Non-invasive Transcranial Magnetic Stimulation mapping of neuroplasticity to inform recovery after brain injury

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Background

Why Motor Mapping Matters:

- Accurate identification of the motor cortex is essential for:
  - Neurosurgical planning
  - Functional risk assessment
  - Rehabilitation after brain injury

Current Challenges

- Functional Magnetic Resonance Imaging(fMRI) identified motor activation
  - Needs patient cooperation
  - Measures function indirectly

Opportunity

- There is a need for non-invasive methods that directly assess motor pathway function and network reorganization
- **Single-pulse transcranial magnetic stimulation (sTMS)** provides complementary information by directly testing motor pathway function and neuroplasticity.

Objective and Approach

Objective:

To evaluate whether neuro-navigated single-pulse transcranial magnetic stimulation (sTMS) can identify motor network organization and characterize neuroplasticity through direct assessment of corticospinal function.

Participants

- Pediatric participants with epilepsy undergoing presurgical evaluation.

Motor Mapping with sTMS

- MRI-guided neuronavigated sTMS
- Motor evoked potential recording
- Cortical excitability mapping

Analysis

- Co-registration of sTMS maps to MRI-derived cortical surfaces
- Comparison with corresponding fMRI activation maps

INDIVIDUALIZED MULTIMODAL MOTOR MAPPING

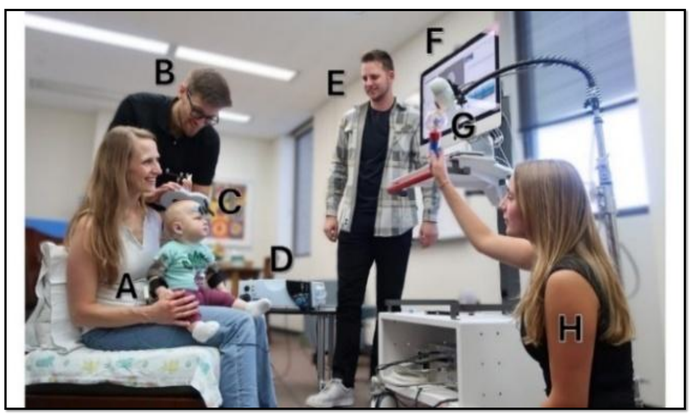

Figure 1. (A) Pilot participant seated with caregiver, (B) Team member delivering sTMS, (C) TMS coil, (D) TMS machine, (E) Team member operating neuronavigation software, (F) Computer interface displaying real-time neuronavigation, (G) Neuronavigation camera, (H) Team member engaging the child with age-appropriate toys or activities.

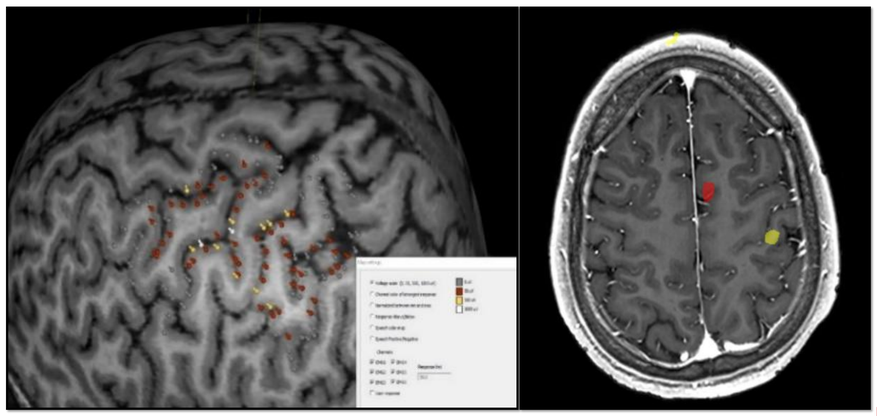

Figure 2. Left: TMS motor maps were obtained from a single subject (red- 50µv MEP, yellow- 500 µV MEP). Right: the corresponding motor map of task-based fMRI (Red- leg area; Yellow- hand area)

Results

- Successful co-registration of sTMS maps with MRI anatomy
- Visualization of participant-specific motor excitability
- Quantification of motor map extent and centroid location
- Direct comparison of functional activation and corticospinal excitability
- Feasible framework for assessing neuroplasticity

FROM ACTIVATION TO FUNCTION

Combining sTMS and fMRI enables individualized mapping of motor pathway function and neuroplasticity.

Clinical Relevance

- Objective biomarkers of motor pathway function
- Quantification of motor network organization
- Potential applications in TBI and neurorehabilitation
- Support for recovery and return-to-function assessment

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