Overview

- Review of safety
- Definitions
- Motor Threshold background
- Attaching EMG electrodes
- Finding the hotspot
- Assessing the motor threshold
- Phosphene hotspot/threshold
- Hands-on
Safety First!!!

- Screen for contraindications and side-effects
- Earplugs **must** be worn by subject and **and** operator
Motor threshold (MT) definition

- The minimum intensity (% of maximum machine output) to elicit a motor response in at least 50% of trials
Role of MT

- Objective measure of relative cortical excitability/reactivity
  - Reflects voltage-dependent ion channel function
  - Highest test-retest reliability of any TMS measure

- Used to individualize intensity of further TMS

- Consistent with safety limits (Rossini et al., 2009)
Factors that influence MT

- **Subject factors:**
  - Inter- and intra-individual variance
  - Activity of brain/muscle
  - Coil-to-cortex distance
  - CNS drugs

- **Physical Parameters:**
  - Device (stimulator and coil)
  - Pulse waveform/shape/direction
  - Navigated vs. Non-navigated TMS
  - Method of determination (visible/EMG)
Types of MT

Resting motor threshold (RMT)  >  Active motor threshold (AMT)
Methods of determining MT

Visual inspection

Electromyography (EMG)

Determining motor threshold
RMT with EMG

Rossini-Rothwell method:

- Minimum intensity to elicit motor evoked potentials (MEPs) of $\geq 50 \, \mu V$ peak-to-peak amplitude in $\geq 50\%$ of consecutive trials (typically 10)
Target muscle

- First dorsal interosseus muscle
- Abductor pollicis brevis
Penfield‘s motor homonculus
Attaching EMG electrodes

Identify
- FDI MUSCLE
- FIRST PHALANX
- ULNAR HEAD

Clean

Attach
Finding the “hot spot” with neuronavigation

Determining motor threshold
Finding the “hot spot” without neuronavigation

≈5 cm lateral from the vertex

(Jaspers, 1958)
Finding a starting location
Finding the “hot spot”

1. Set intensity to 30% and deliver a couple of pulses
2. Go up in steps of 5-10% until MEPs are observed
3. Deliver several pulses to ensure a consistent response is evident (suprathreshold)
4. Test four spots around the location of the MEP (north, east, south, west)
5. Repeat Step 4 until the individual’s “hot spot” is identified

Whatever you do, do it consistently.
Finding the MT

1. Record 10 MEPs
2. Progressively lower intensity (1-2%) until ≥5/10 trials elicit an MEP of ≥50 μV (or visible twitch)
3. Always check 1 intensity lower
Finding the MT

- Alternatives under time constraints:
  - ≥3/6
  - Adaptive MT determination/Parameter estimation by sequential testing (PEST) with the TMS Motor Threshold Assessment Tool (clinicalresearcher.org)

- Trouble shooting:
  - No MEP detected (relaxation, AMT, silent period)
  - MEP latencies = 20-30 ms
Phosphenes

- Visual percept not triggered by phototransduction (i.e., rubbing your eyes, blow to the head, TMS to visual cortex)

- Means to probe excitability of visual cortex (like MEPs)
- Unlike MEPs, phosphenes are subjective
Phosphene hotspot/threshold

- Measure 2cm dorsal and 2cm lateral from the inion
- Center the coil with handle pointing away from midline
- Phosphenes should appear in contralateral visual field
- Increase intensity or move coil until phosphenes are reported
- Assess phosphene threshold same as motor (i.e., 5 of 10)
Safety First!!!

- Screen for contraindications and side-effects
- Earplugs must be worn by subject and operator