22th World Congress of Neurology

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Use of TMS for diagnosis: CMCT

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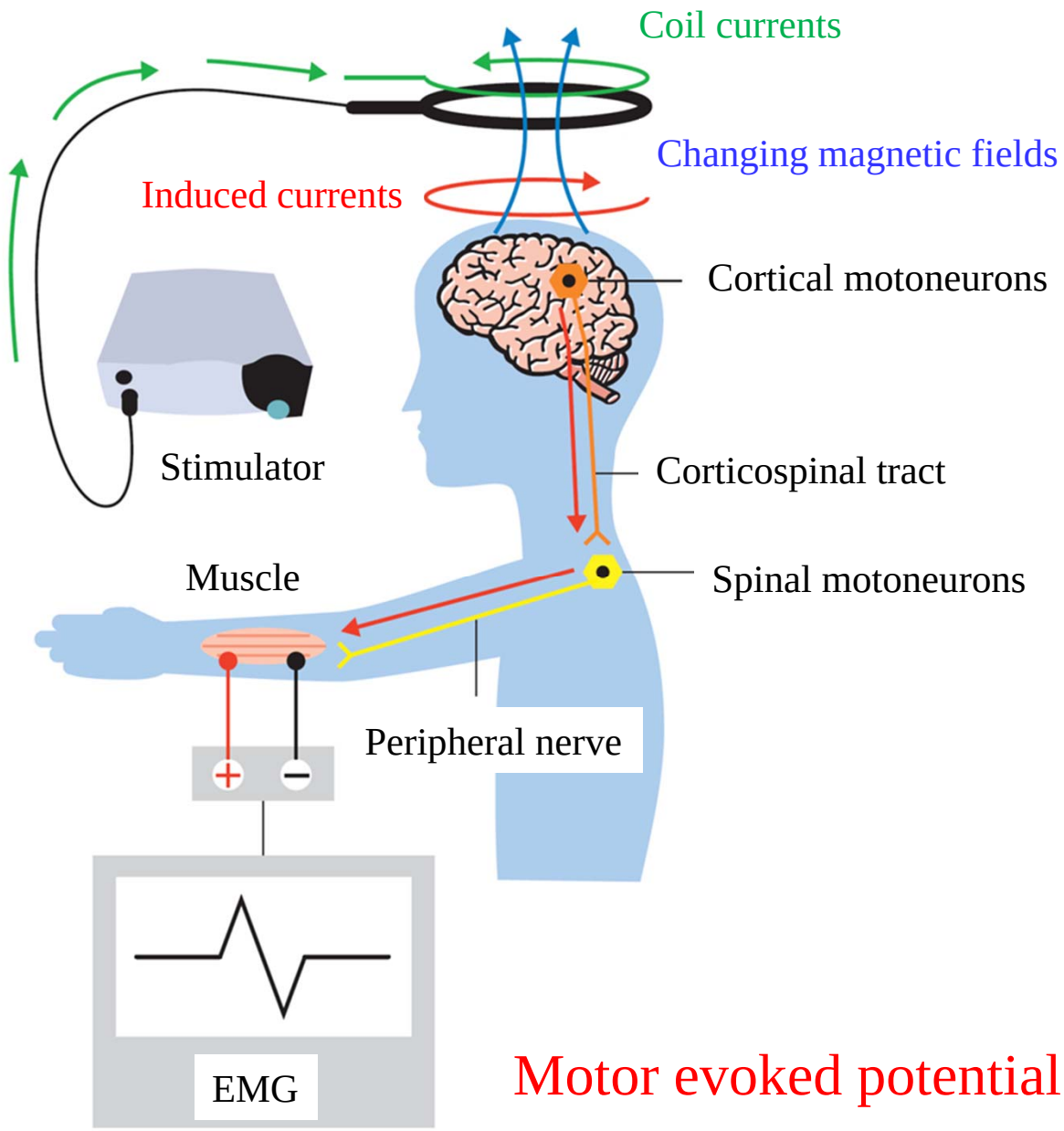
Mechanisms of TMS

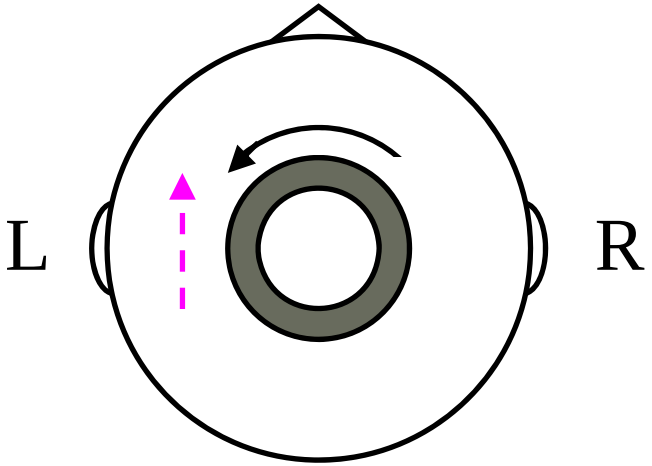
Faraday's law



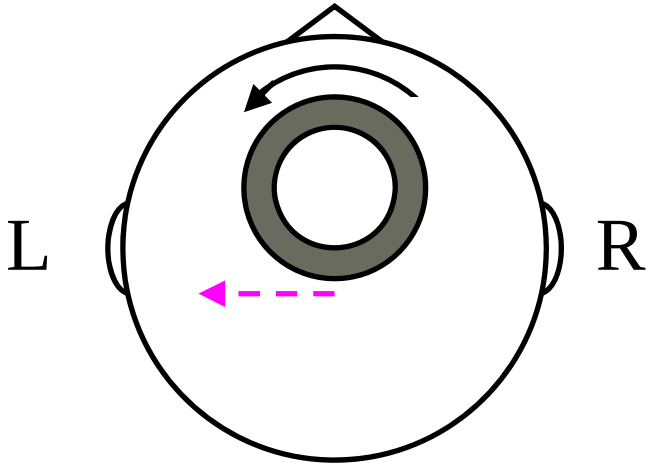
Motor evoked potential (MEP)

TMS

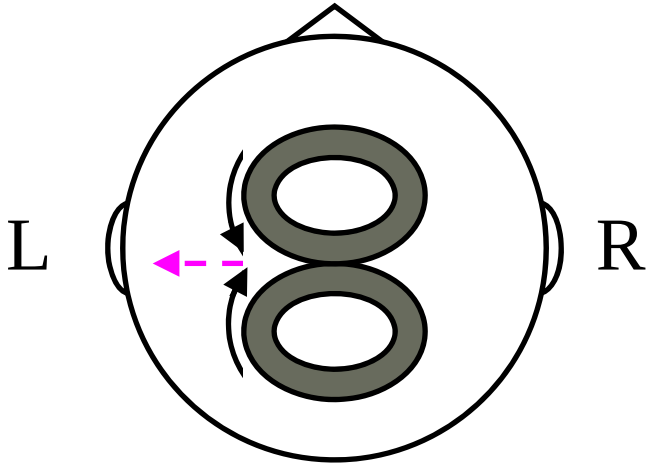
Hand muscle



Leg muscle

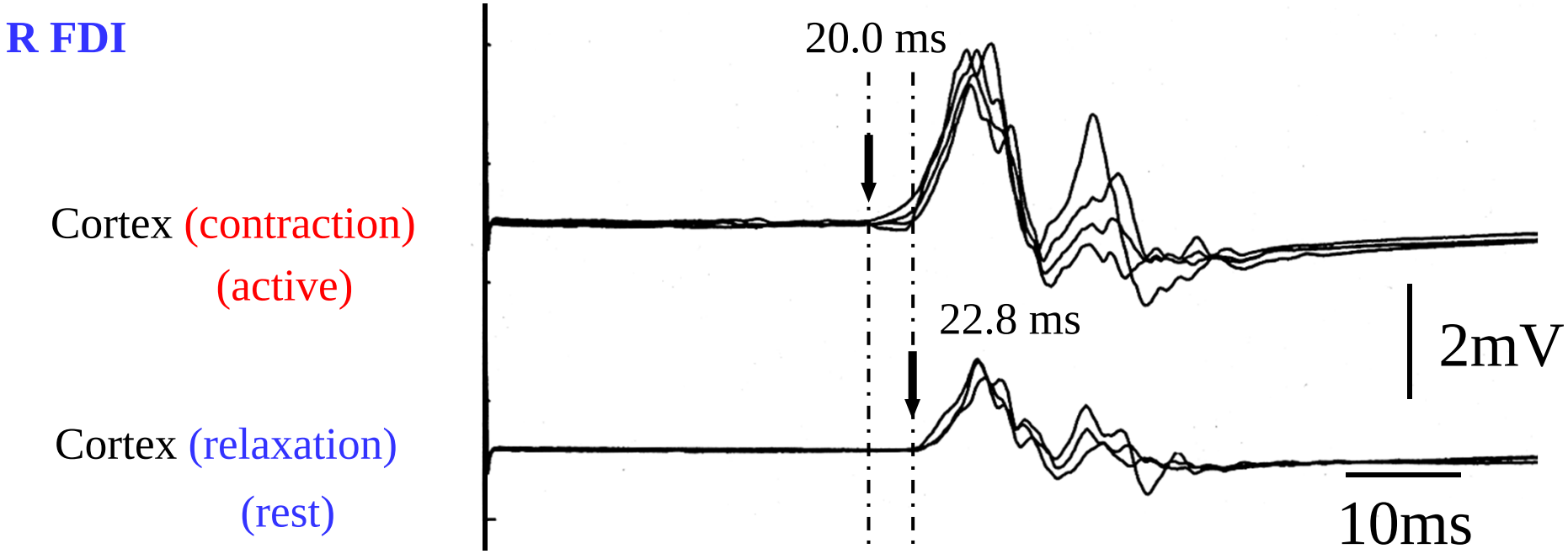


or



Round coil Double cone coil

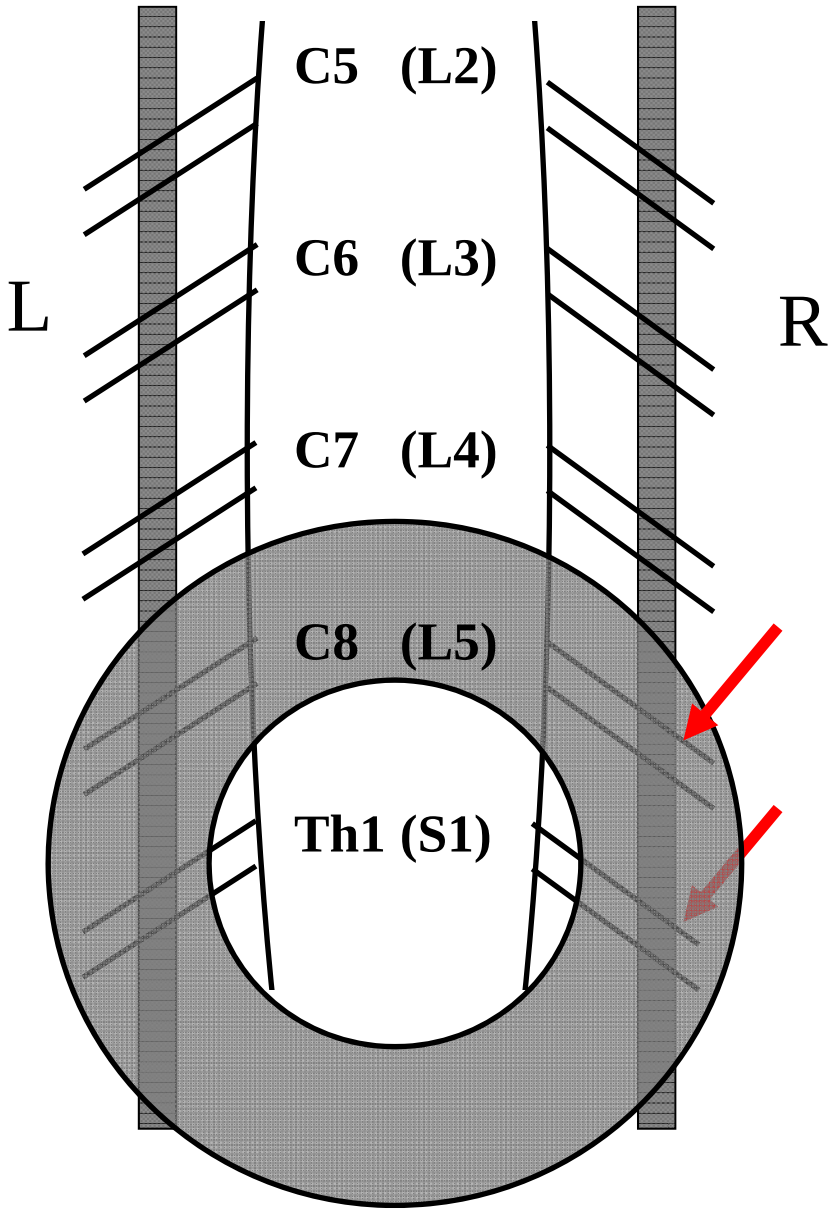
Contraction vs Relaxation in TMS



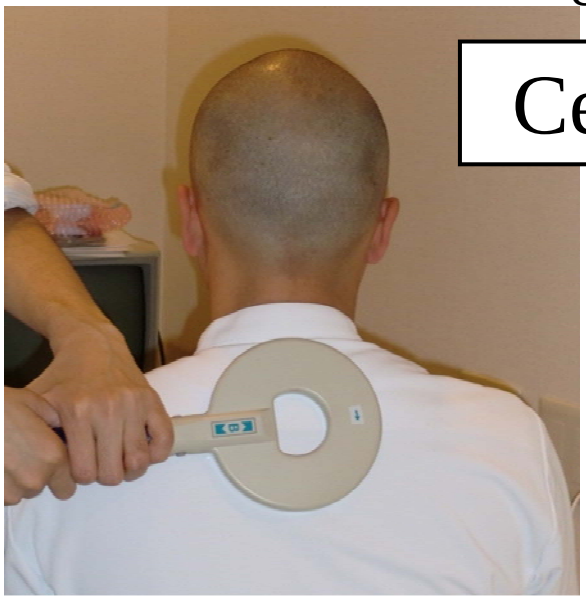
During muscle contraction, MEP amplitude is enlarged and MEP latency is shortened (2-3 ms).

To obtain the shortest MEPs reflecting the corticospinal tract conduction, TMS should be performed during muscle contraction.

Magnetic motor root stimulation



Ugawa et al. 1989



Cervical

Lumbosacral

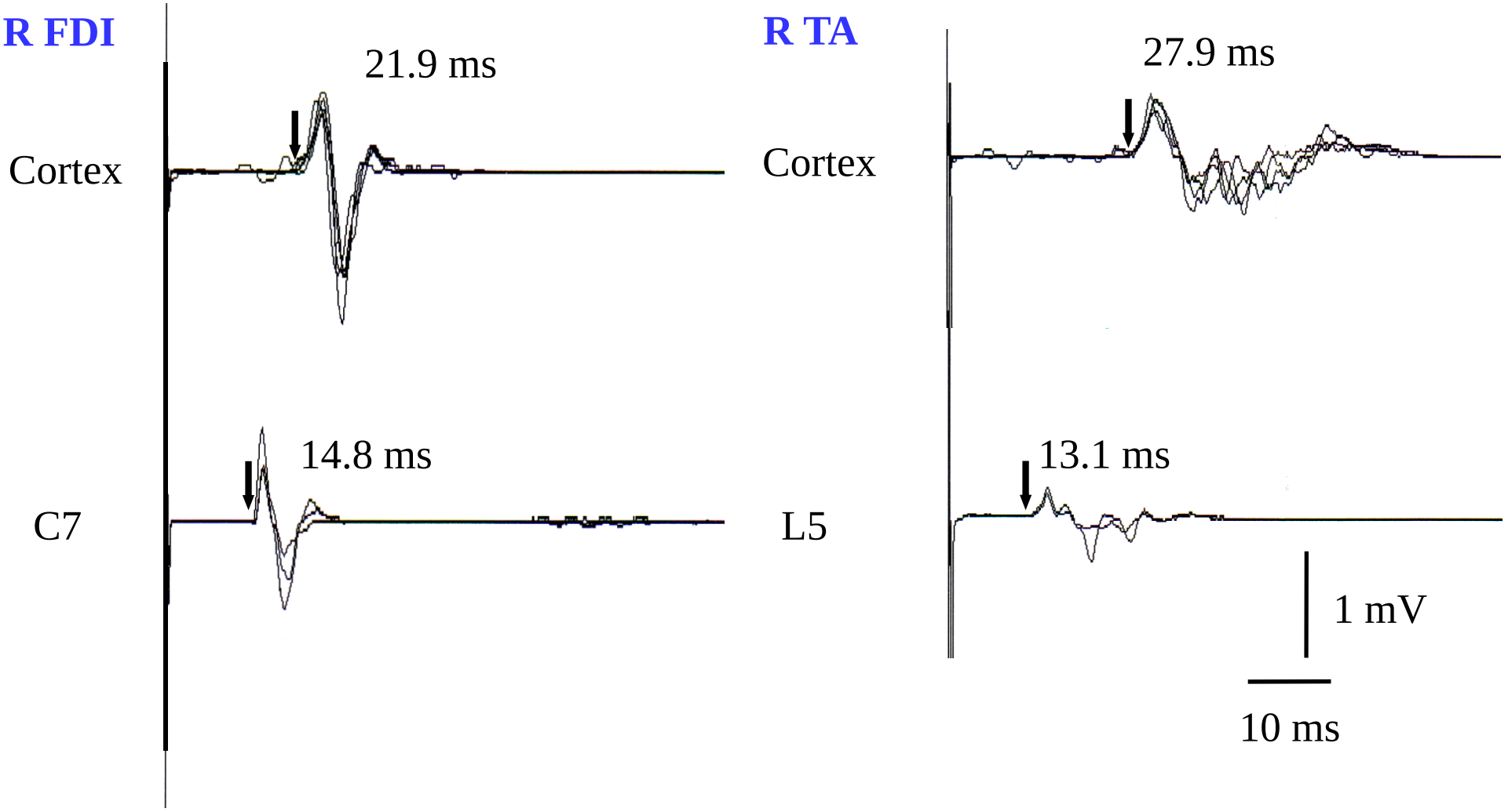
MATS coil

CMCT (central motor conduction time)

TMS

CMCT 7.1 ms

CMCT 14.8 ms



Why does CMCT prolong?

Caution: CMCT can be prolonged due to several mechanisms.

1. **Demyelination** of the corticospainal tract (MS)
2. **Axonal loss** of the corticospainal tract (ALS)

(Impaired EPSP summations, synaptic delays)

3. **Conduction though the other descending tracts**

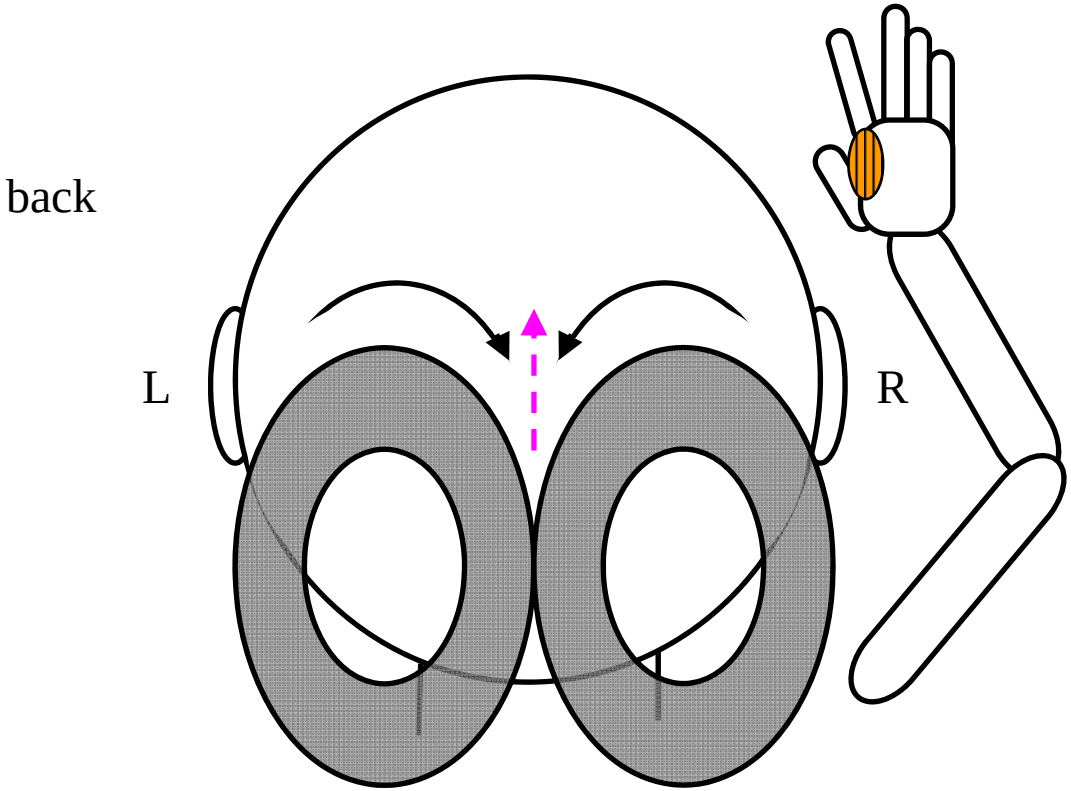
due to the corticospinal tract involvement (ALS)

(reticulospinal/ rubrospinal/ vestibulospinal/ tectospinal tracts)

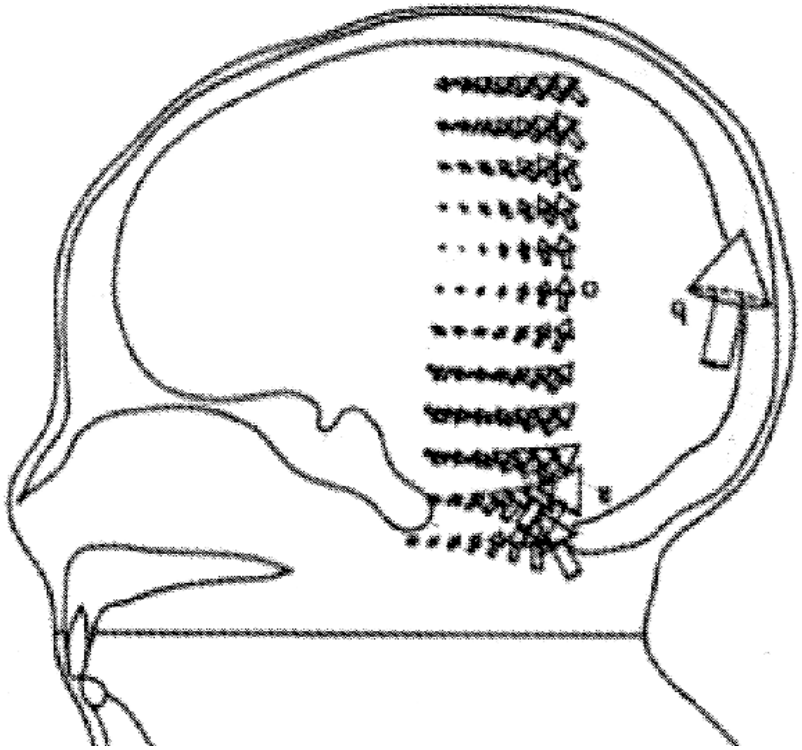
4. **Difficulty of muscle contraction** (Psychogenic)
5. **Root conduction delay** (Neuropathy)

Magnetic brainstem stimulation

Ugawa et al. 1994

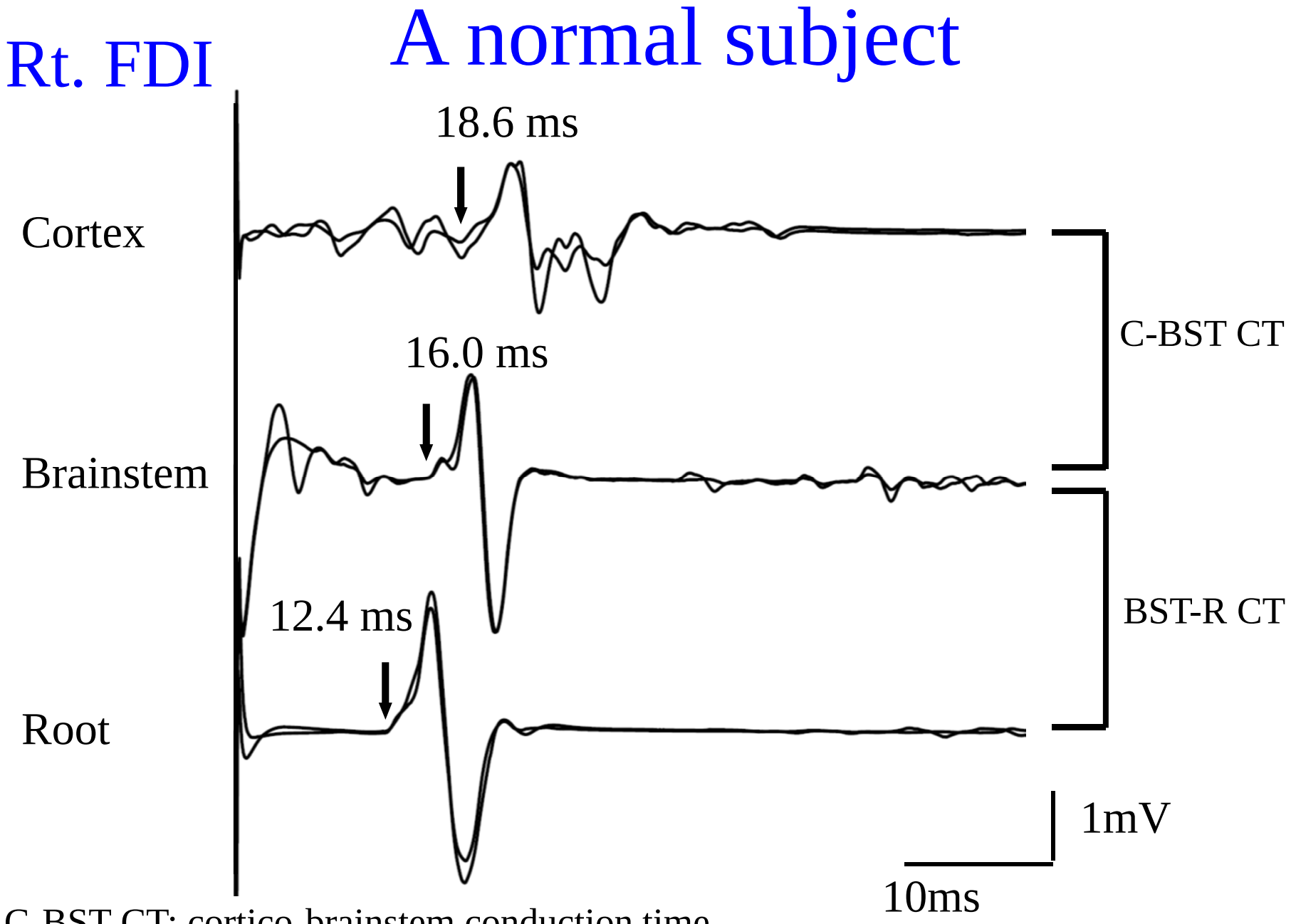


Magnetic brainstem stimulation



Because the induced currents concentrate into the foramen magnum, brainstem stimulation activates the corticospinal tract at the pyramidal decussation level.

A normal subject

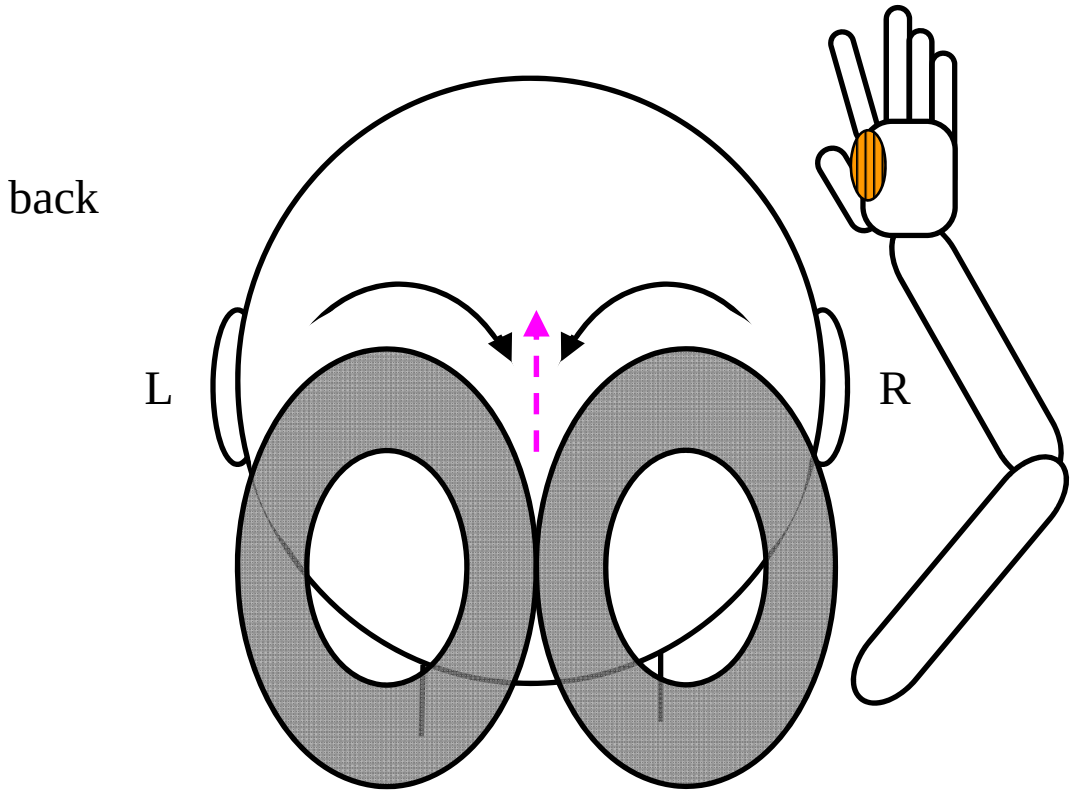


C-BST CT: cortico-brainstem conduction time

BST-R CT: brainstem-root conduction time

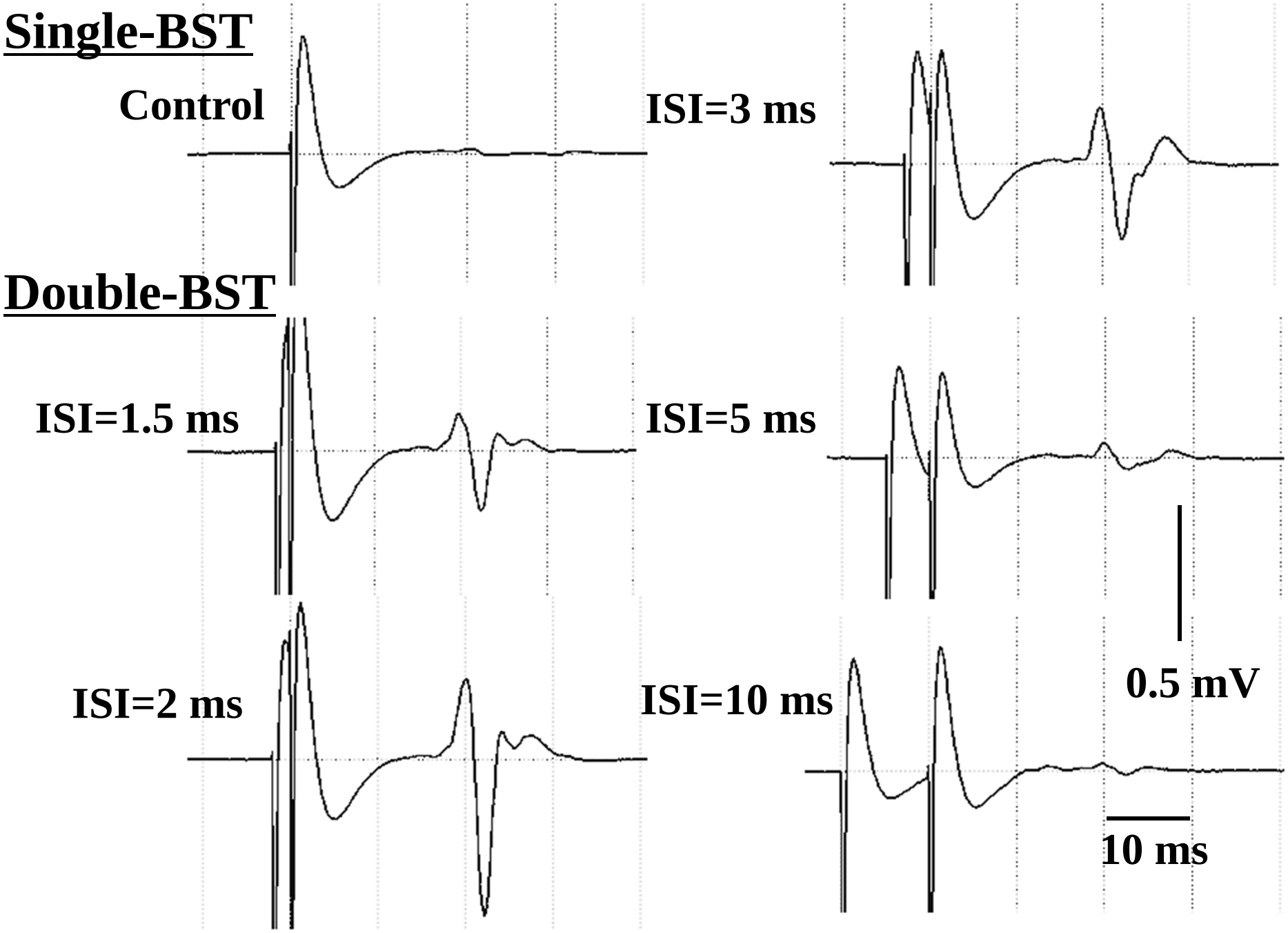
Double-pulse magnetic brainstem stimulation

Matsumoto et al. 2008

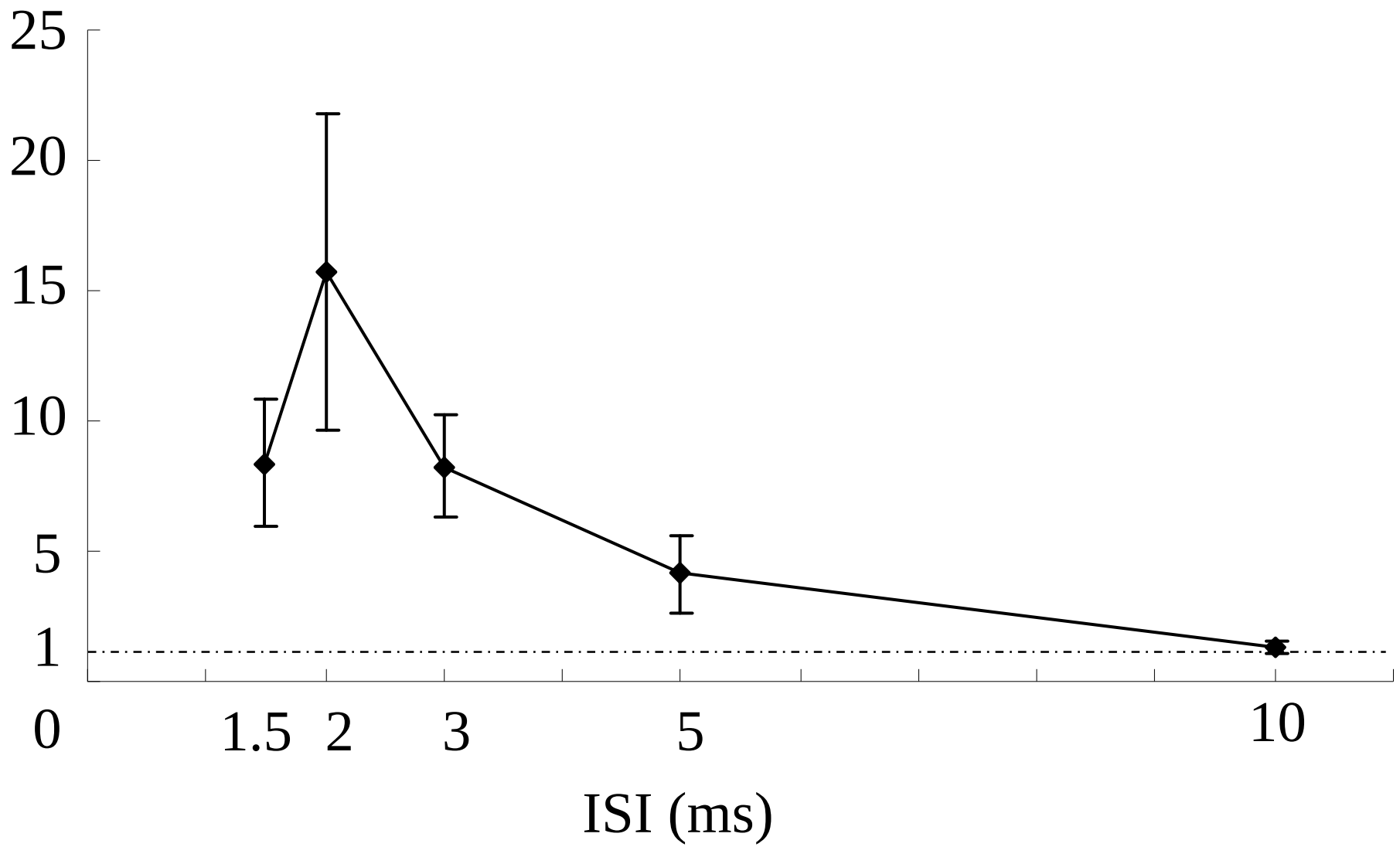


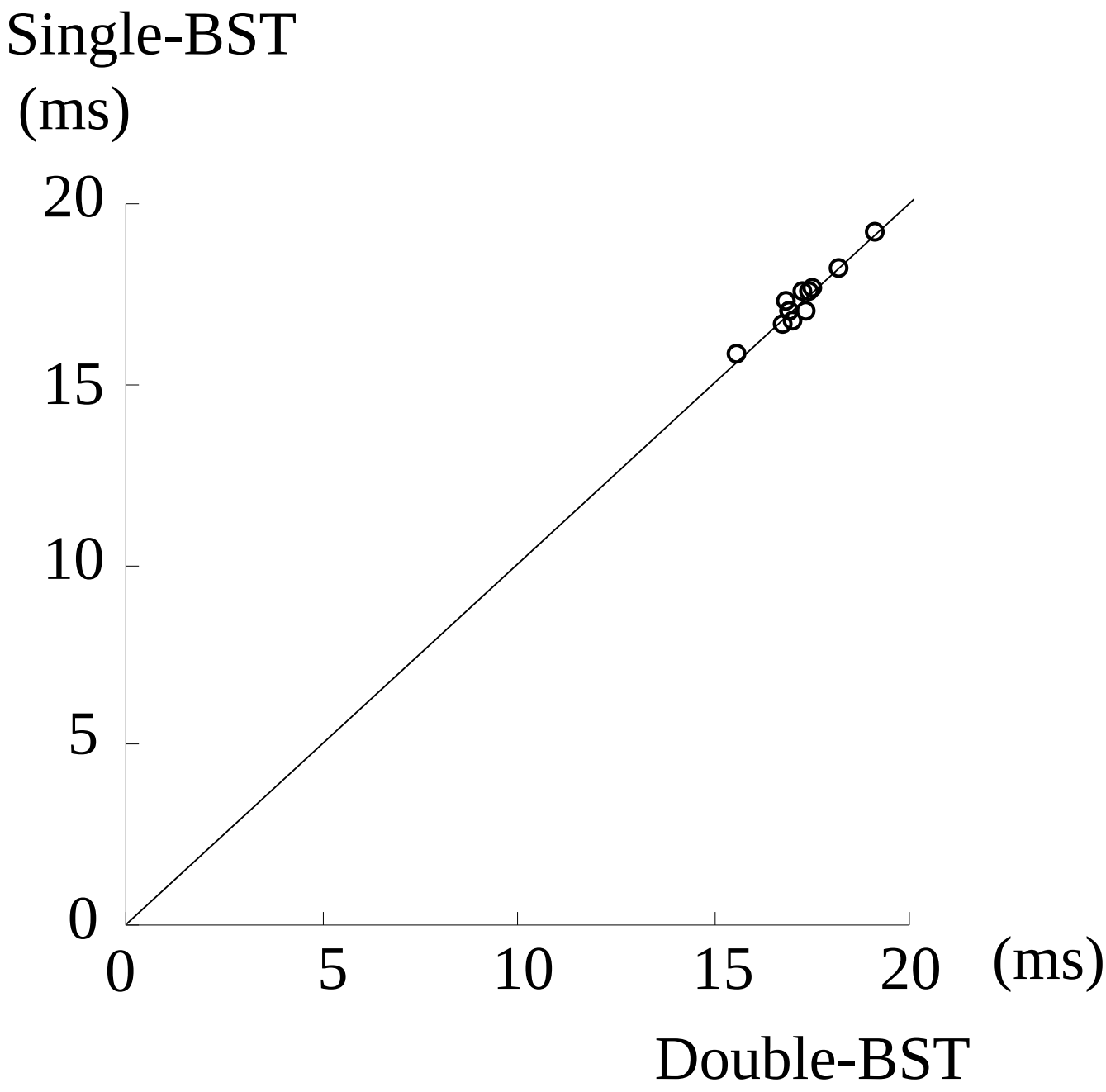
Single-BST produces a single descending volley.

Double-BST produces double descending volleys.


Single-BST
Control
ISI=3 ms
Double-BST
ISI=1.5 ms
ISI=5 ms
ISI=2 ms
ISI=10 ms
0.5 mV
10 ms

MEP size ratio (double-BST/single-BST)




Single-BST
(ms)
20
15
10
5
0
0
5
10
15
20
(ms)
Double-BST

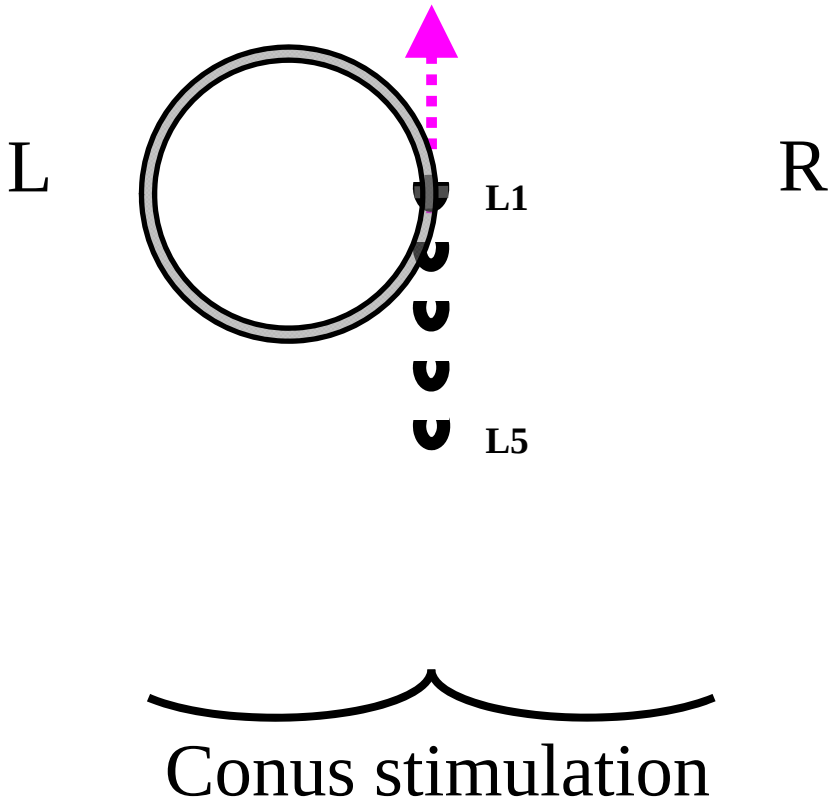
Double-pulse magnetic brainstem stimulation

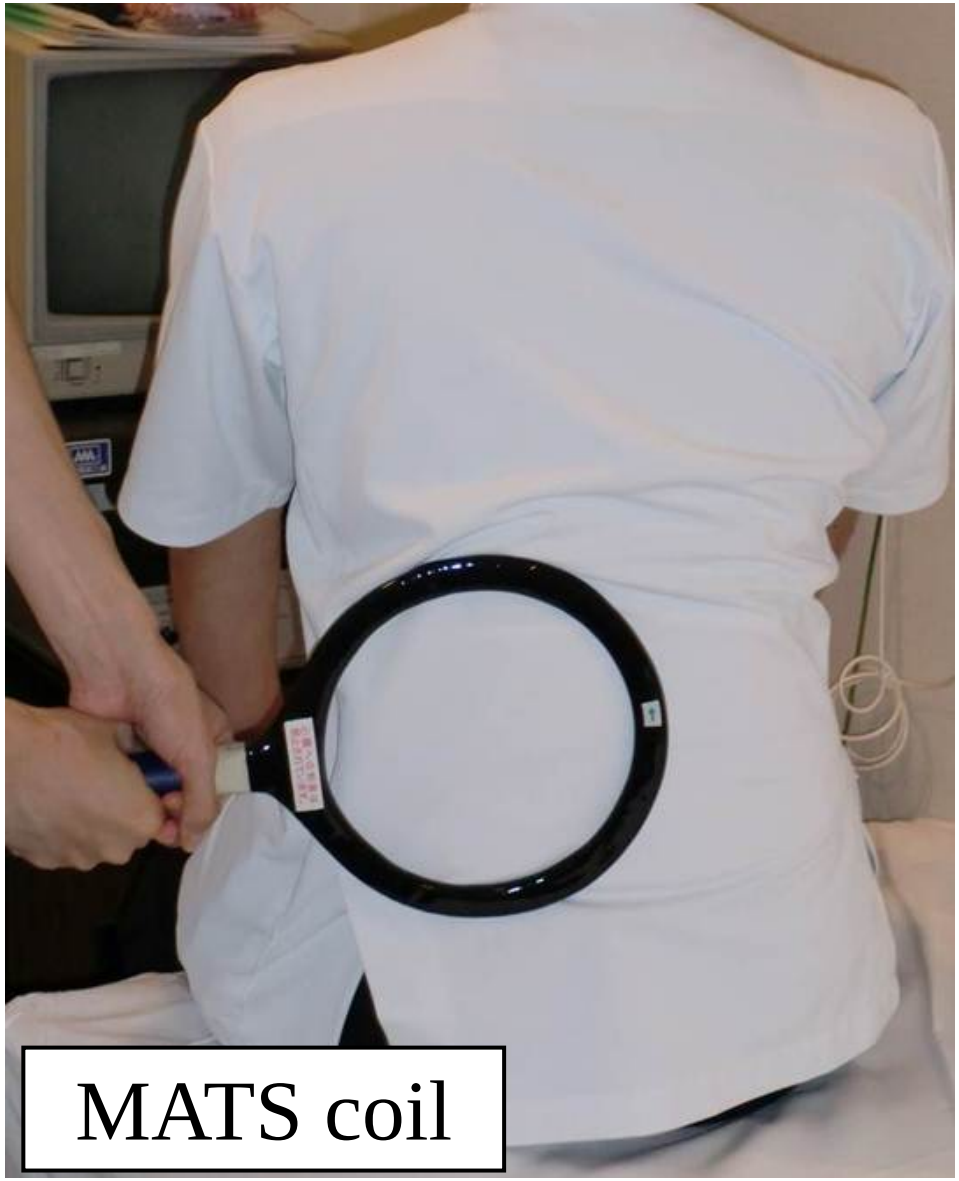
1. MEP size is the largest at ISI 2 ms due to the temporal EPSP summation.
2. MEP latency is the same between single-BST and double-BST.

Double-BST may be useful to obtain MEPs.

Magnetic conus stimulation

Matsumoto et al. 2009





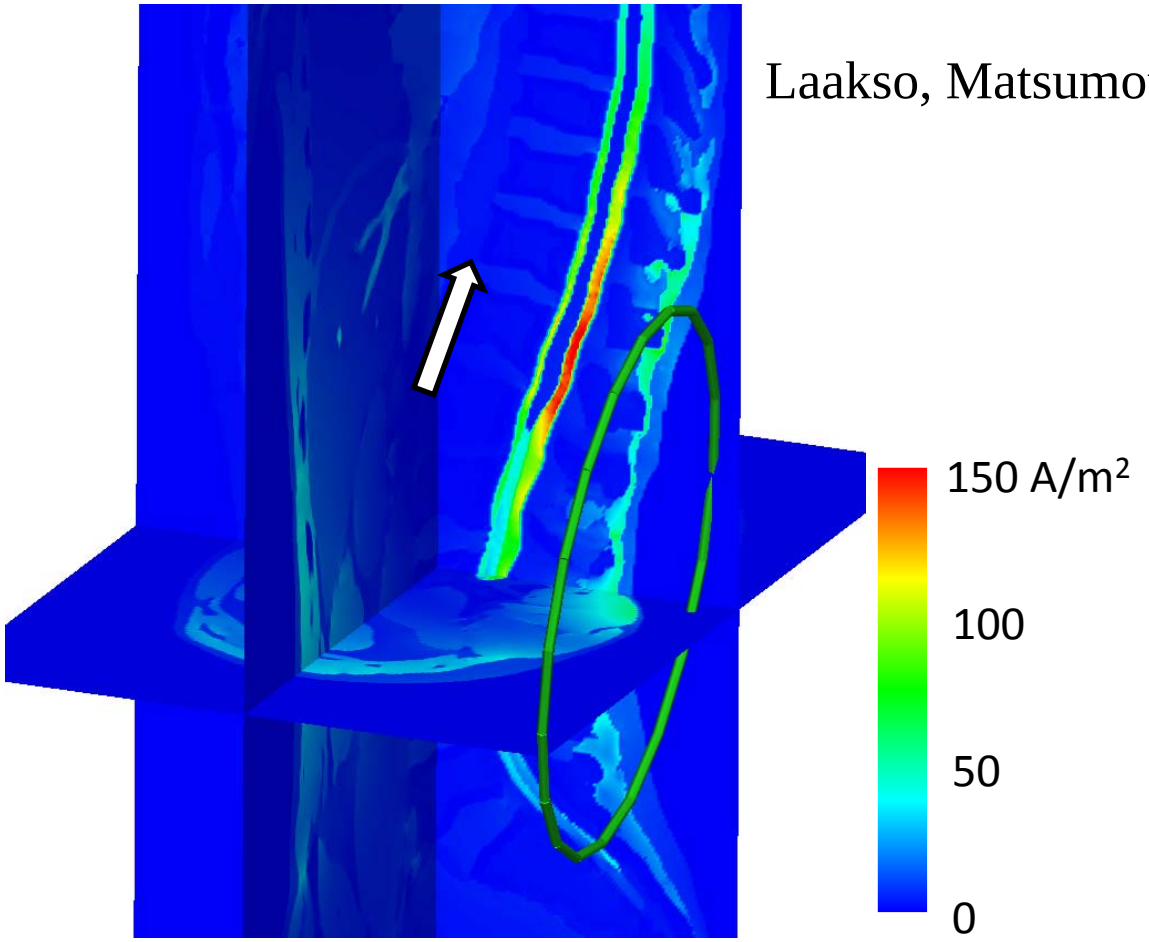
MATS coil

Matsumoto et al. 2009

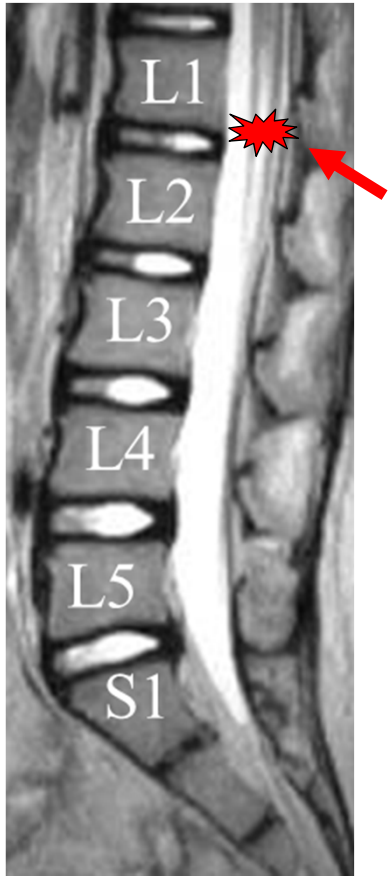
Magnetic Augmented Translumbosacral Stimulation coil

Diameter 20cm (0.98T, 7 turns)

Magnetic conus stimulation



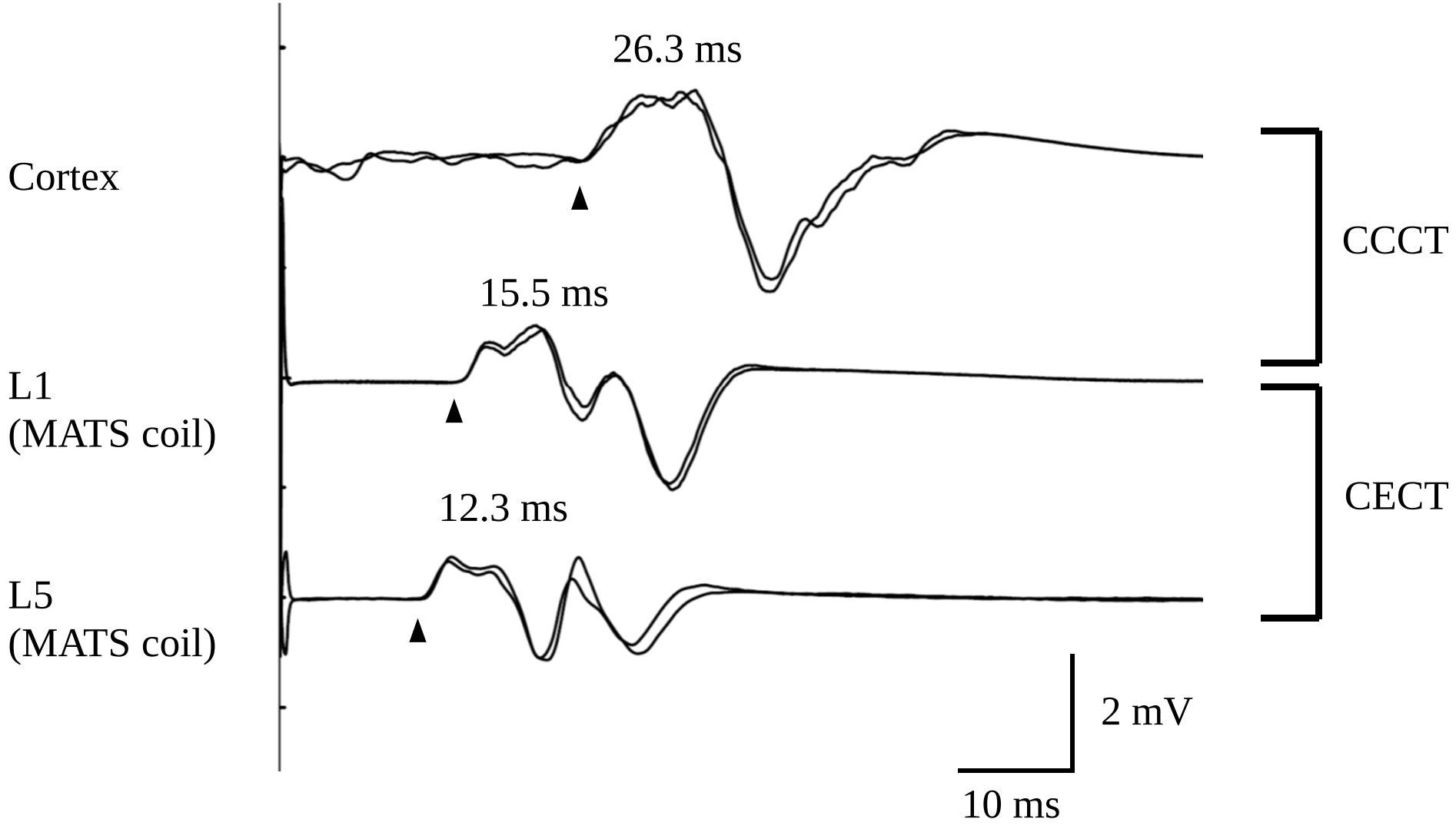
Laakso, Matsumoto et al. 2014



Because the induced currents concentrate around the conus medullaris, conus stimulation activates the most proximal cauda equina.

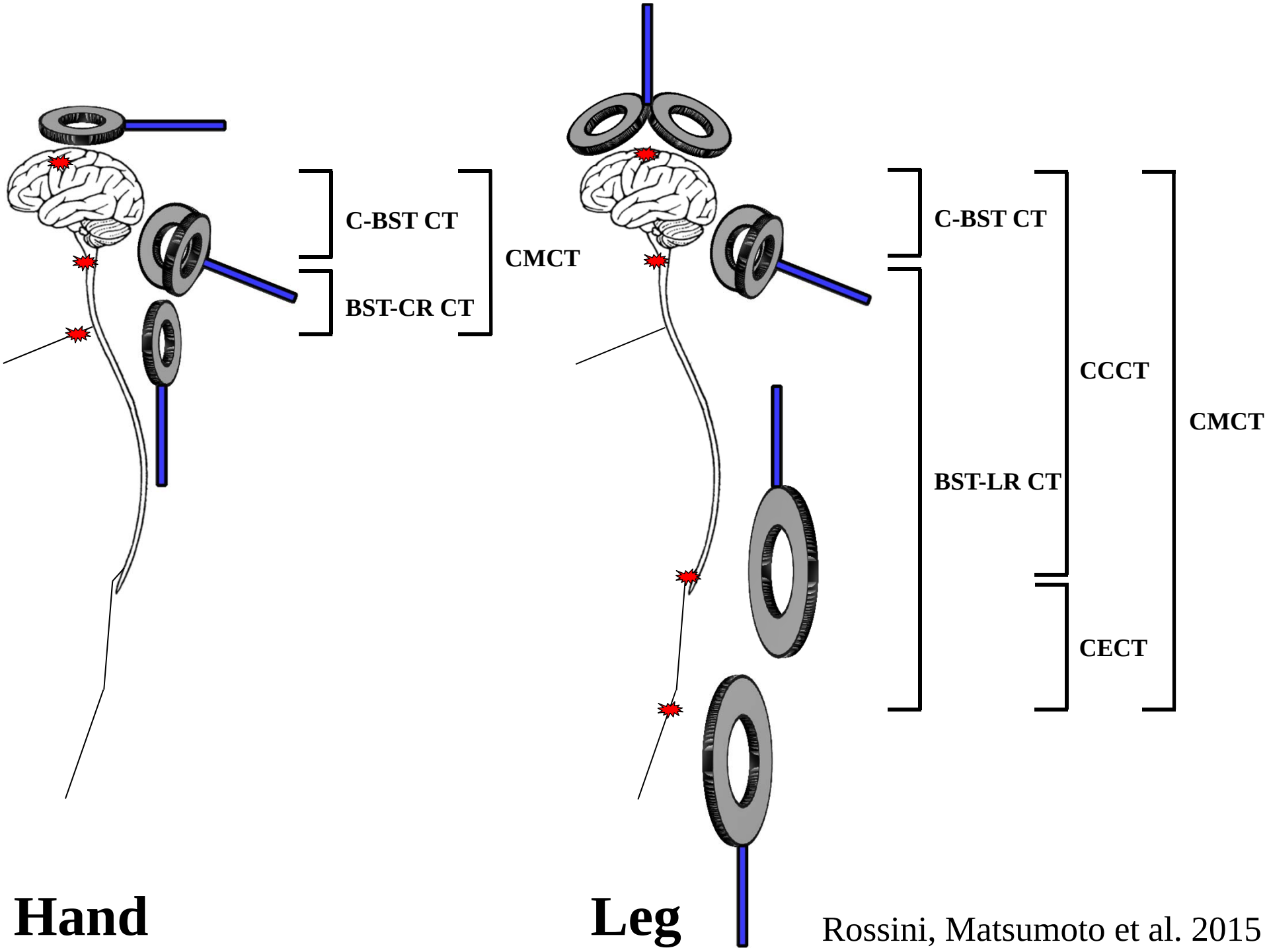
A normal subject

Rt. TA



CCCT: cortico-conus motor conduction time

CECT: cauda equina conduction time



Rossini, Matsumoto et al. 2015