Determining motor threshold

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What are the learning objectives of this session?

1. What is motor threshold (MT)?
2. Why do we determine MT?
3. What types of MT can be determined?
4. What are the available methods to determine MT?
5. What are the key steps for determining resting MT with electromyography?

→ Hands-on practice
What is motor threshold (MT)?

- The minimum amount of machine output necessary to elicit a motor response in a participant or patient in at least 50% of all attempts
- Represents membrane-related excitability of cortical axons
- Depends on:
  - Inter- and intraindividual variance
  - Device (stimulator and coil)
  - Type of MT
  - Method of determination
  - Hemisphere stimulated
Why do we determine MT?

- Easy to observe
- Objective (see phosphene threshold)
- Indicator of relative cortical excitability
- A way of calibrating and normalizing TMS coil output energy for inter- and intraindividual physiologic variability in experimental designs and therapeutic applications
- Determines dosage and safety limits
What types of MT can be determined?

Resting motor threshold (RMT) > Active motor threshold (AMT)
What are the available methods to determine MT?

- Visual inspection
- Electromyography (EMG)
RMT with EMG

- The minimum amount of machine output necessary to elicit a motor response in a participant or patient in at least 50% of all attempts

Minimum single-pulse stimulator output intensity resulting in motor-evoked potentials (MEPs) of at least 50 µV peak-to-peak amplitude in ≥50% of n consecutive trials (≥5/10; Rossini-Rothwell method)

Determining motor threshold
What are the key steps for determining RMT with EMG?

1. Choosing an output target
2. Setting up and ensuring safety
3. Locating the motor hotspot (adjusting location)
4. Assessing the MT (adjusting intensity)
Choosing an output target

Determining motor threshold
Choosing an output target

Determining motor threshold
Setting up and ensuring safety
Locating the motor hotspot

≈5 cm lateral from the vertex

(Jaspers, 1958)
Locating the motor hotspot

$\approx 5 \text{ cm lateral from the vertex}$
Locating the motor hotspot

Nasion

Right ear A

B

D

Left ear C

A

Inion

Right ear

45°
Locating the motor hotspot

1. Set intensity to 30% maximum stimulator output (MOS) and deliver 3 pulses (6-10 s apart)
2. Go up in steps of 10% until you observe a muscle twitch
3. Deliver several pulses to ensure a consistent response (MEP) is evident (suprathreshold)
4. Test points 1 cm anterior, medial, posterior, and lateral
   - Move clockwise, starting with anterior spot
   - Deliver 3 pulses at each location
Locating the motor hotspot

1. Set intensity to 30% maximum stimulator output (MOS) and deliver 3 pulses (6-10 s apart)
2. Go up in steps of 10% until you observe a muscle twitch
3. Deliver several pulses to ensure a consistent response (MEP) is evident (suprathreshold)
4. Test points 1 cm anterior, medial, posterior, and lateral
   - Move clockwise, starting with anterior spot
   - Deliver 3 pulses at each location
5. Repeat Step 4 until the individual’s hotspot is identified

Determining motor threshold
Locating the motor hotspot

1. Set intensity to 30% maximum stimulator output (MOS) and deliver 3 pulses (6-10 s apart)
2. Go up in steps of 10% until you observe a muscle twitch
3. Deliver several pulses to ensure a consistent response (MEP) is evident (suprathreshold)
4. Test points 1 cm anterior, medial, posterior, and lateral
   - Move clockwise, starting with anterior spot
   - Deliver 3 pulses at each location
5. Repeat Step 4 until the individual’s hotspot is identified
6. The location that elicits the largest peak-to-peak MEP amplitude is the motor hotspot
Locating the motor hotspot

- Keep in mind:
  - The hotspot is **not** at the interior curve of the TMS coil
  - The distance between center and the interior curve of a figure-of-eight coil varies across vendors/coil types
Assessing the MT

1. Set intensity to 30% MOS and deliver 3 pulses (6-10 s apart)
2. Go up in steps of 10% until you observe an MEP
3. Deliver several pulses to ensure a consistent response (MEP) is evident (suprathreshold)
4. Record 10 MEPs
5. Progressively lower intensity (1-2%) until <5/10 show an MEP of ≥50 µV
6. The lowest intensity that elicits MEPs in ≥5/10 pulses is your MT
Assessing 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, silence period)
- MEP latencies > 150 ms
- Expectation