Fast motor mapping with 2-channel multi-locus TMS

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[1]Centre for Cognition and Decision Making, Institute for Cognitive Neuroscience, National Research University Higher School of Economics, Moscow, Russia; [2]Department of Neuroscience and Biomedical Engineering, Aalto University School of Science, Espoo, Finland; [3]BioMag Laboratory, University of Helsinki and Helsinki University Hospital, HUS Medical Imaging Centre, Helsinki, Finland; [4]The Ministry of Healthcare of the Russian Federation, Federal State Budget Institution Federal Centre for Cerebrovascular Pathology and Stroke, Moscow, Russia; [5]Max Planck Institute for Human Cognitive and Brain Sciences, Department of Neurology, Leipzig, Germany; *These authors contributed equally to the work.

Fig. A:

We investigated the possibility to perform fast TMS motor mapping with 1-mm resolution along a 30-mm line in the latero–medial direction.

We used a multi-locus (mTMS) transducer, which allows controlling the stimulus location electronically.

Fig. B:

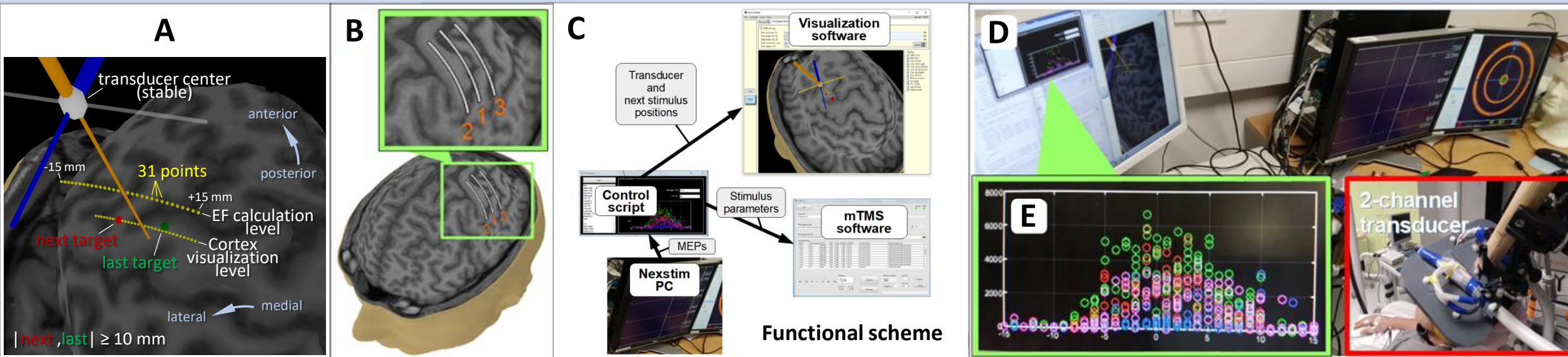mTMS was applied to the left primary motor cortex along three/five lines with a 10–15 mm anterio–posterior shift.

We performed five repetitions per location in random order resulting in 155 stimuli per line with interstimulus intervals of 1.5–2 s.

Fig. C,D,E:

Three healthy subjects (one female, 32–34 y.o.) participated in this study.

Motor evoked potentials (MEPs) were recorded from four upper limb muscles (APB, ADM, EDC, FDI).

MEP amplitudes were visualized in real time, according to the location of the induced EF maximum (Fig. E).

A — transducer center (stable); anterior; posterior; −15 mm; 31 points; +15 mm; EF calculation level; Cortex visualization level; next target; last target; lateral; medial; |next, last| ≥ 10 mm

B — 1 2 3

C — Transducer and next stimulus positions; Visualization software; Control script; Stimulus parameters; mTMS software; MEPs; Nexstim PC; Functional scheme

D

E — 2-channel transducer

Conclusions:

- Mapping of up to 18 cm^2 of the motor cortex lasted only 14–23 minutes (for 3- or 5-line design, 465–775 stimuli) compared to conventional MRI-navigated TMS mapping (>one hour).
- The spatial topography of the muscle responses was comparable to the topography typically obtained with conventional mapping.

Limitation:

Using this line mapping design it was not possible to keep the EF orientation perpendicular to the central sulcus for all the stimuli.