Characterising supplementary motor area—primary motor cortex connectivity in younger and older adults.

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Age-related decline in voluntary movement

↑ movement variability
↓ movement speed
↓ movement smoothness
Age-related decline in brain structure and function

Age-related decline quantity and quality of white matter

Hedden & Gabrieli 2004 Nat Rev Neurosci
Age-related decline in brain structure and function

Age-related decline quantity and quality of white matter

Hedden & Gabrieli 2004 Nat Rev Neurosci

Age-related decline functional connectivity between motor areas

→ associated with motor control

Stančák et al. 2003 Cerebral Cortex
Supplementary motor area (SMA)

Planning bilateral movements

Timing and coordination of bilateral movements

Nachev et al. 2008 Nat Rev Neurosci
SMA is densely connected to the M1

→ stimulation of SMA evokes short-latency responses in M1
Transcranial magnetic stimulation (TMS) to measure SMA—M1 connectivity

Dual-coil TMS

Motor evoked potential
Transcranial magnetic stimulation (TMS) to measure SMA—M1 connectivity

Dual-coil TMS
Transcranial magnetic stimulation (TMS) to measure SMA—M1 connectivity

MEP evoked by dual-coil TMS is facilitated (compared to the MEP evoked by single-pulse TMS) → due to the activation (by the conditioning stimulus) of direct facilitatory connections between SMA and M1 → glutamatergic

Luppino et al. 1993, *J Comp Neurol*
AIM: Characterise SMA-M1 connectivity in younger and older adults.
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1. Is the dual-coil TMS measure of SMA—M1 connectivity reliable?
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Two identical sessions
Inter-session interval ~7 days
Is the TMS measure of SMA—M1 connectivity reliable?

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Test stimulus to M1: intensity to evoke ~1 mV MEP
Is the TMS measure of SMA—M1 connectivity reliable?

Two identical sessions
Inter-session interval ~7 days

Test stimulus to M1: intensity to evoke ~1 mV MEP

Conditioning stimulus to SMA: target SMA site 4 cm anterior to Cz
Is the TMS measure of SMA—M1 connectivity reliable?

Two identical sessions
Inter-session interval ~7 days

Test stimulus to M1: intensity to evoke ~1 mV MEP

Conditioning stimulus to SMA: target SMA site 4 cm anterior to Cz

Inter-stimulus intervals: 6 ms and 7 ms
Is the TMS measure of SMA—M1 connectivity reliable?

Younger adults: N = 30 (18 – 35 years)

SESSION 1

SESSION 2

Younger

SMA-M1 ratio

0.0 0.5 1.0 1.5 2.0

SMA-M1 ratio

0.0 0.5 1.0 1.5 2.0

6 ms
Is the TMS measure of SMA—M1 connectivity reliable?

Younger adults: N = 30 (18 – 35 years)

![Graph showing ICC = 0.39 for younger adults with SMA-M1 ratio vs. SMA-M1 ratio.

ICC = 0.39

Younger adults: N = 30 (18 – 35 years)
Is the TMS measure of SMA—M1 connectivity reliable?

Younger adults: N = 30 (18 – 35 years); older adults: N = 28 (60 – 84 years)
Is the TMS measure of SMA—M1 connectivity reliable?

6 ms

7 ms

DO NOT COPY
1. Is the dual-coil TMS measure of SMA—M1 connectivity reliable?

Moderate-to-good test re-test reliability in both younger and older adults

→ dual-coil protocol with 7 ms inter-stimulus interval
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   Moderate-to-good test re-test reliability in both younger and older adults
   
   → dual-coil protocol with 7 ms inter-stimulus interval

2. Is SMA—M1 connectivity reduced in older compared to younger adults?
Reduced SMA—M1 connectivity in older than younger adults?

6 ms

7 ms

SMA-M1 ratio

Session 1  Session 2

Younger

Older
Supplementary motor area—primary motor cortex facilitation in younger but not older adults

Peta E. Green, Michael C. Ridding, Keith D. Hill, John G. Semmler, Peter D. Drummond, Ann-Maree Vallence
SMA-M1 connectivity in younger and older adults.

1. Is the dual-coil TMS measure of SMA—M1 connectivity reliable?
   Moderate-to-good test re-test reliability in both younger and older adults
   → dual-coil protocol with 7 ms inter-stimulus interval

2. Is SMA—M1 connectivity reduced in older compared to younger adults?
   Facilitatory interaction evident in younger but not older adults
   SMA-M1 connectivity might decline with age.
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   Moderate-to-good test re-test reliability in both younger and older adults
   → dual-coil protocol with 7 ms inter-stimulus interval

2. Is SMA—M1 connectivity reduced in older compared to younger adults?
   Facilitatory interaction evident in younger but not older adults
   SMA-M1 connectivity might decline with age.

3. Is SMA—M1 connectivity associated with bimanual control?
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Purdue Pegboard bimanual function
Is SMA—M1 connectivity associated with bimanual control?

Purdue Pegboard bimanual function
Is SMA—M1 connectivity associated with bimanual control?

6 ms

Session 1

Session 2

$r = 0.37$

$r = 0.58$

7 ms

Session 1

Session 2

$r = 0.43$

$r = 0.53$
Supplementary motor area—primary motor cortex facilitation in younger but not older adults

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SMA-M1 connectivity in younger and older adults.

- Moderate-to-good test re-test reliability of dual-coil TMS SMA—M1 connectivity (7 ms ISI)
- Facilitatory SMA—M1 interaction in younger but not older adults
- Facilitatory SMA—M1 interaction is functionally important
- Neural correlate of age-related decline in bimanual control → target for interventions to improve bimanual control
Collaborators
Brittany Rurak
Prof Peter Drummond

Funding

GNT1088295