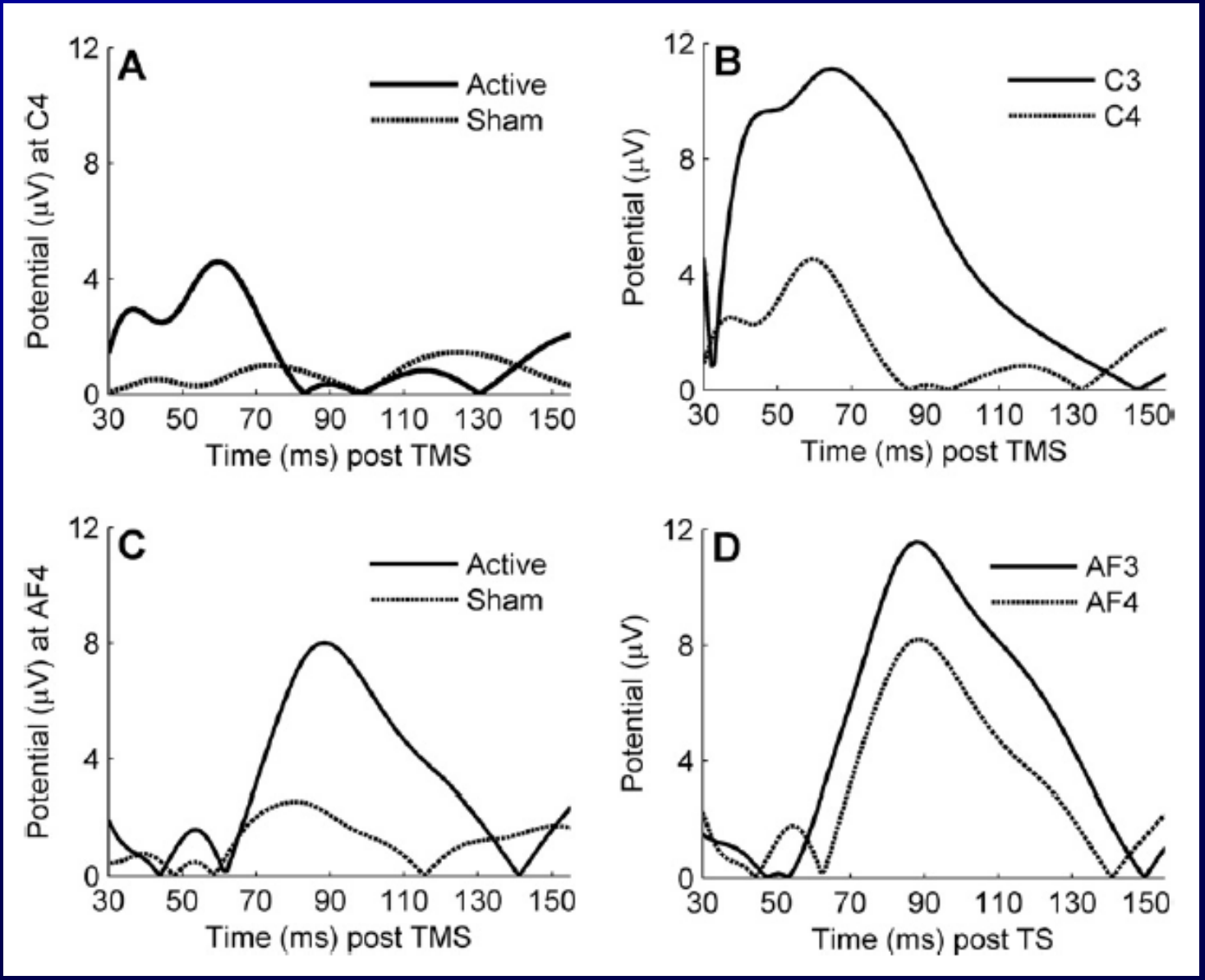


McClintock et al., *Biological Psychiatry*, in press



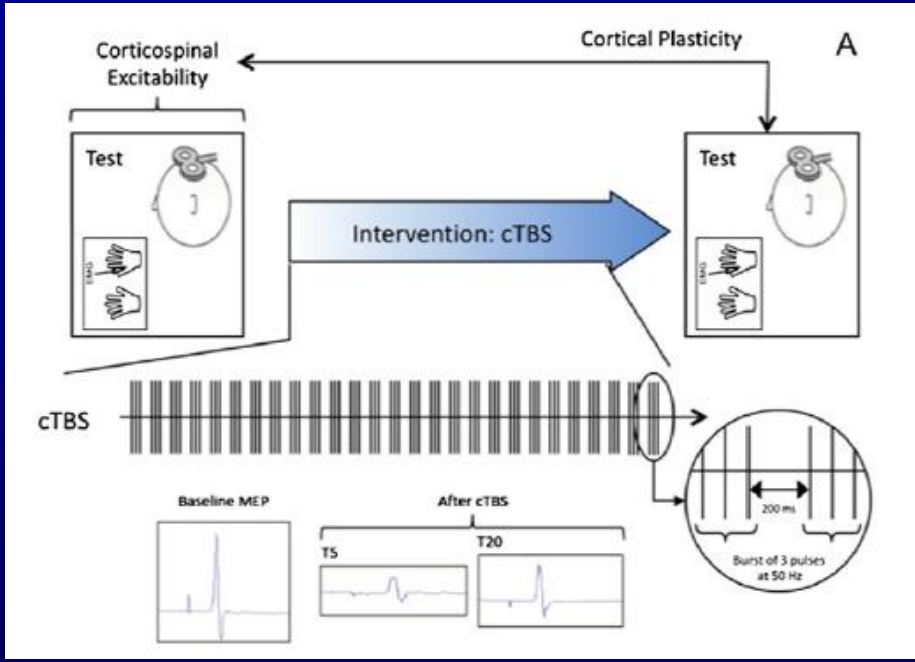


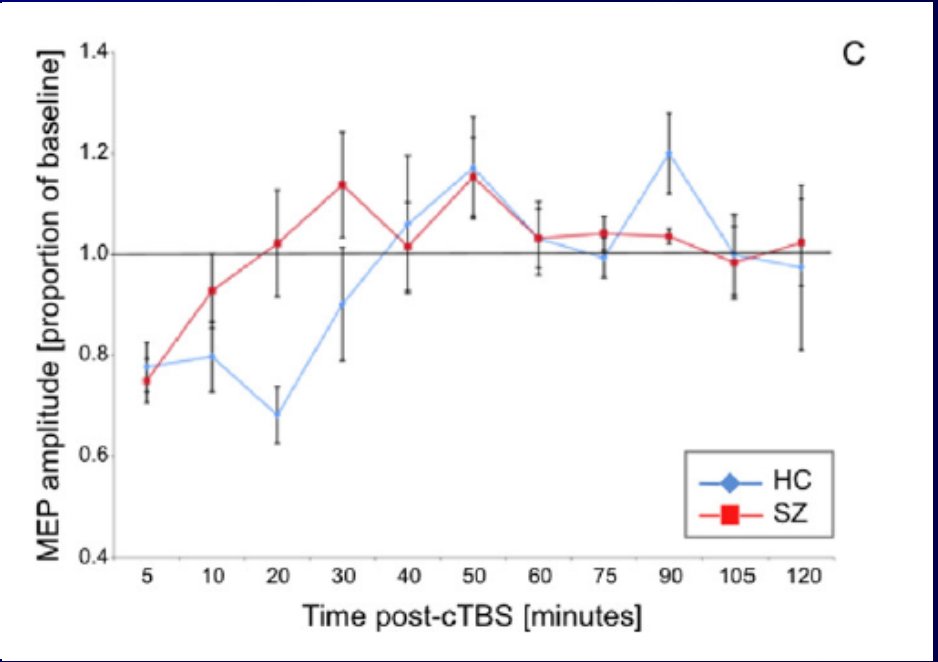
Julkunen et al., Journal of Neuroscience Methods, 2008



Voineskos et al., *Biological Psychiatry*, 2010

Theta Burst Stimulation – Model for tDCS





McClintock et al., *Biological Psychiatry*, in press

Advantages of EEG/ERP

- Direct measure of neuronal activity
- Chronometric sensitivity
- Potential to assess local and network effects
- Many components and processing correlates well-described
- Ease of use
  - Cheep, location-independent, non-invasive
- Developing literature on its use for longer-lived effects of TMS

Thank you!