Congresso Società Italiana di Psicofisiologia e Neuroscienze cognitive
10/11/2023

Multimodal interaction with motor cortex: the effect of motor resonance, placebo effect and pain

Placebo effect and motor performance

Mirta Fiorio

Dipartimento di Neuroscienze, Biomedicina e Movimento
Università di Verona

Outline

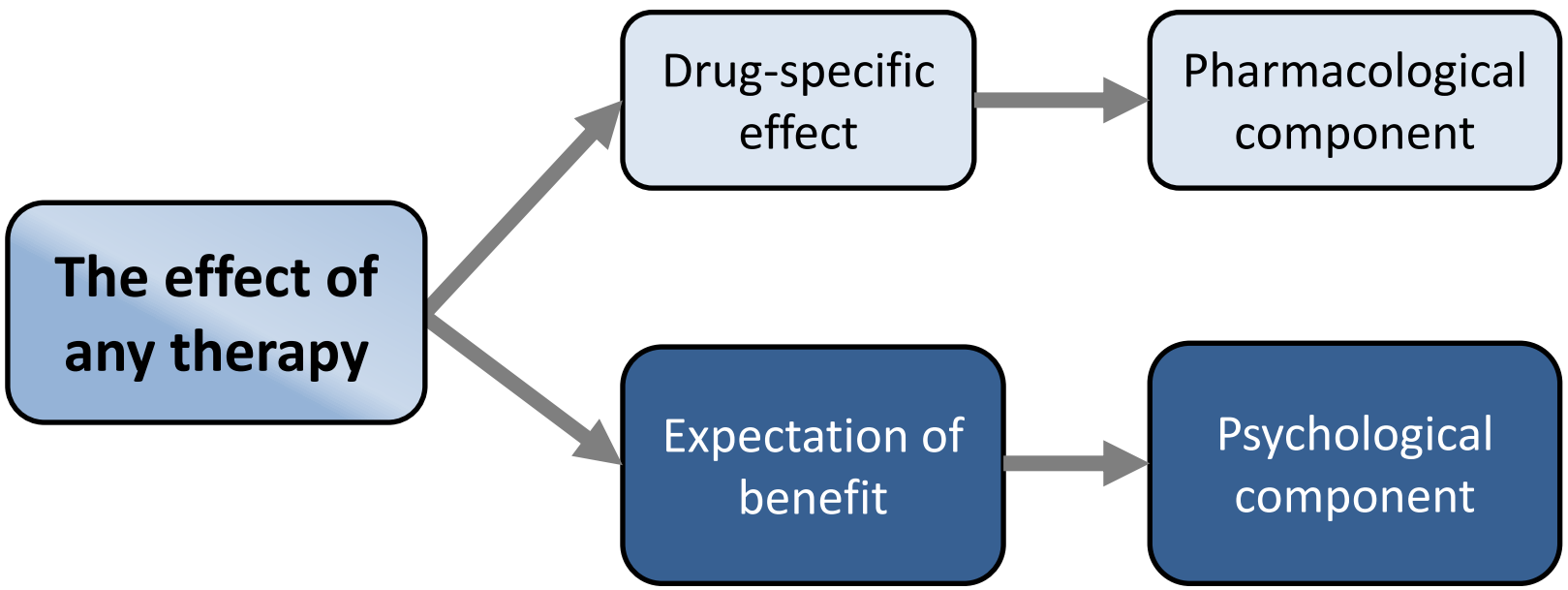
The placebo effect in the motor domain

1. Definition and mechanisms

2. Behavioral evidence

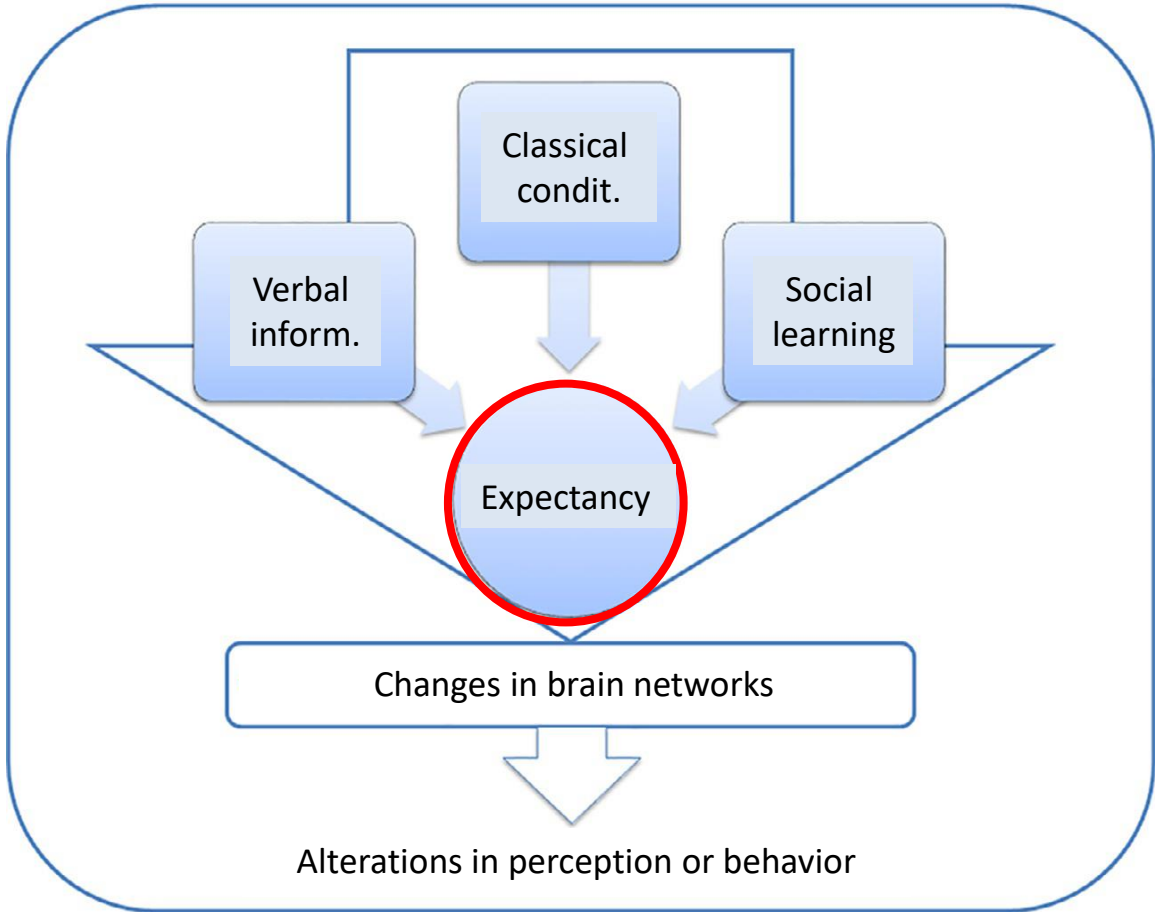
3. Neurophysiological mechanisms: the role of M1

The effect of any therapy



The placebo effect

«A complex phenomenon whereby an **inert treatment** can induce a therapeutic **benefit** if the subject is made to **believe** that it is effective» (Benedetti et al., *Nat Neurosci* 2004).



Adapted from Klinger et al., *Int Rev Neurobiol* 2018

Behavioral evidence in athletes

The role of **expectation** as a cognitive mechanism that can influence sport performance has been extensively demonstrated with placebo manipulations.

Well-trained ciclists, who thought to have ingested caffeine, showed improved performance, even if they received a placebo.

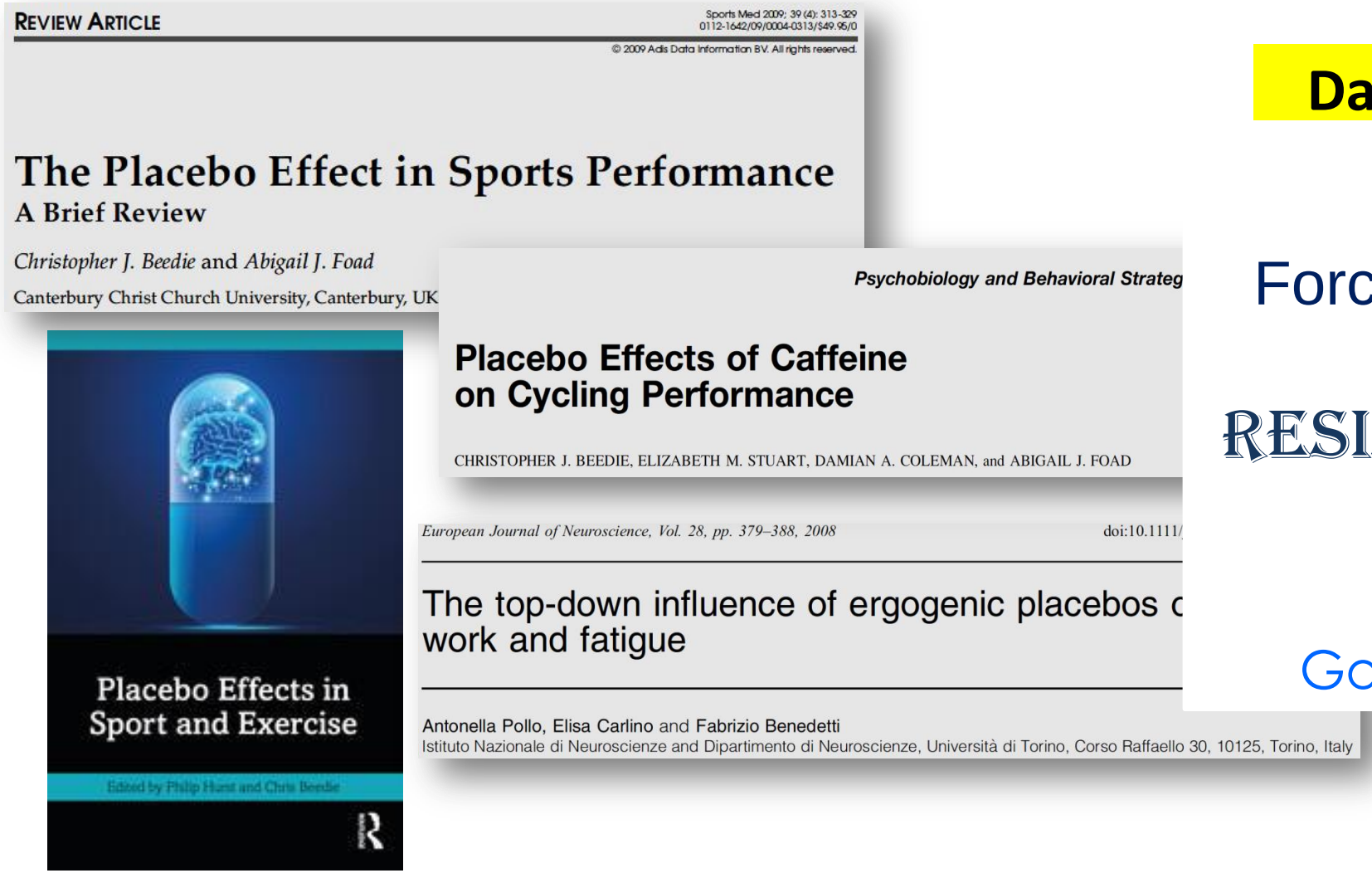
Told to receive:		Improvement
low dose caffei	) ⇨	**1.3%** power increase
high dose c	.0 mg/kg) ⇨	**3.1%** power increase

Actually placebo!

Dose-dependent response

Beedie et al., 2006

Behavioral evidence in athletes and non-athletes



Placebo Effects in Sport and Exercise
Edited By Philip Hurst, Chris Beedie

Daily-life motor functions

Motor learning

Force

Speed

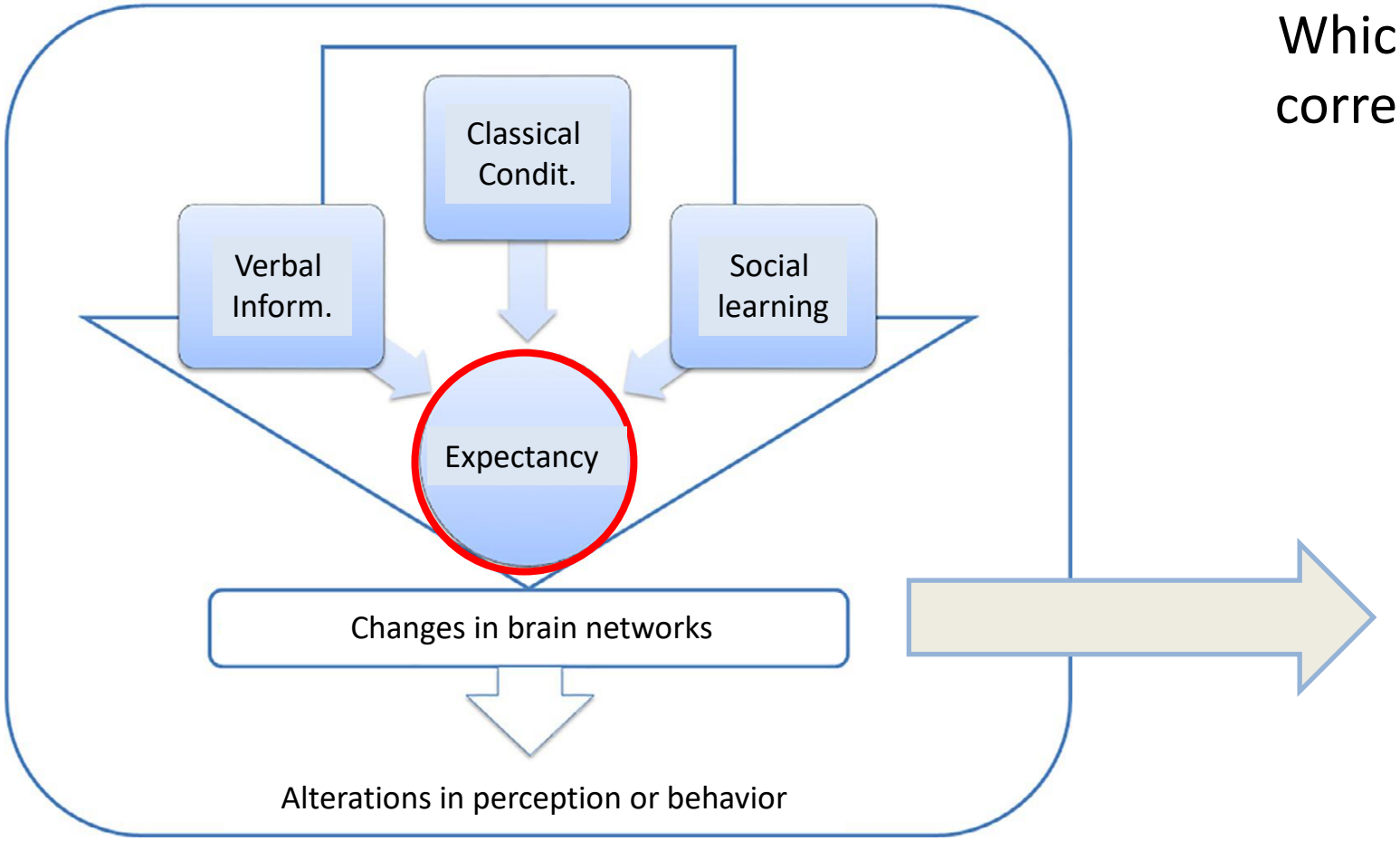
RESISTANCE TO FATIGUE

Balance control

Gait

Goal-directed movement

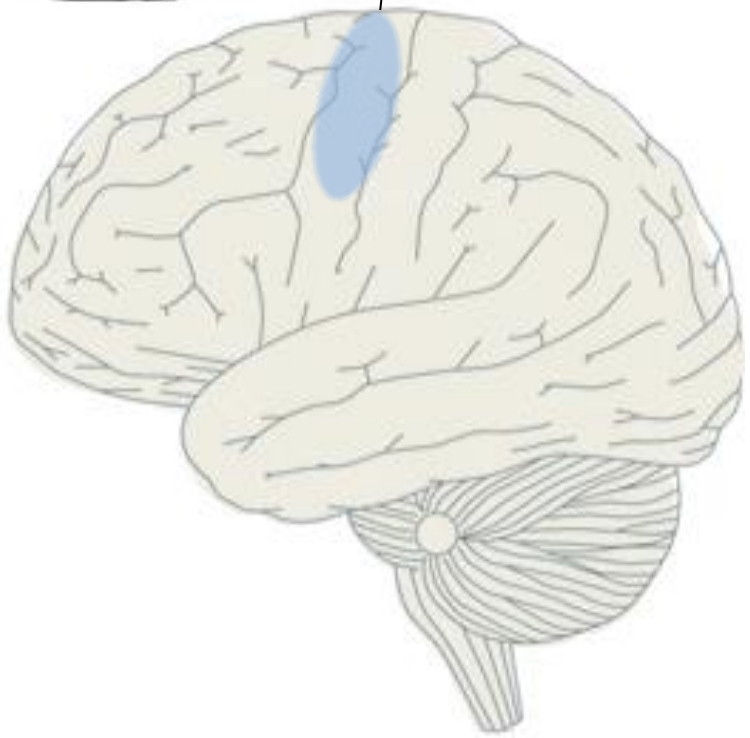
Neurocognitive mechanisms



Which are the neurophysiological correlates of the placebo effect in the motor domain?

The role of the primary motor cortex

Primary motor cortex



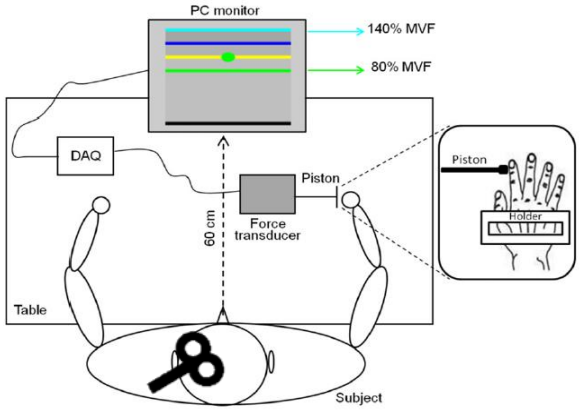
Behavioral/Cognitive

J. Neurosci., March 12, 2014 • 34(11):3993– 4005

Placebo-Induced Changes in Excitatory and Inhibitory Corticospinal Circuits during Motor Performance

Mirta Fiorio,[1*] Mehran Emadi Andani,[1,2*] Angela Marotta,[1] Joseph Classen,[3] and Michele Tinazzi[1]

Baseline



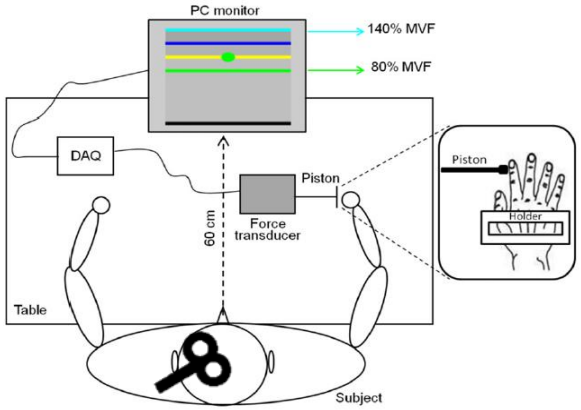
TMS@30%MVF

TENS

Placebo device

5 min

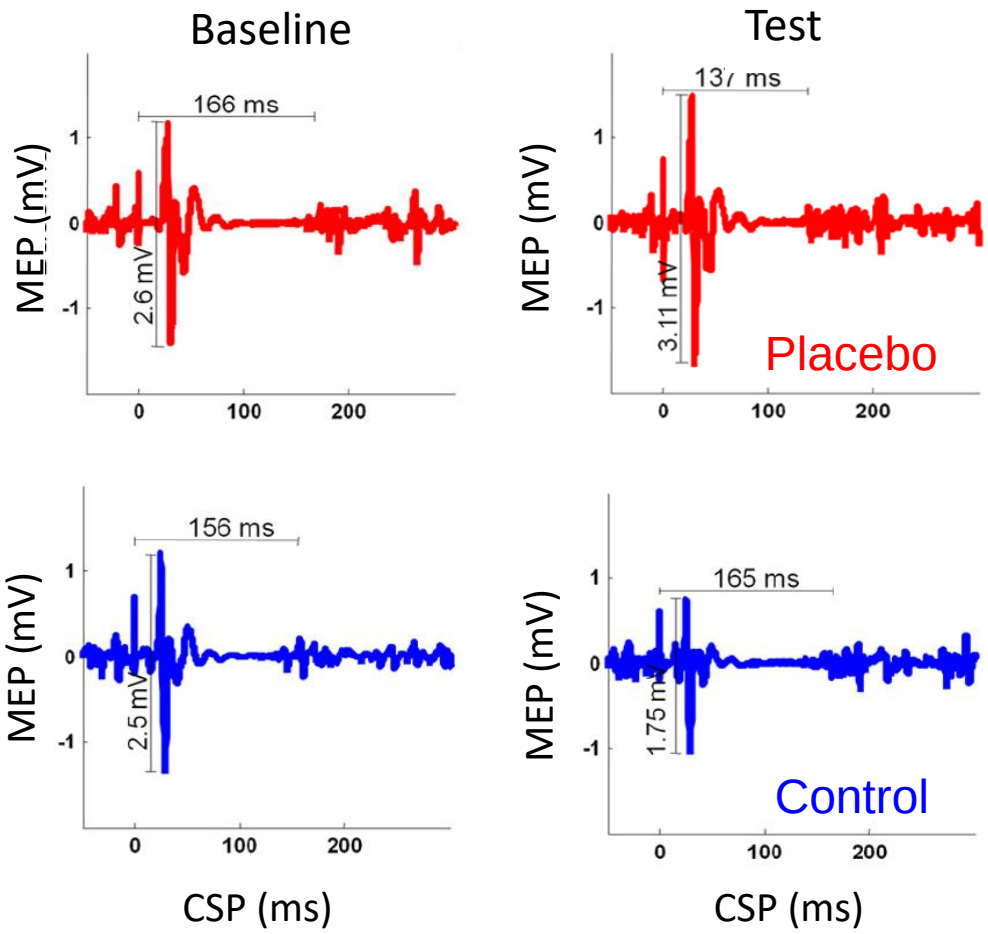
Test



TMS@30%MVF

The role of the primary motor cortex

Primary motor cortex



The role of the primary motor cortex

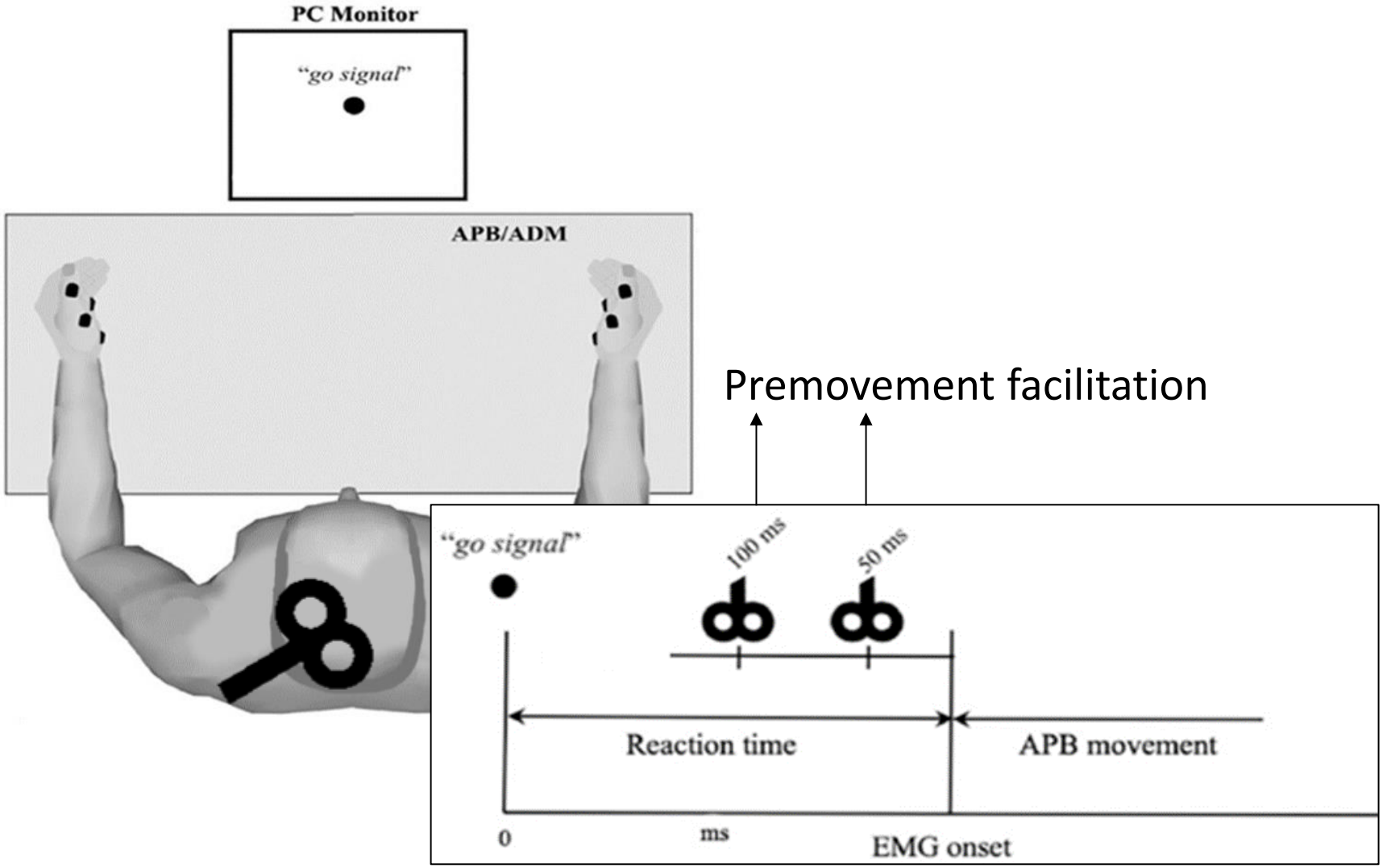
Does this neurophysiological effect occur even ***before*** movement initiation?

Premovement facilitation

«Increase of MEP amplitude after a go signal and before movement onset which begins approximately 100 ms before the EMG/movement onset».

Rossini et al., 1988; Hiraoka et al., 2010; Cirillo et al., 2021

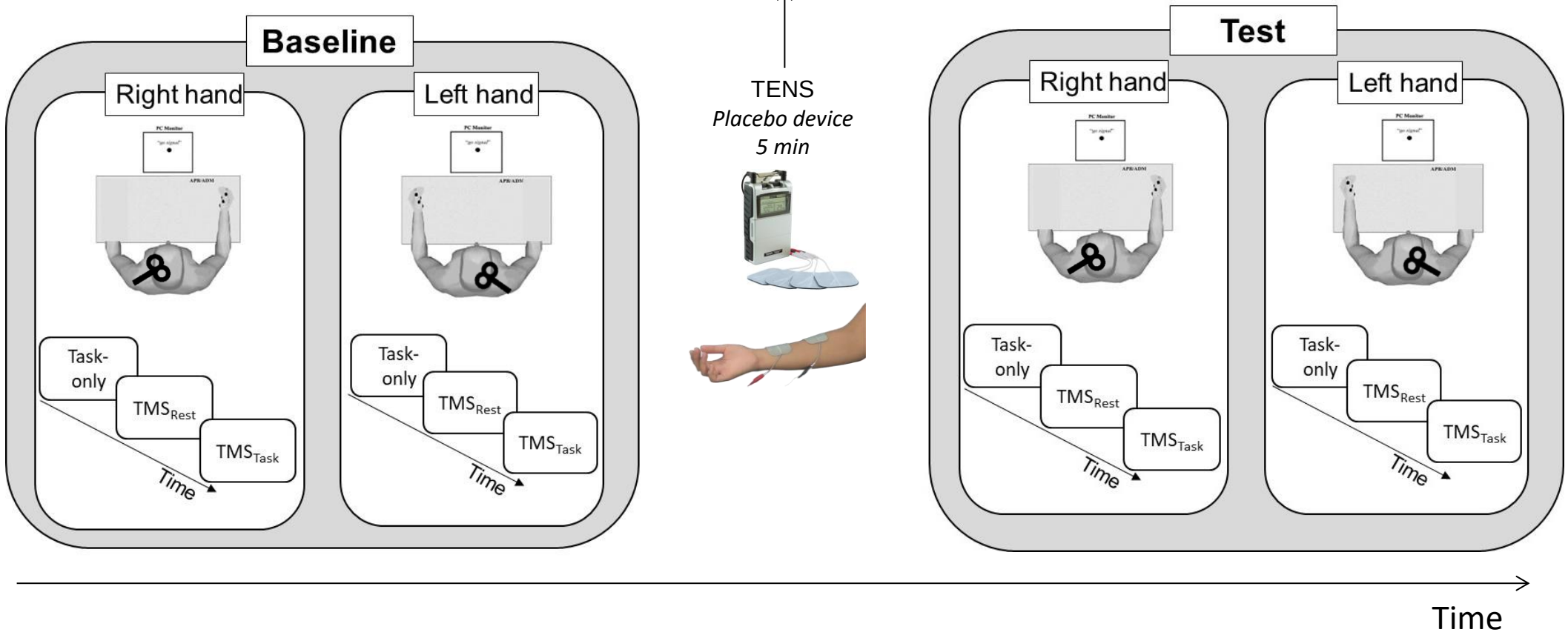
The motor reaction time task



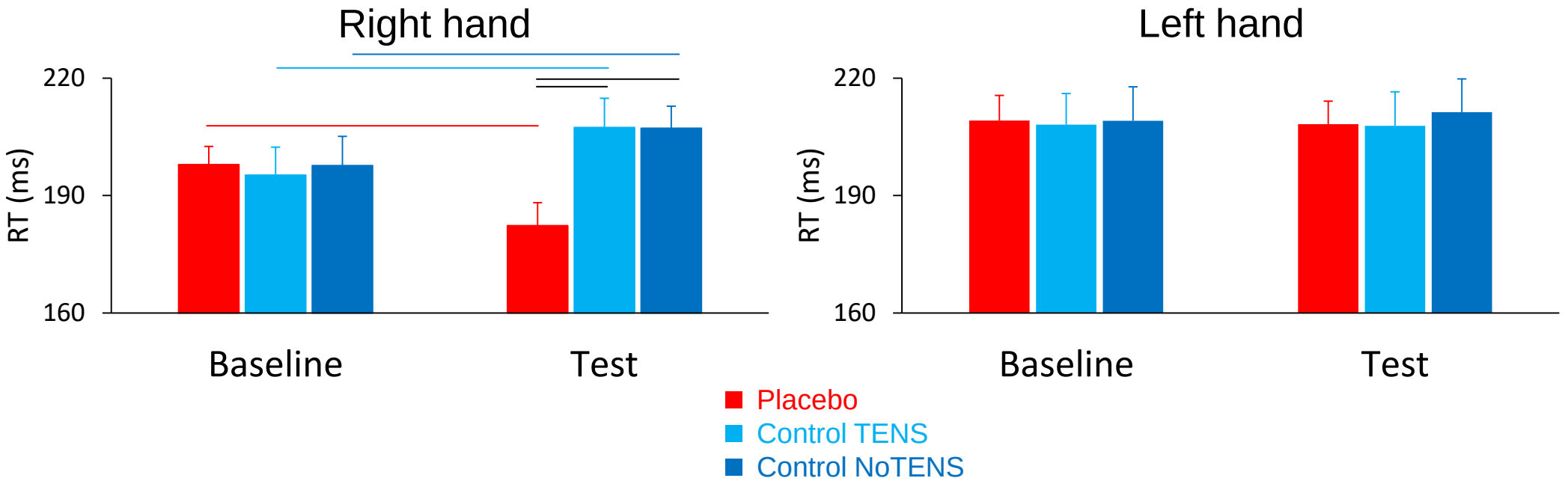
Adapted from Cirillo et al., 2021

Study design

Groups (n=16 each):
Placebo group: TENS + positive verbal suggestion
Control TENS group: TENS + neutral verbal suggestion
Control NoTENS group: without TENS or verbal suggestion

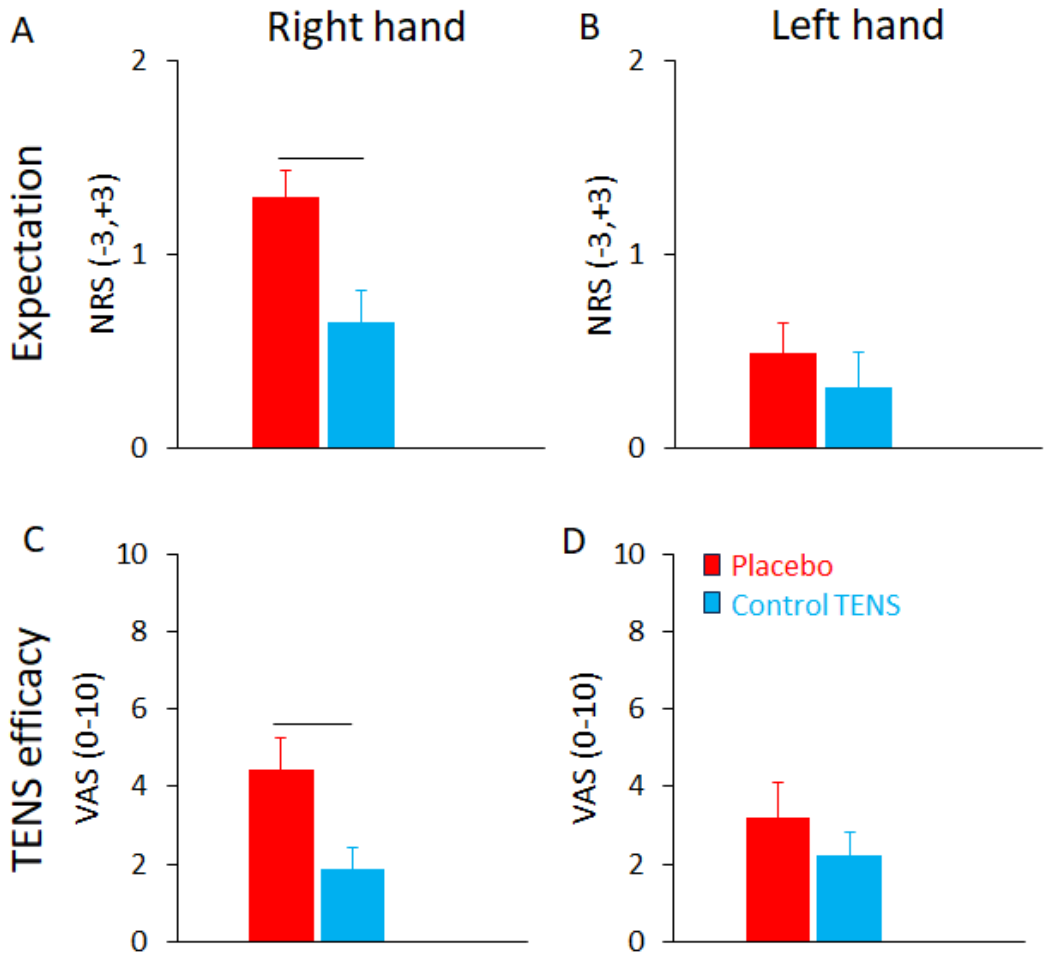


Reaction times



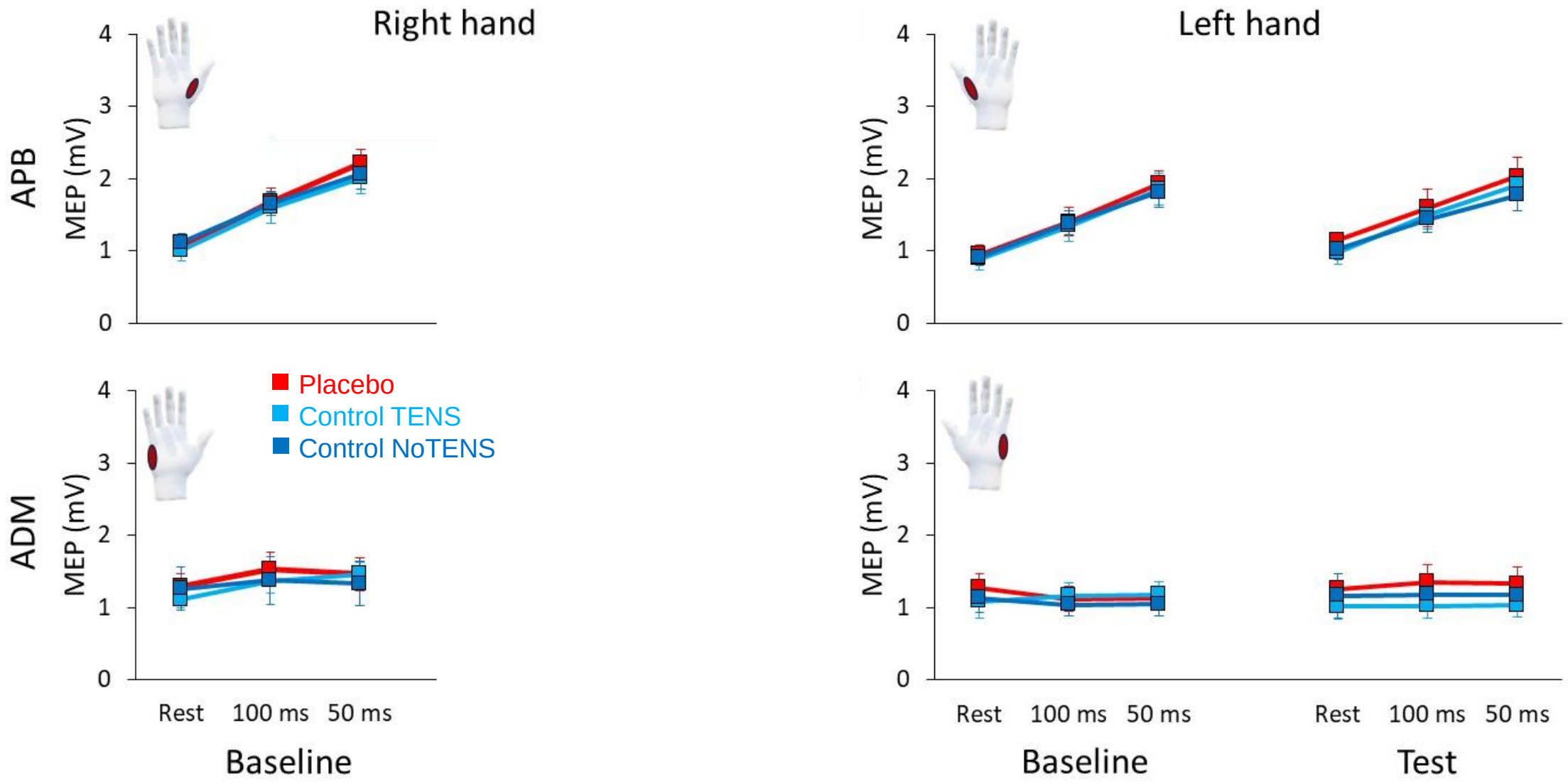
Emadi Andani et al., in preparation

Expectation and belief in the treatment



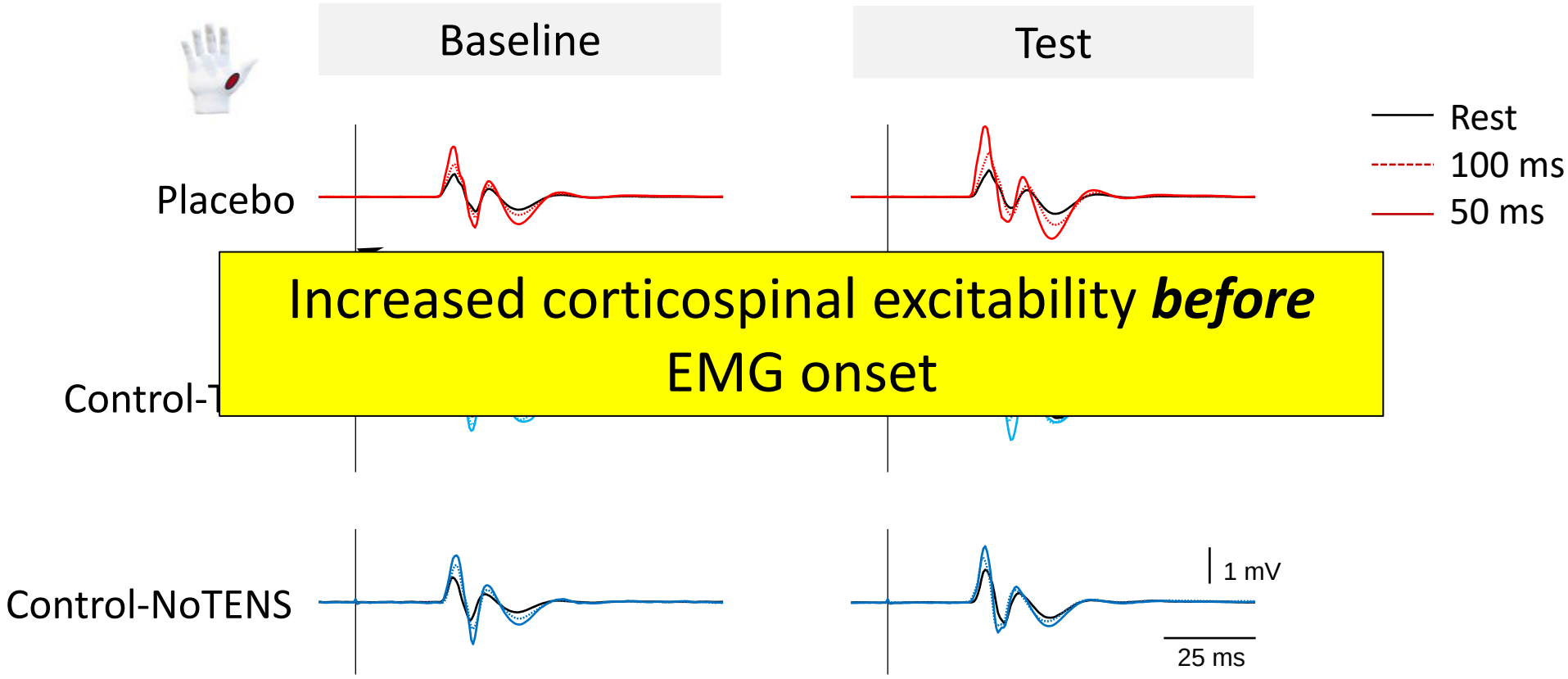
Emadi Andani et al., in preparation

Pre-movement facilitation



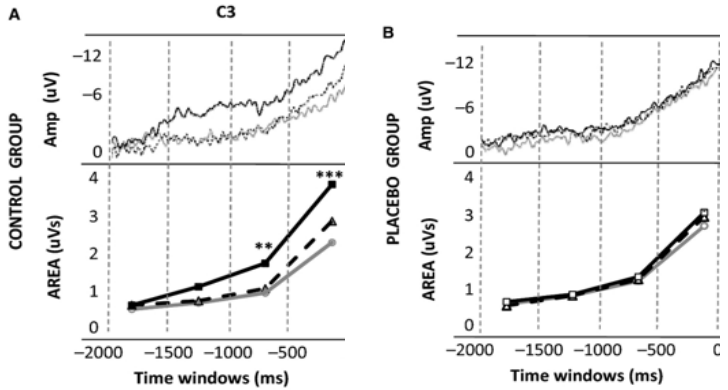
Emadi Andani et al., in preparation

Pre-movement facilitation

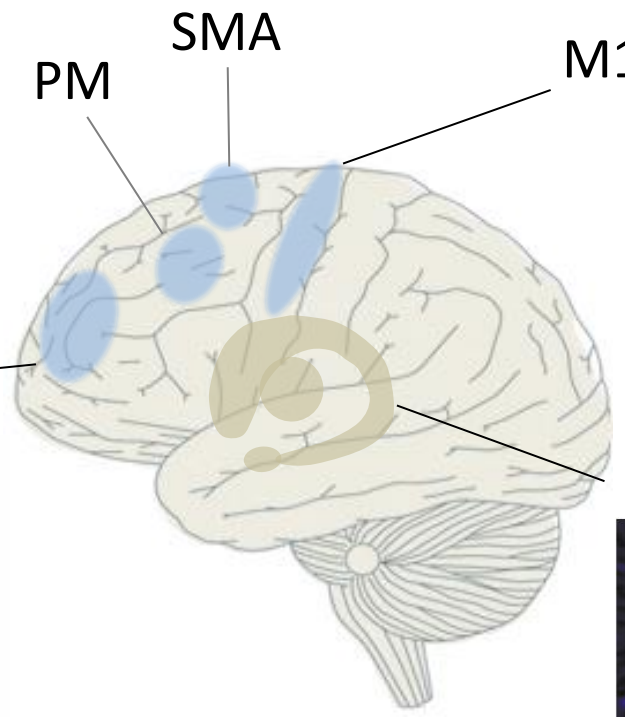


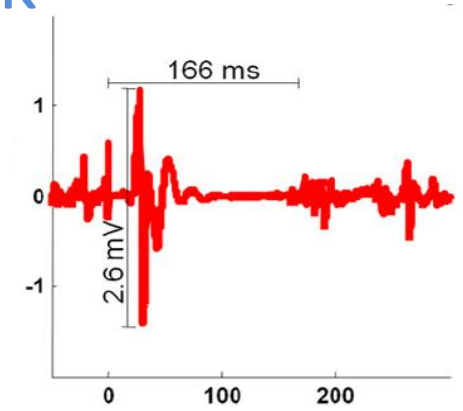
An overall view

Motor control network

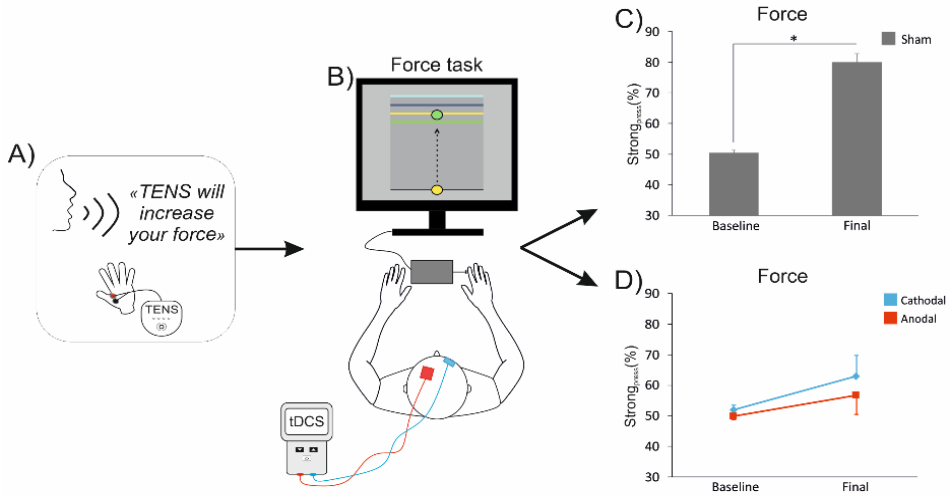


Piedimonte et al., Eur J Neurosci 2015



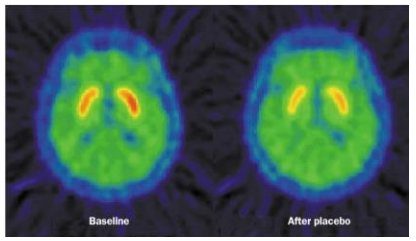


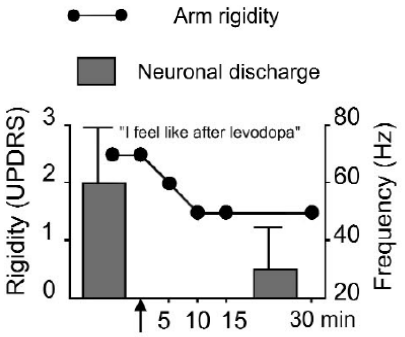
Fiorio et al., J Neurosci 2014
Emadi Andani et al., in prep.



Villa-Sanchez et al., Eur J Neurosci 2018
Broelz et al., Sci Rep 2019

Basal ganglia



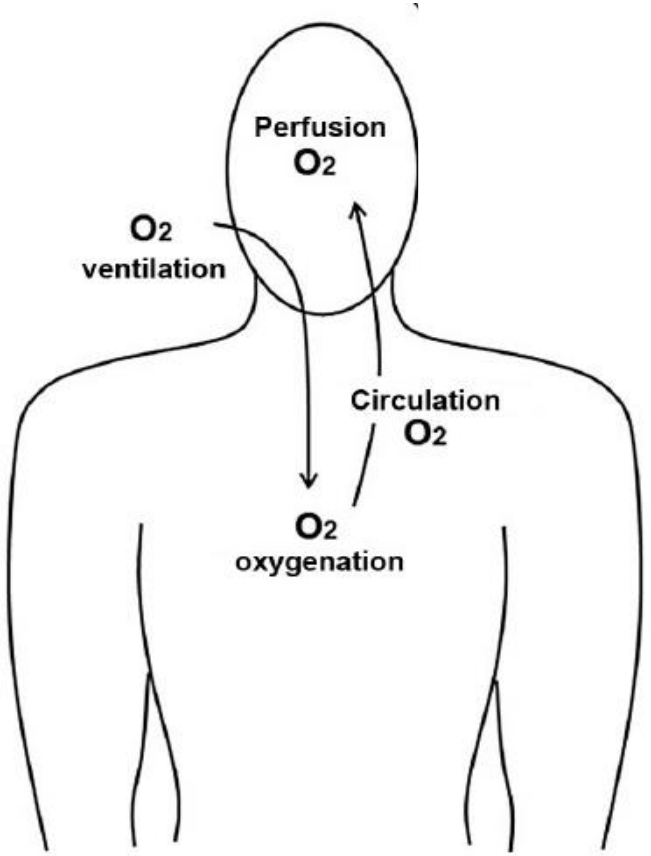


de la Fuente-Fernandez et al., Science 2001
de la Fuente-Fernandez et al., Lancet Neurol 2002
Benedetti et al., Nat Neurosci 2004
Benedetti et al., J Physiol. 2016

Other systems involved?

- Ventilation
- Circulation
- Perfusion

Physiological changes



Benedetti et al., 2018

Conclusion

The placebo effect works in different sport disciplines and for different types of motor functions

The placebo effect in the motor domain is associated with increased corticospinal excitability that starts before movement initiation

A network of brain regions implicated in motor control may be involved

From the lab to field

European Journal of Sport Science, 2015
Vol. 15, No. 4, 315–321, http://dx.doi.org/10.1080/17461391.2014.955126

Routledge
Taylor & Francis Group

ORIGINAL ARTICLE

Elite athletes' attitudes towards the use of placebo-induced performance enhancement in sports

MÁRK BÉRDI, FERENC KÖTELES, KRISZTINA HEVESI, GYÖRGY BÁRDOS, & ATTILA SZABO

Abstract

While an increasing number of research is devoted to the understanding of placebo effects in sports, athletes' experiences with and attitudes towards the use of placebo for performance enhancement remain poorly understood. In this study, 79 elite athletes from different sports were surveyed on five issues related to placebo use in sports. Results showed that 47% of the athletes have experienced placebo effects in the past. A majority of the athletes (82%) thought that placebos could affect their sports performances. A wider use of placebos in sport settings was endorsed more by those who have experienced placebo effects in the past than those who did not ($P = .005$). Regardless of past experience with placebo, more than half of the athletes (53%) would accept an unknown but legitimate substance from the coach, and 67% of them would not mind a placebo-linked deception if that was effective. These findings confirm that most elite athletes believe in the power of placebos in enhancing sports performance, and those having a positive past experience exhibit slightly more favourable attitudes in contrast to those without such experiences.

From the lab to the field

How could we make optimal use of placebo effects?

- For practical applications, it is important to know that placebo research yielded ethical possibilities to use placebo effects **without deception** and **without the use of placebos**.

- The principles are to modulate expectancies by a targeted use of verbal instructions, cues, associations, and social learning models in order to foster a use of placebos that not only is ethically permissible, but which also supports individuals' self-efficacy.

Klinger et al., *Int Rev Neurobiol* 2018; Colloca & Howick, 2018; Kaptchuk et al., *BMJ* 2020

Thank you for listening

@UNIVR

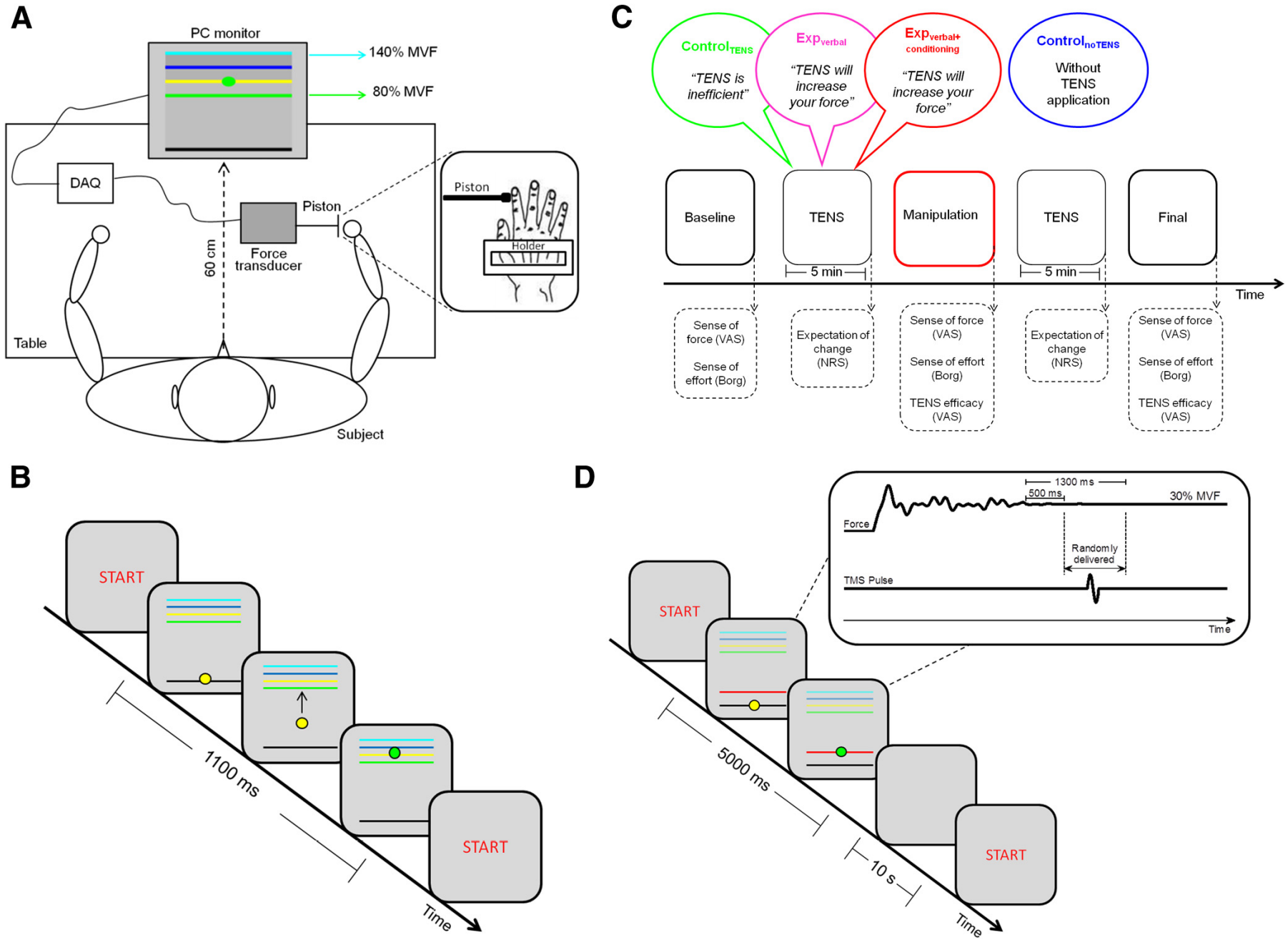
Mehran Emadi Andani
Miriam Braga
Diletta Barbiani
Michele Tinazzi
Angela Marotta
Emanuela Pizzolla
Irene Lozzi
Francesco Da Dalt

@UNITO

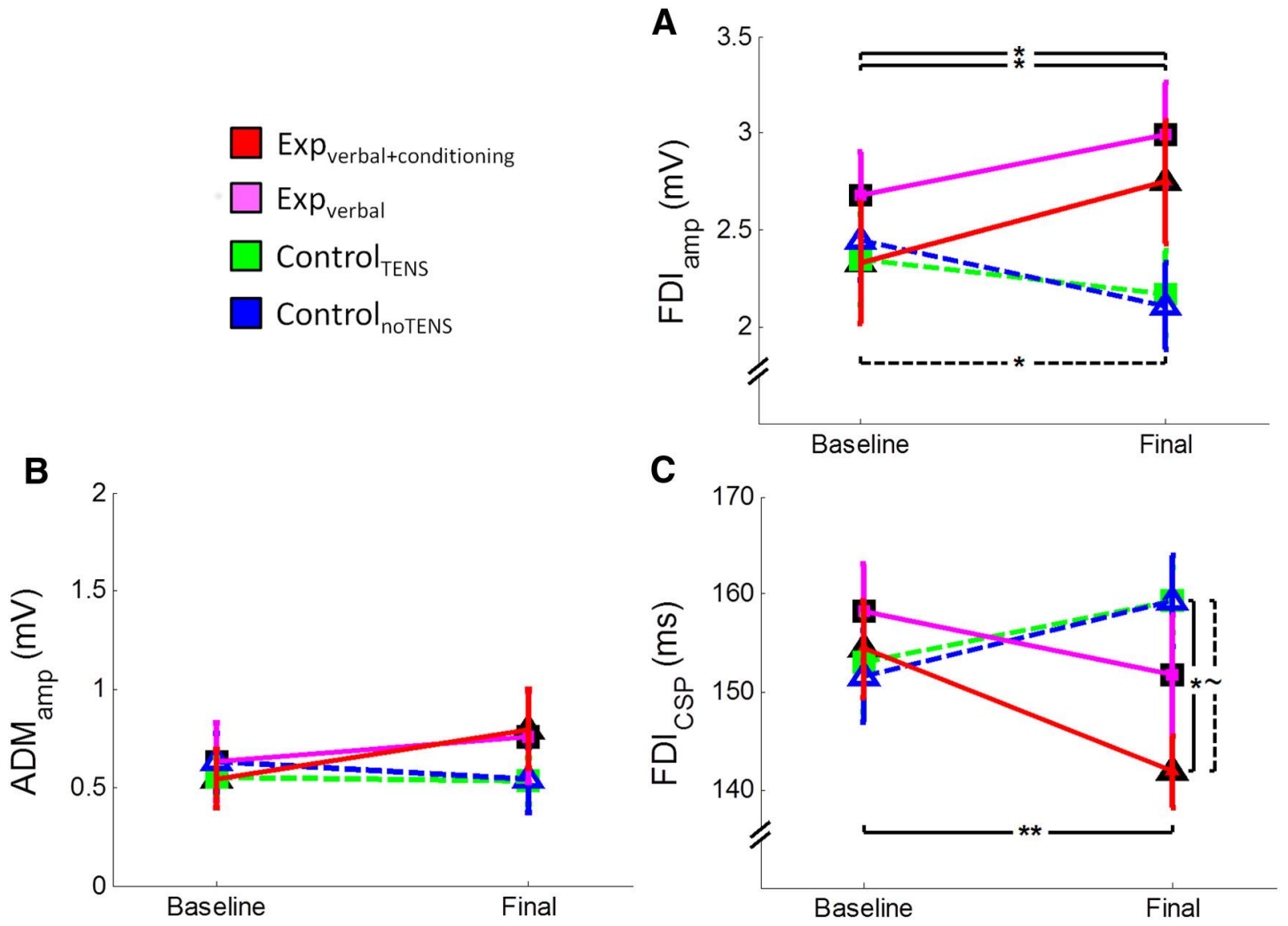
Elisa Carlino
Alessandro Piedimonte

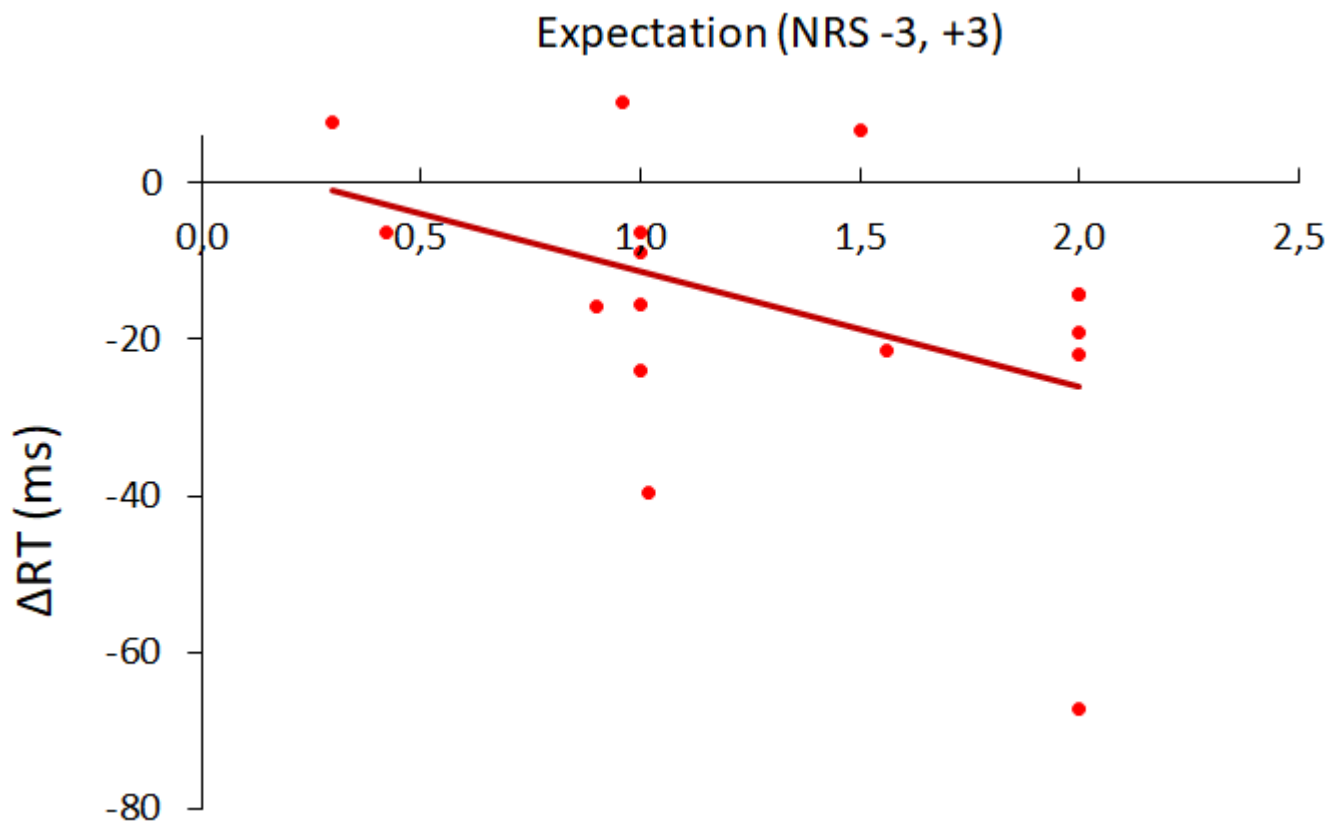
mirta.fiorio@univr.it

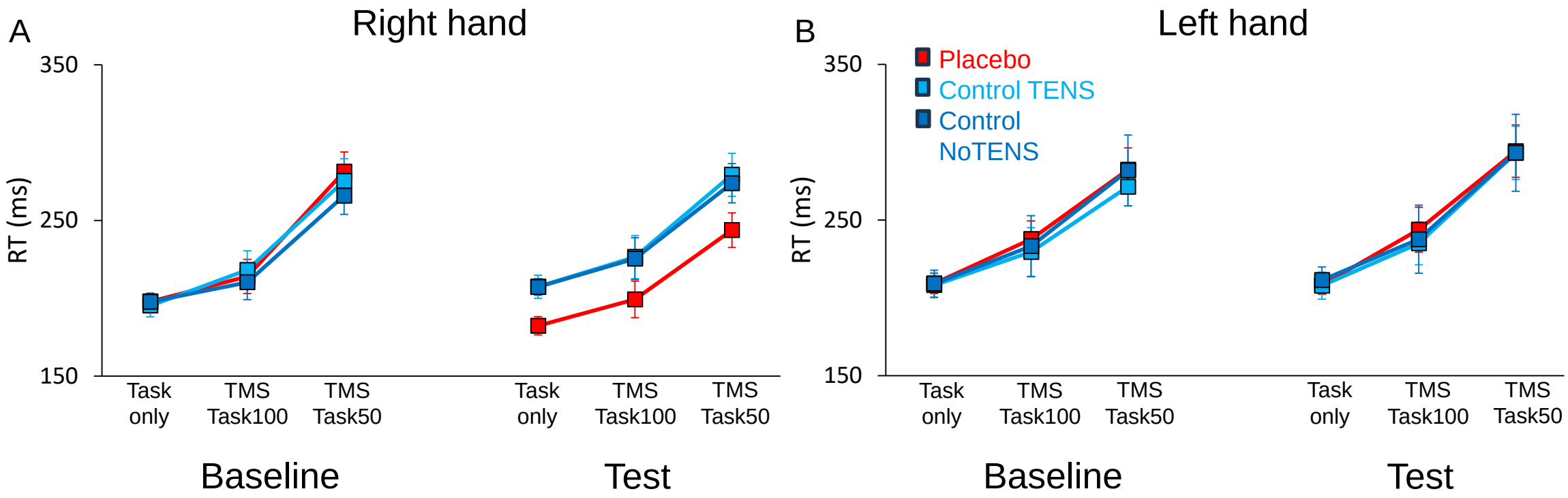
PRIN 2022

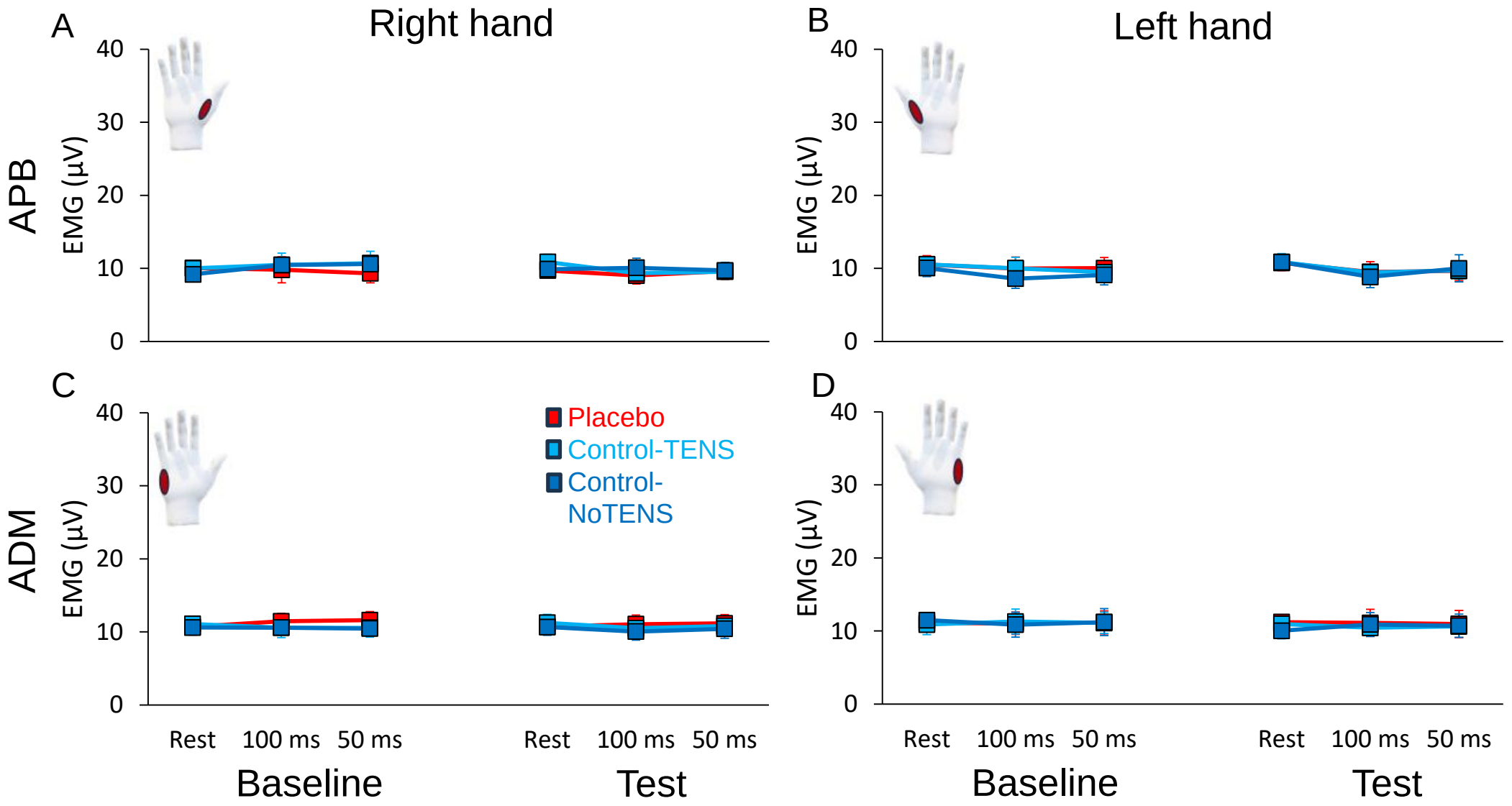

A
PC monitor
140% MVF
80% MVF
DAQ
Piston
Force transducer
60 cm
Table
Subject
Piston
Holder
C
Control TENS
"TENS is inefficient"
Exp verbal
"TENS will increase your force"
Exp verbal+ conditioning
"TENS will increase your force"
Control noTENS
Without TENS application
Baseline
TENS
Manipulation
TENS
Final
5 min
5 min
Time
Sense of force (VAS)
Sense of effort (Borg)
Expectation of change (NRS)
Sense of force (VAS)
Sense of effort (Borg)
TENS efficacy (VAS)
Expectation of change (NRS)
Sense of force (VAS)
Sense of effort (Borg)
TENS efficacy (VAS)
B
START
1100 ms
START
Time
D
1300 ms
500 ms
30% MVF
Force
Randomly delivered
TMS Pulse
Time
START
5000 ms
10 s
START
Time

The role of the primary motor cortex




Expectation (NRS -3, +3)
0
-20
-40
-60
-80
ΔRT (ms)
0,0
0,5
1,0
1,5
2,0
2,5


A
Right hand
B
Left hand
Placebo
Control TENS
Control NoTENS
RT (ms)
350
250
150
Task only
TMS Task100
TMS Task50
Baseline
Test


A
Right hand
B
Left hand
APB
ADM
EMG (μV)
40
30
20
10
0
C
D
Placebo
Control-TENS
Control-NoTENS
Rest
100 ms
50 ms
Baseline
Test