EEG/ERP: Potential Applications for tDCS

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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
Limited Spatial Resolution

- Skin
- Galea aponeurotica
- Bone
- Epidural space
- Superior sagittal sinus
- Dura mater
- Subdural space
- Arachnoid
- Subarachnoid space
- Pia mater
- Falx cerebri
- Cerebral hemisphere

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