resolutions of the TMS mapping approach depending on a research question. We will combine the talks dedicated to the methodology and the output of the motor and non-motor cortical TMS mapping and add a non-cortical area – the cerebellum to the TMS mapping framework, discussing cerebellar TMS mapping as a possible translational model for investigating TMS cellular mechanisms. The symposium will include four talks from the Athinoula A. Martinos Center for Biomedical Imaging at Massachusetts General Hospital, Harvard Medical School, US; Max Planck Institute for Human Cognitive and Brain Sciences, Germany; and the Aalto University, Finland.

Abstract
Upper limb dexterity is one of the unique abilities of humans, which is usually compromised in patients with motor impairment. We suggest that adequate local balance among neighboring regions in the motor cortex may be one of the markers of such ability, and such balance may be non-invasively probed by means of transcranial magnetic stimulation (TMS). MRI navigated TMS (nTMS) cortical motor mapping has been FDA approved for presurgical brain mapping for more than a decade. Despite such great potential, nTMS mapping is still underused for the assessment of motor cortex plasticity, especially in clinical settings. In this talk, we will discuss the prerequisites and benefits of using multi-muscle TMS mapping for the within-limb somatotopy probing, and demonstrate the possibilities of the TMSmap (https://tmsmap.ru/), a versatile program for analyzing TMS mapping results. We will present our results of multi-muscle TMS mapping absolute and relative reliability assessment in a test-retest study in healthy subjects. Then we will present the results of the use of the same approach of multi-muscle TMS mapping to study motor cortex malleability in healthy subjects undergoing finger dexterity training. Lastly, we will discuss our results about the importance of probing motor evoked potentials (MEPs) - as a surrogate of the corticospinal tract integrity in stroke - in multiple hand muscles, to decrease the percentage of false-negative MEP patients in patients with various levels of motor impairment and time after stroke.

Research Category and Technology and Methods
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Keywords: brain mapping, cortical mapping, motor cortex, cerebellum

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Abstract key: PL- Plenary talks; S- Regular symposia oral; FS- Fast-Track symposia oral; OS- On-demand symposia oral; P- Posters

OS24.2

TMS MAPPING OF THE CEREBELLUM AS A WAY OF UNDERSTANDING TMS CELLULAR MECHANISMS

Mariia Nazarova [1], Parker Kotlarz [1], Mohammad Daneshzand [1], Anastasia Sukmanova [2], Milana Makarova [2], Yoshio Okada [3], Aapo Nummenmaa [1], Padmavathi Sundaram [1]. [1] *Harvard Medical School, USA;* [2] *National Research University, Russia;* [3] *Boston Children's Hospital, USA*

Abstract
The human cerebellum has around 80% of the surface area of the neocortex and contains more than half of all neurons in the brain. Functionally, the cerebellum is connected with multiple cerebral regions serving motor, associative, and affective functions. Anatomically, the cerebellum is located rather superficially compared to other deeply located non-cortical brain regions, making it possible to reach it using non-invasive brain stimulation. During the last decade, the cerebellum has been reported as a promising target for therapeutic neuromodulation in a wide range of pathological conditions from spinocerebellar ataxias to schizophrenia. From a different perspective, cerebellar TMS may be a promising way to understand the cellular mechanisms of TMS because compared to cortical structures, its principal structures are arranged in a mutually orthogonal configuration invariant across species. In this study, our aim is to develop an approach to TMS cerebellar functional mapping using multiple types of neurophysiological responses, including tracing the somatotopic specificity of the motor cortical modulation (e.g. cerebellar inhibition), and behavioral modulation for the eye, limb, and swallowing (deglutition) movements. The stimulation location and orientation will be guided by individual electric field modeling and diffusion MRI tractography of the highly structural orthogonal cerebellar white matter. Moreover, our goal is to differentiate whether Purkinje cells are stimulated directly or trans-synaptically through the parallel or climbing fibers translating relative electric field thresholds for the Purkinje cells and parallel fibers activation from our ongoing in vitro TMS study on a turtle cerebellum. We hope that this type of translational study will substantially increase our knowledge of the basic mechanisms of TMS and will also be a step forward in developing effective cerebellar neuromodulation approaches in humans.

Research Category and Technology and Methods
Translational Research: 10. Transcranial Magnetic Stimulation (TMS)
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OS24.3

PRECISE MOTOR MAPPING WITH TMS

Ole Numssen [1], Konstantin Weise [1], Benjamin Kalloch [1], Anna Leah Zier [2], Jens Thielscher [3], Gesa Hartwigsen [1], Thomas Knösche [1]. [1] *Max Planck Institute for Human Cognitive and Brain Sciences, Germany;* [2] *Goethe-University, Germany;* [3] *Copenhagen University Hospital Amager and Hvidovre, Denmark*

Abstract
We describe a routine to precisely localize cortical muscle representations within the primary motor cortex with transcranial magnetic stimulation (TMS) based on the functional relation between induced electric fields at the cortical level and peripheral muscle activation (motor evoked potentials; MEPs). Besides providing insights into structure-function relationships, this routine lays the foundation for TMS dosing metrics based on subject-specific cortical electric field thresholds.
MEPs for different coil positions and orientations are combined with electric field modeling, exploiting the causal nature of neuronal activation to pinpoint the cortical origin of the MEPs. This involves constructing an individual head model from magnetic resonance imaging (MRI) data, recording MEPs via electromyography during TMS, and computing the induced electric fields with numerical modeling. The cortical muscle representations are determined by relating the TMS induced electric fields to the MEP amplitudes. Subsequently, the coil position to optimally stimulate the origin of the identified cortical MEP can be determined by numerical modeling. Using this approach, we could distinguish cortical muscle representations of three finger muscles (FDI, ADM, APB) with high spatial resolution on the individual subject level and localized them primarily on the crowns and rims of the precentral gyrus. A post-hoc analysis revealed exponential convergence of the mapping with the number of stimulations, yielding a minimum of about 180 stimulations from random coil positions to obtain stable results.
Establishing a functional link between the modulated effect and the underlying mode of action, the induced electric field, is a fundamental step to fully exploit the potential of TMS. In contrast to previous approaches, the presented protocol is particularly easy to implement, fast to apply, and very robust due to the random coil positioning and therefore is suitable for practical and clinical applications.

Research Category and Technology and Methods
Basic Research: 10. Transcranial Magnetic Stimulation (TMS)
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