HYBRID NEURO

Motor-cognitive interventions in gait & balance studies

Uroš Marušič, PhD

Hybrid Neural Interfaces 2024 Summer School, Maribor, Slovenia, 8th -12th of June 2024

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Motor-cognitive interventions in gait & balance studies

Uros Marusic, PhD [1,2]

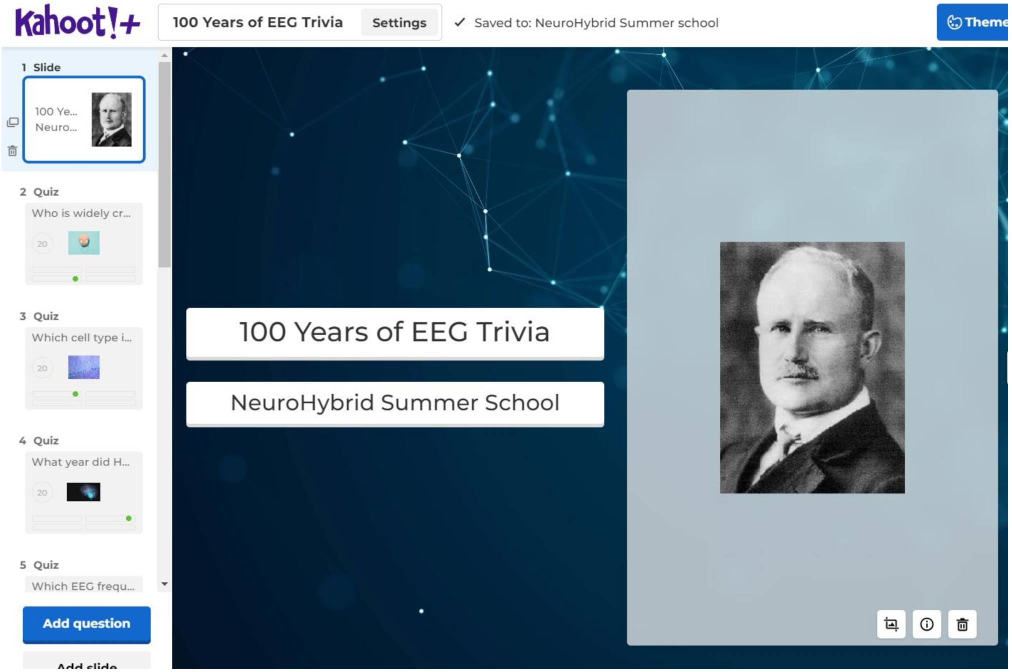
1: Slovenian Mobile Brain/Body Imaging Lab @Science and Research Centre Koper (ZRS Koper), Slovenia
2: Alma Mater Europaea – ECM, Slovenia

Maribor – 8 July 2024

Agenda

- Why neuroscience of movement?
- When & why postural and gait research?
- Cognitive-motor interventions – rehabilitation and countermeasures
- Mobile brain/body imaging


Kahoot!


Kahoot!+
100 Years of EEG Trivia
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Saved to: NeuroHybrid Summer school
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100 Years of EEG Trivia
NeuroHybrid Summer School

MSc: Biomedical engineering

University of Ljubljana

CZECH TECHNICAL UNIVERSITY IN PRAGUE

UNIVERZA NA PRIMORSKEM
UNIVERSITÀ DEL LITORALE

PhD: Kinesiology & Neuroscience

VUB
VRIJE UNIVERSITEIT BRUSSEL

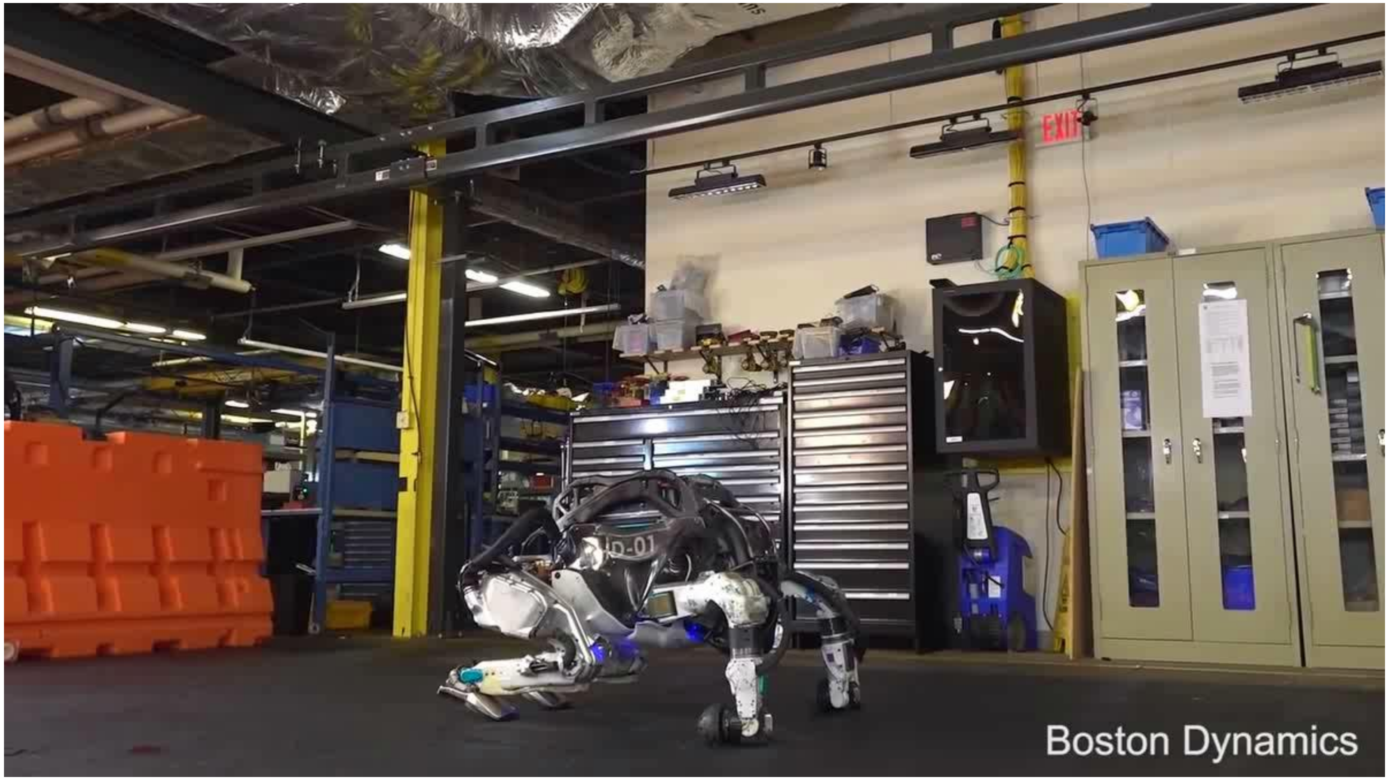
EINSTEIN
Albert Einstein College of Medicine

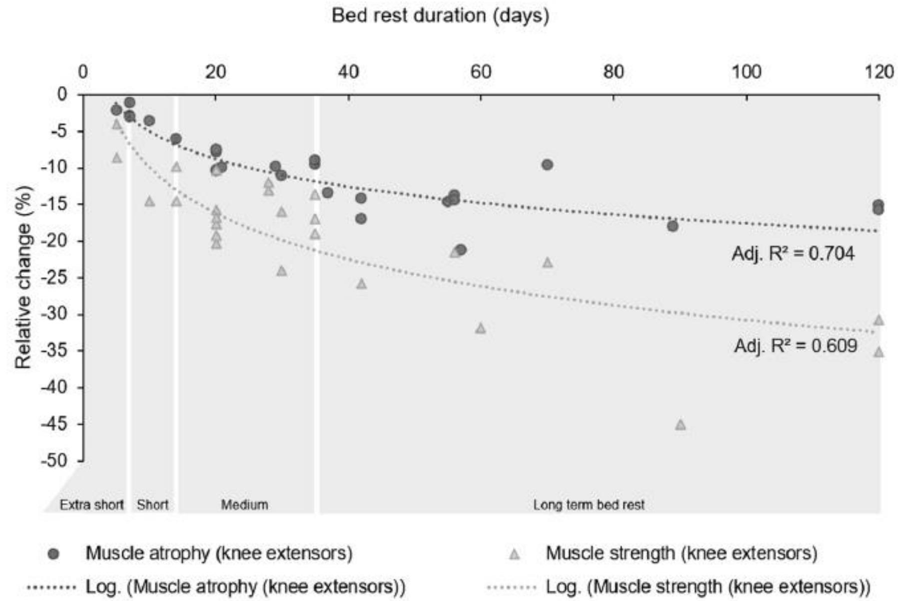
UNIVERSITY OF MICHIGAN

University of Michigan Medical School

Functional Neuroimaging, Cognitive and Mobility Lab


Pause (k)


EXIT
Boston Dynamics



2

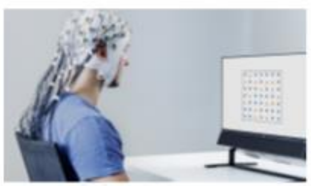
Bed rest experiments:

Valdoltra 2001, 2006, 2007, 2008, 2012

Izola 2019 and **2023**!

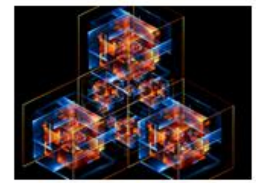
3: neuroscience of movement

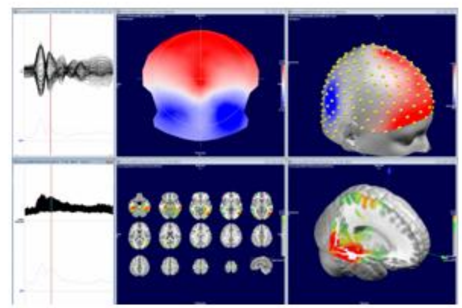
Current issue: static conditions, not allowing imaging brain dynamics in actively moving humans



Berlin's BeMoBIL (P2): allowing imaging brain dynamics in actively moving humans. Issue: large-scale data requiring not standard data and statistical analyses

UNIGE(P3): large-scale data analyses using artificial intelligence and advanced brain imaging techniques



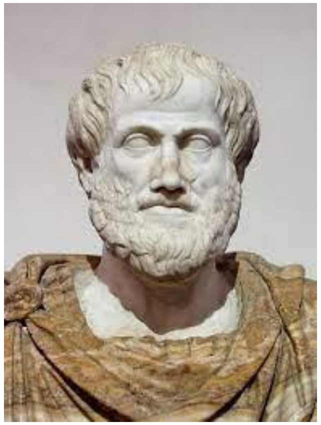


SRC (P1, leading partner from Widening country): Enhanced scientific and technological capacity as well as networking activities; application into sport/rehabilitation/ageing for neuro-muscular efficiency **(long-lasting infrastructure and research excellence)**

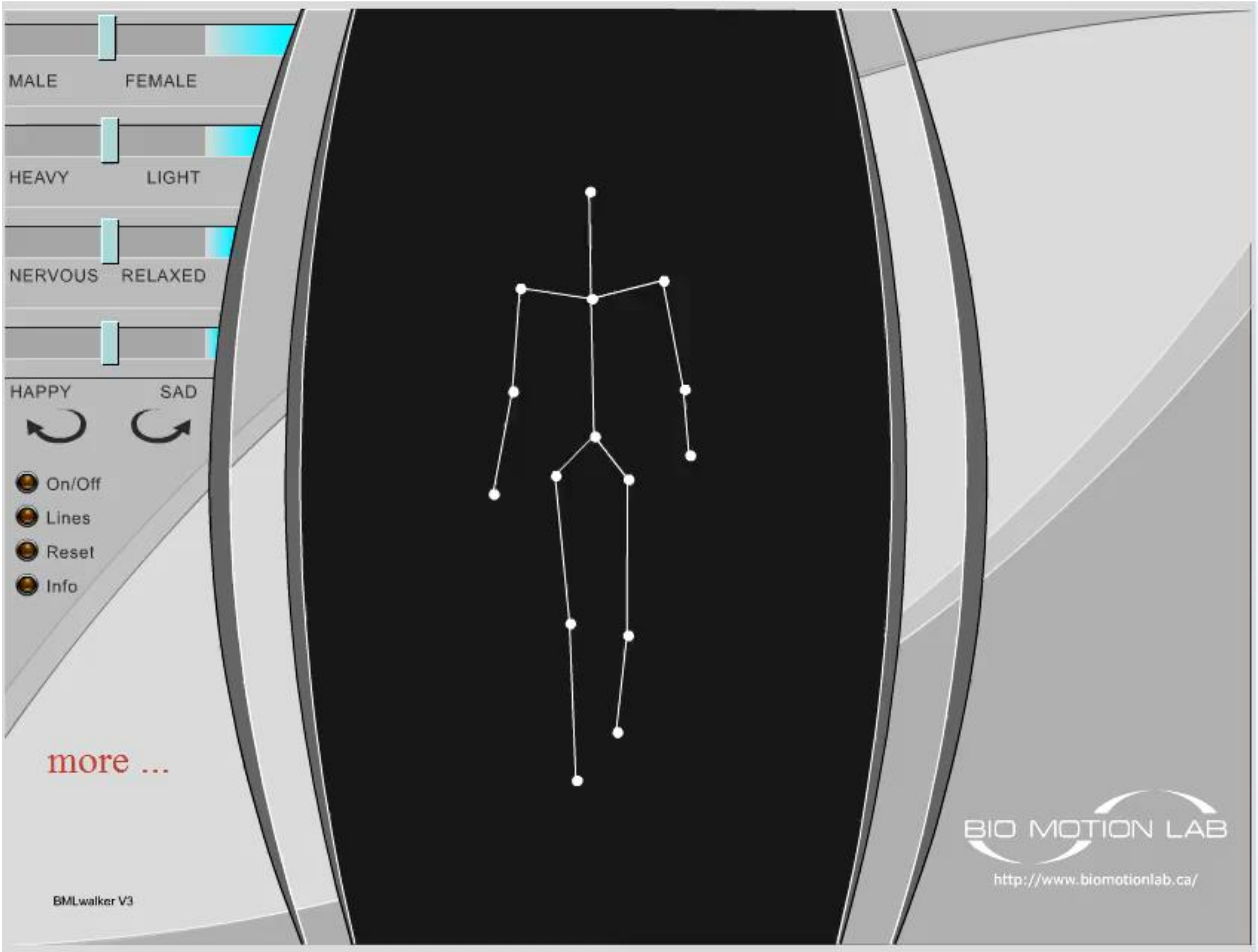
UNITS(P4): application into clinical practice with intention to efficiently treat Parkinson's disease and post-stroke patients

Ancient Theatre in Epidaurus, Greece (AUG 2020)

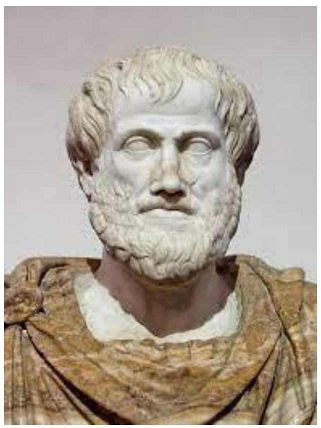
Human locomotion



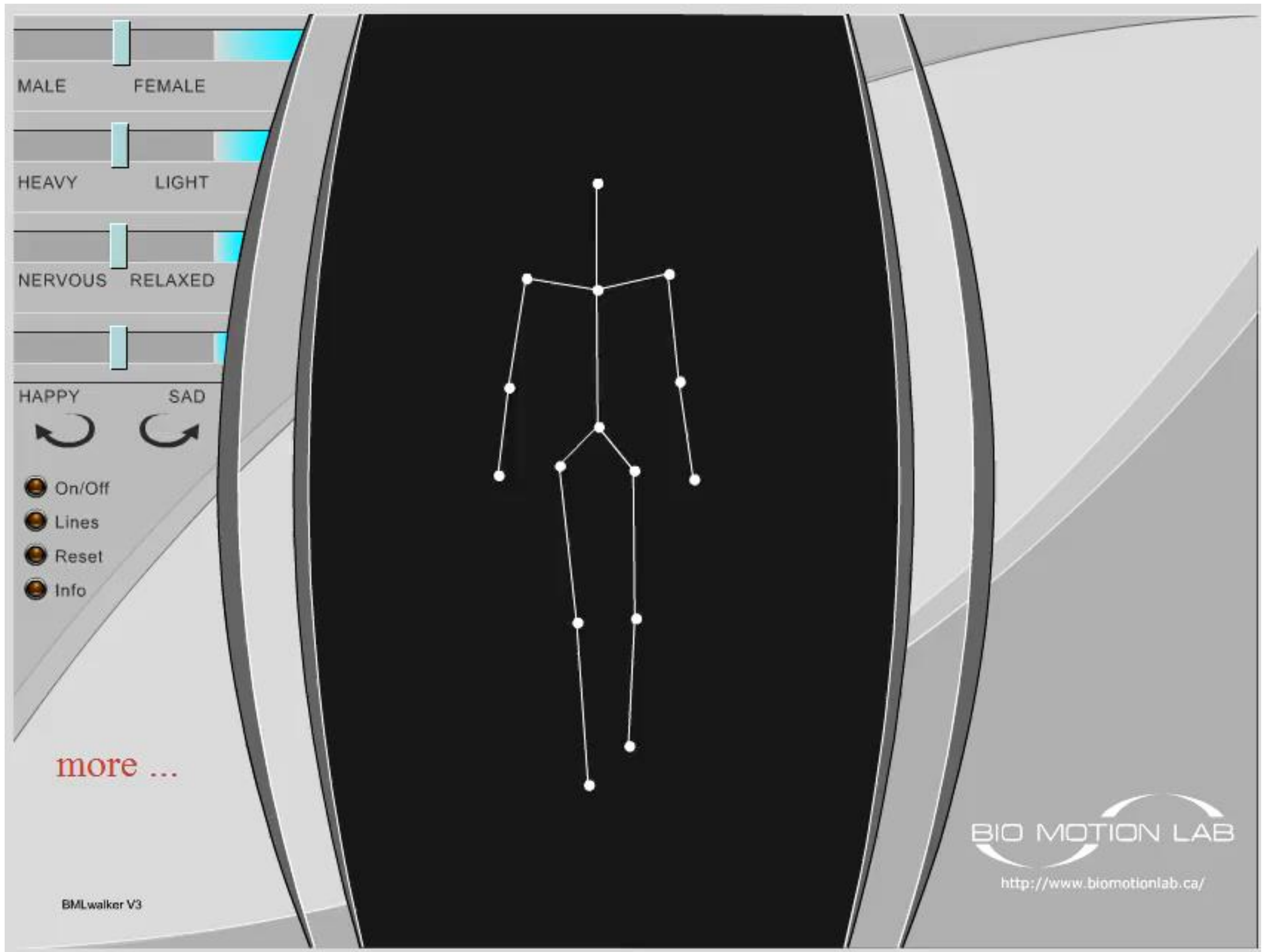
384–322 BC



Human locomotion



384–322 BC

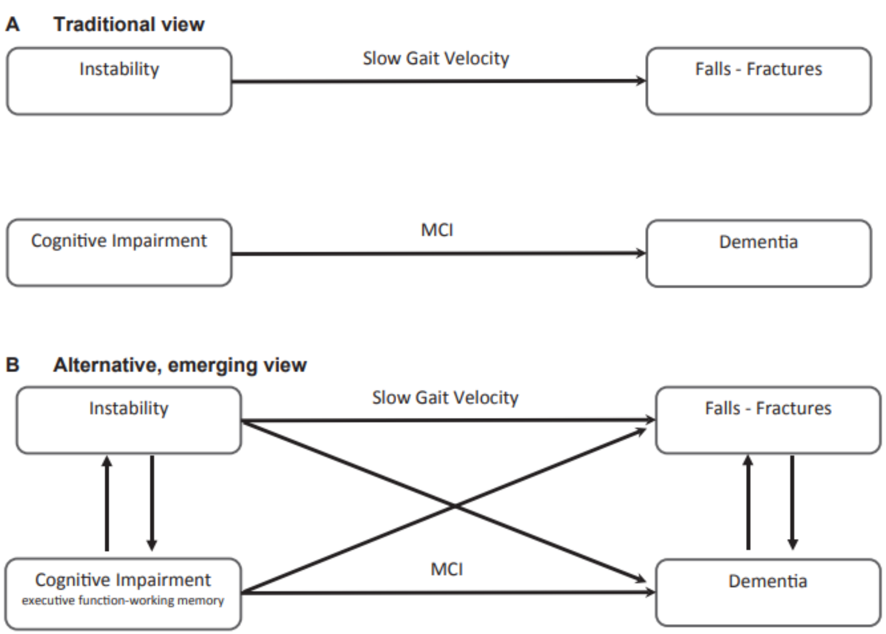


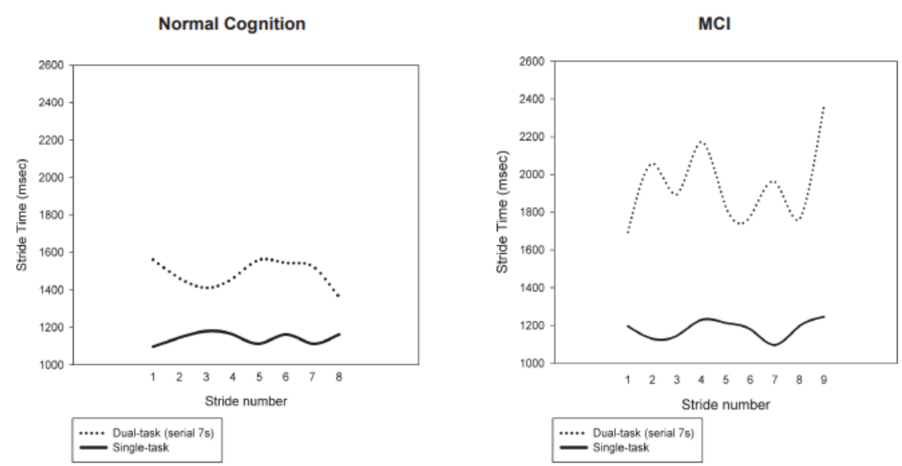
PROGRESS IN GERIATRICS

Gait and Cognition: A Complementary Approach to Understanding Brain Function and the Risk of Falling

Manuel Montero-Odasso, MD, PhD, AGSF,[*†] *Joe Verghese, MB, BS,*[‡] *Olivier Beauchet, MD, PhD,*[§] *and Jeffrey M. Hausdorff, PhD*[‖#**]

- Gait and cognition are interrelated in older adults

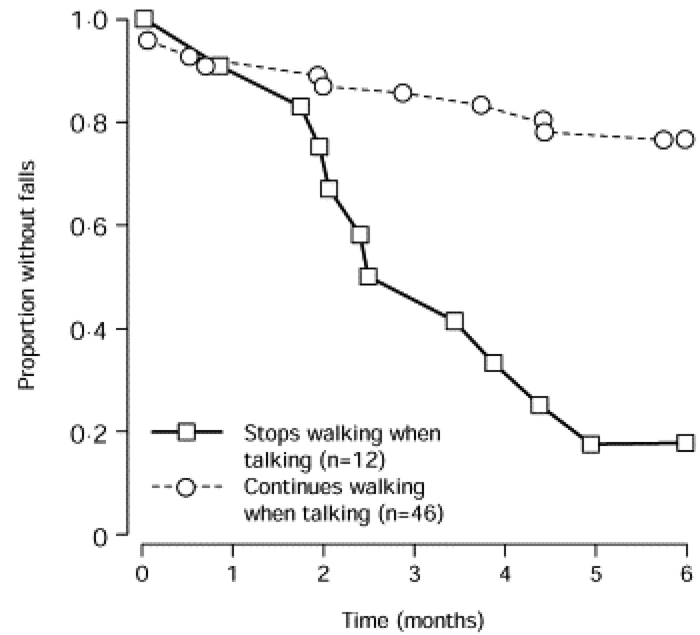




Examples with students:

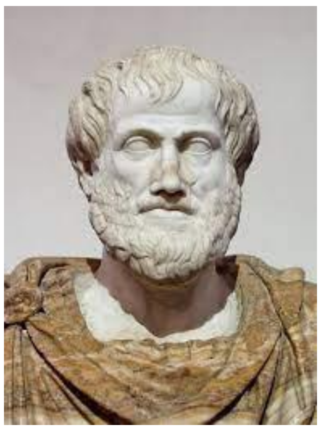
1. Walking while talking

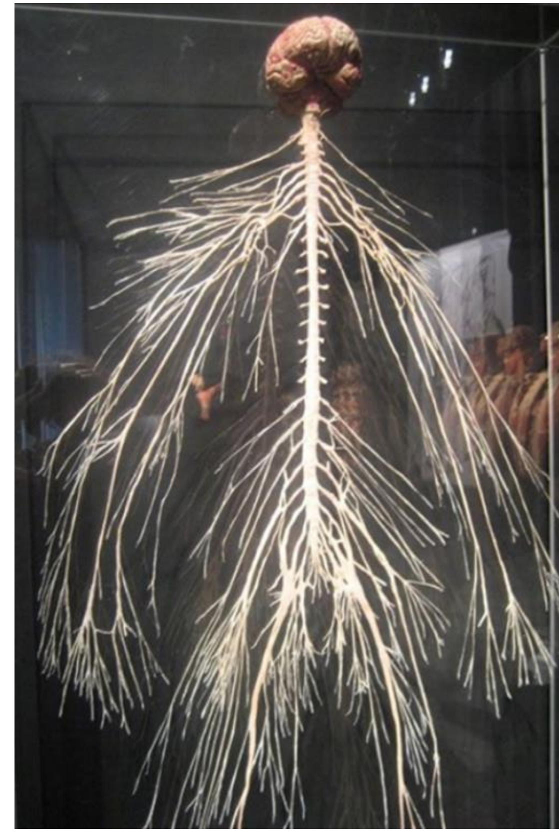
2. Single Leg Stance (ST, DT)

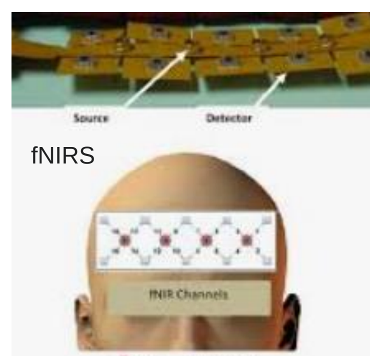


Lundin-Olsson, Nyberg & Gustafson (Lancet 1997)

Human locomotion


384–322 BC

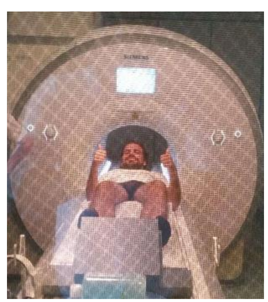


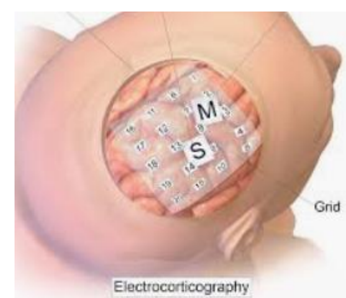


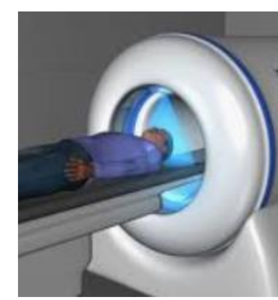
fNIRS

Neuroimaging Method	Activity Measured	Temporal Resolution	Spatial Resolution	Risk	Portability
EEG	Electrical	∼0.001 s	∼10 mm	Non-invasive	Portable
MEG	Magnetic	∼0.05 s	∼5 mm	Non-invasive	Non-portable
ECoG	Electrical	∼0.003 s	∼1 mm	Slightly invasive	Portable
Intracortical neuron recording	Electrical	∼0.003 s	∼0.5 mm (LFP) ∼0.1 mm (MUA) ∼0.05 mm (SUA)	Strongly invasive	Portable
fMRI	Metabolic	∼1 s	∼1 mm	Non-invasive	Non-portable
SPECT	Metabolic	∼10 s–30 min	∼1 cm	Non-invasive	Non-portable
PET	Metabolic	∼0.2 s	∼1 mm	Non-invasive	Non-portable
NIRS	Metabolic	∼1 s	∼2 cm	Non-invasive	Portable

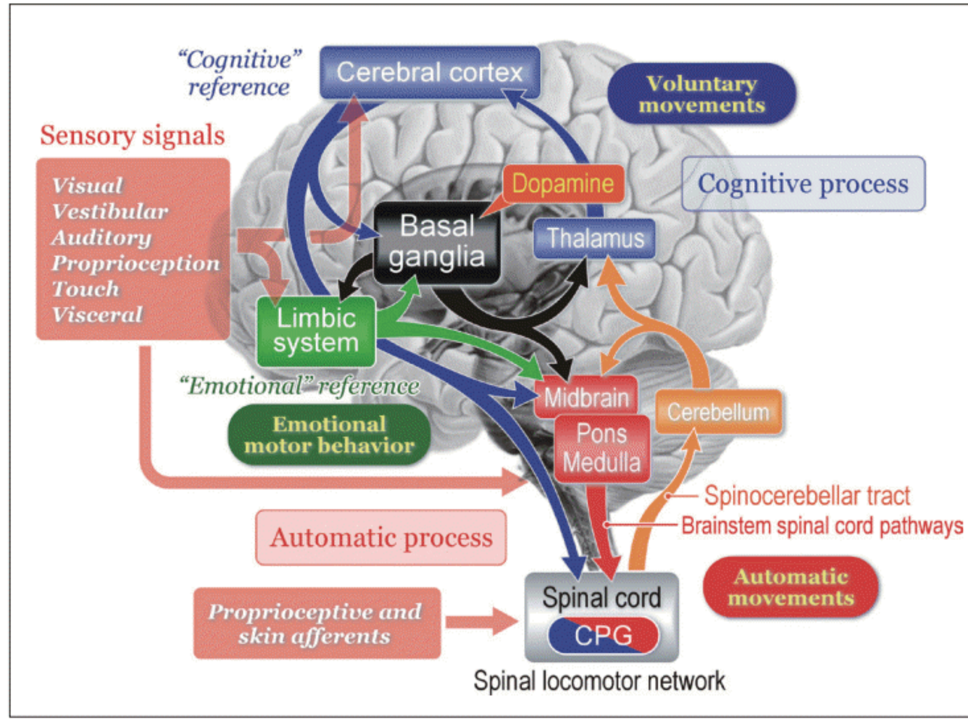








Human locomotion



Takakusaki, 2017 J Mov Disord

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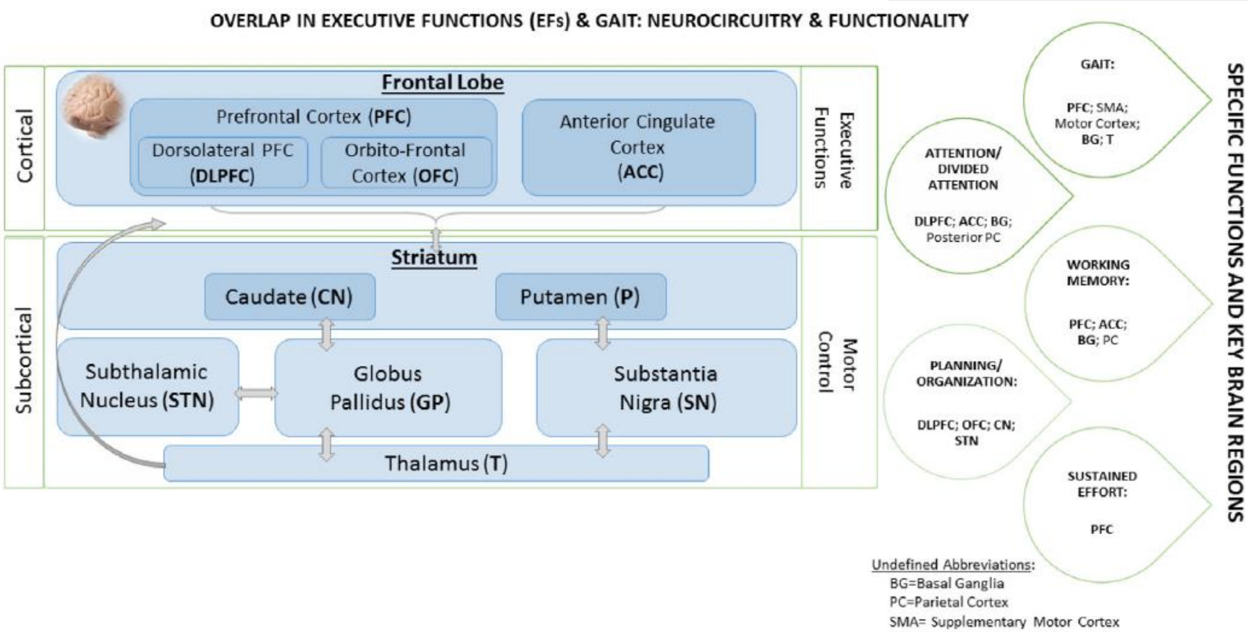


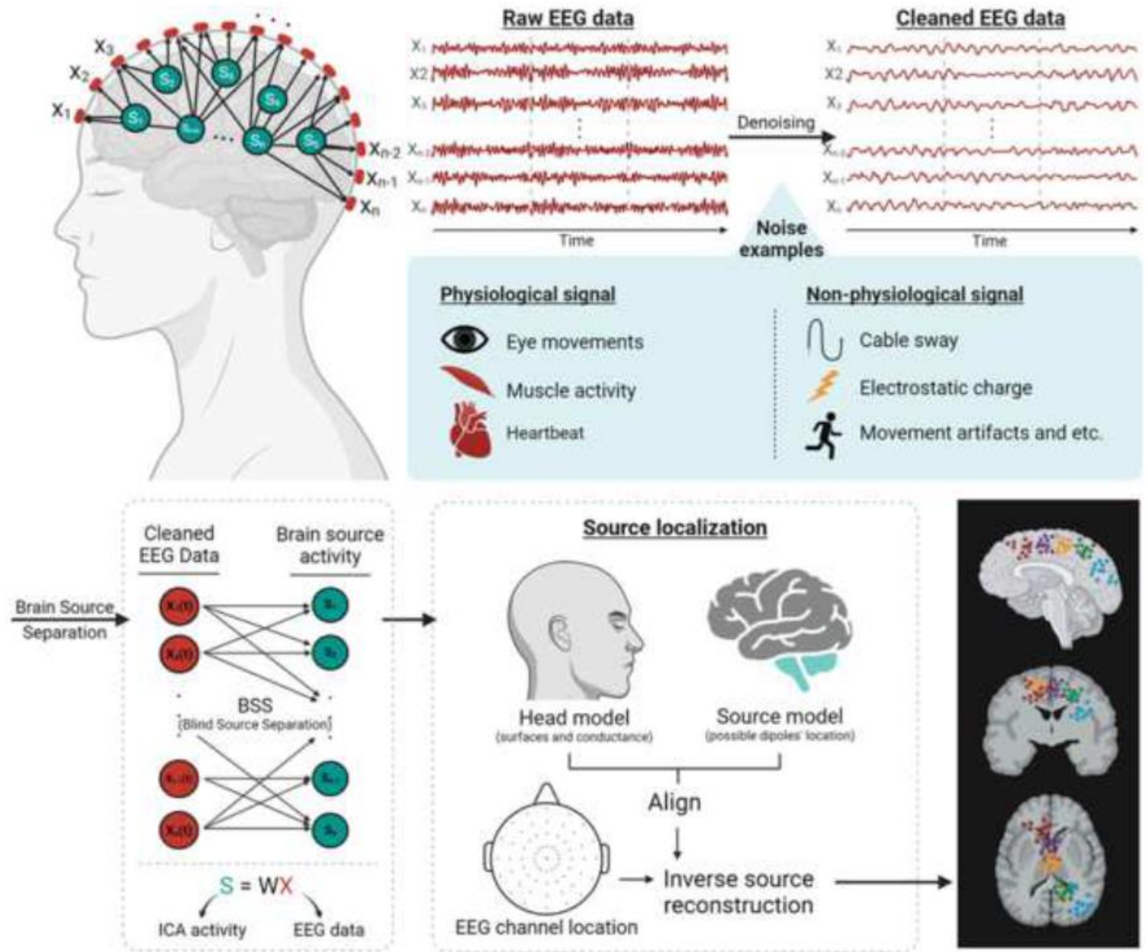
Fig. 4. Proposed model of cognitive training–related gait improvements.

Marusic, Verghese, Mahoney, 2018 JAMDA

ELSEVIER
Neuroscience & Biobehavioral Reviews
Available online 12 May 2024, 105718
In Press, Journal Pre-proof What's this?

Mobile neuroimaging: What we have learned about the neural control of human walking, with an emphasis on EEG-based research

Natalie Richer [a], J. Cortney Bradford [b], Daniel P. Ferris [c]

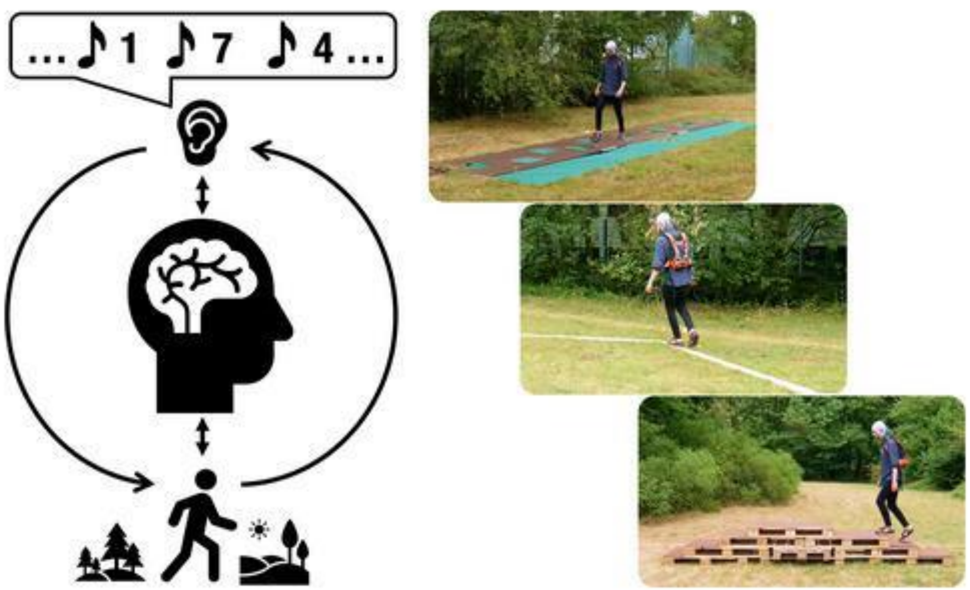


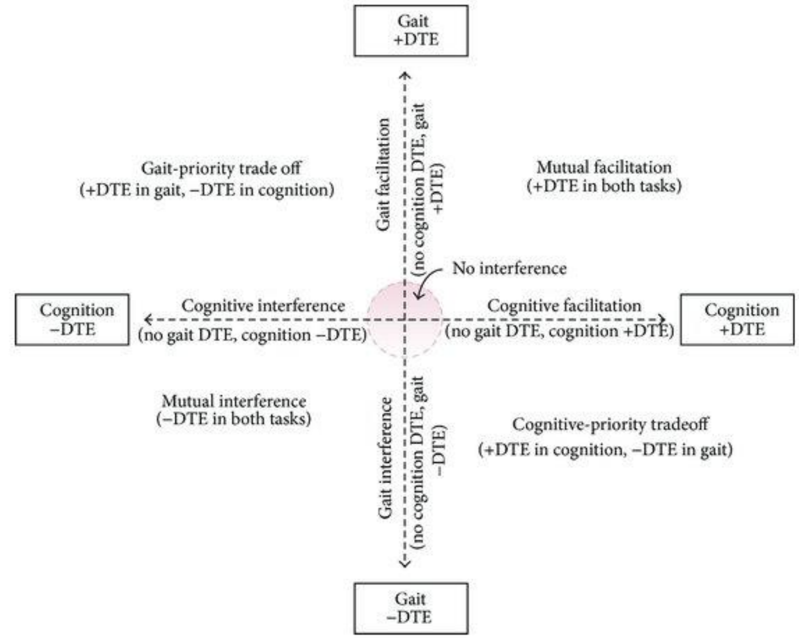
Cognitive-motor interference (CMI)

Received: 21 February 2020 | Revised: 26 August 2020 | Accepted: 27 August 2020
DOI: 10.1111/ejn.14959
SPECIAL ISSUE ARTICLE
EJN European Journal of Neuroscience FENS WILEY

Cognitive-motor interference in the wild: Assessing the effects of movement complexity on task switching using mobile EEG

Julian E. Reiser | Edmund Wascher | Gerhard Rinkenauer | Stefan Arnau





Plummer et al., 2014

CMI:
- sensory (early processes)
- Integration (info. processing)
- Executive control
- Motor processes (planning, execution)


START

Cognitive interventions to improve mobility

- 1st RCT with sedentary seniors performing CCT targeting EF & attention [1]
- 24 sessions, 8 weeks, 3x/week

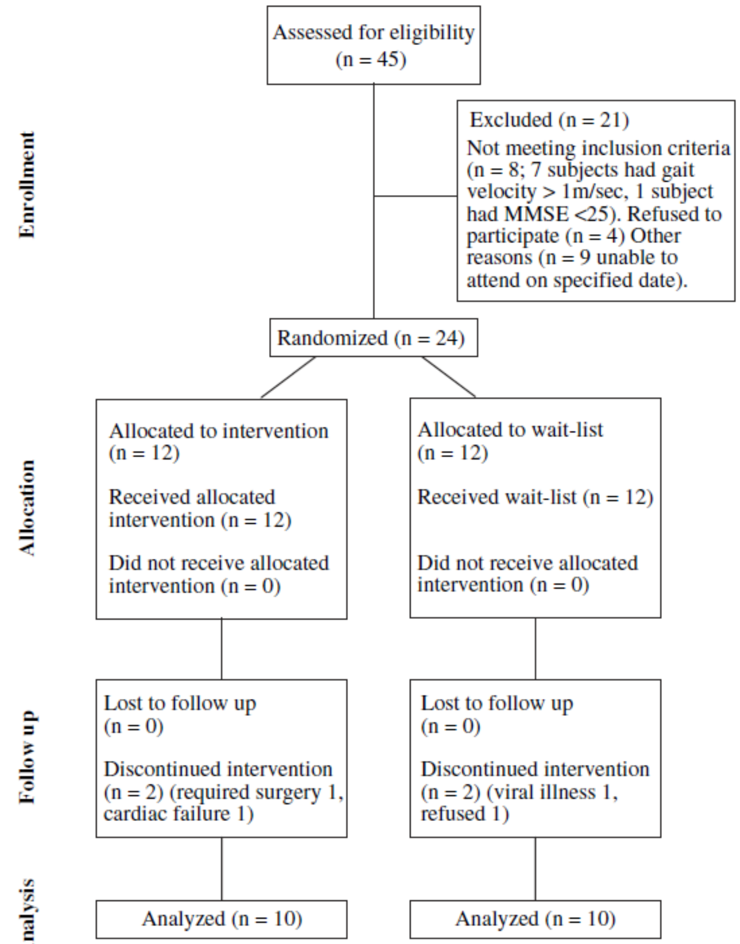


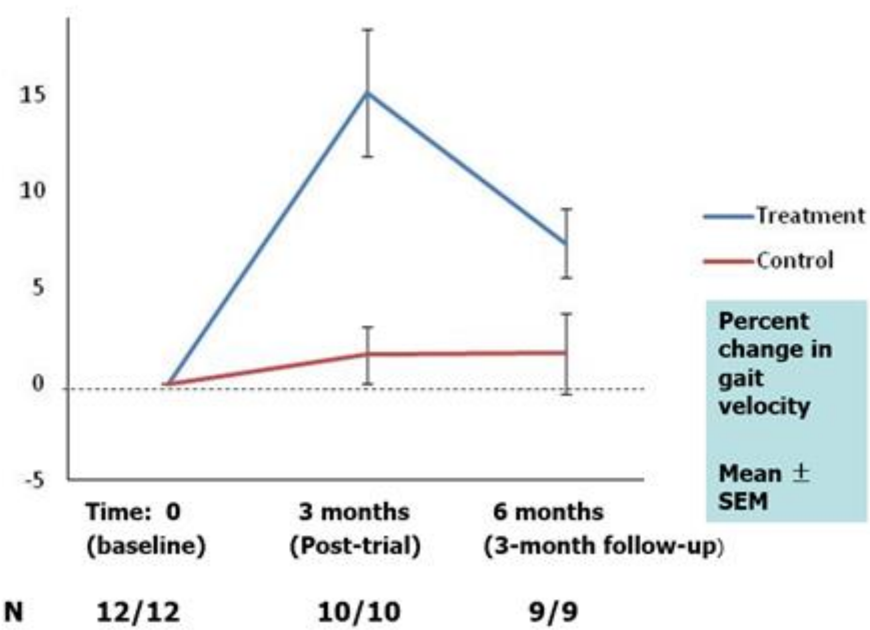
Figure 1. CONSORT diagram showing the flow of participants.

1 Verghese et al., 2010

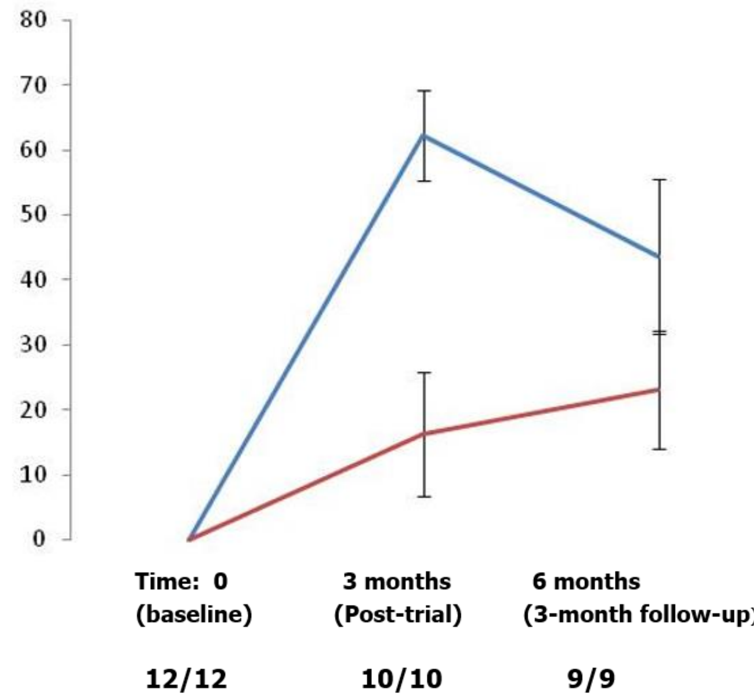
Cognitive interventions to improve mobility

- 1st RCT with sedentary seniors and 24 sessions of CCT targeting EF&attention [1]
- %change from baseline:

a) Normal walking



b) WWT: Walking while reciting alternate alphabets



1 Verghese et al., 2010

Spatial navigation training modifies hippocampal volumes

ELSEVIER

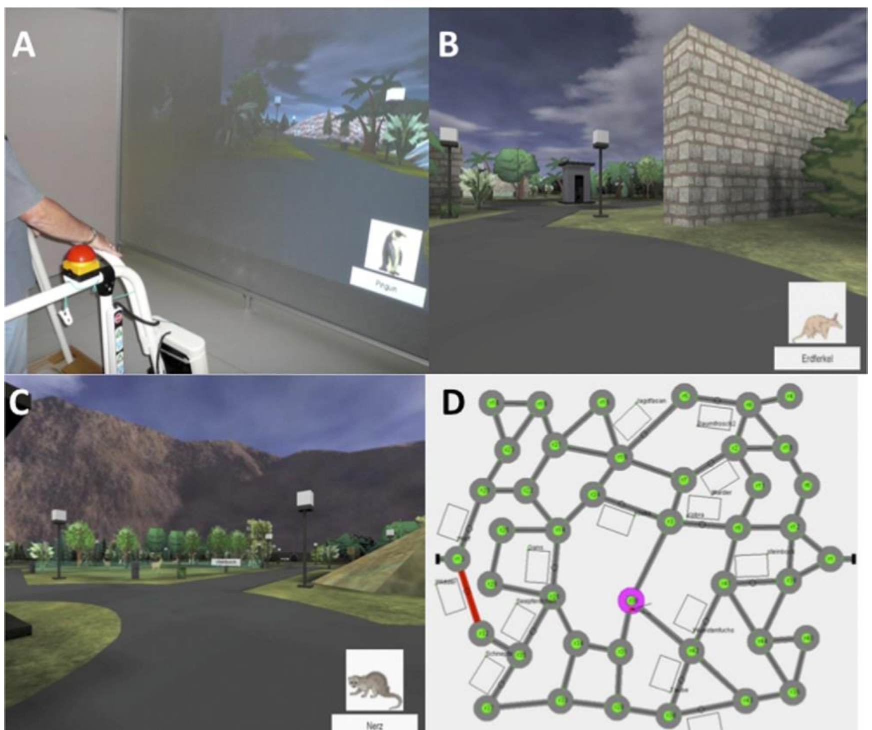
Neurobiology of Aging 33 (2012) 620.e9–620.e22

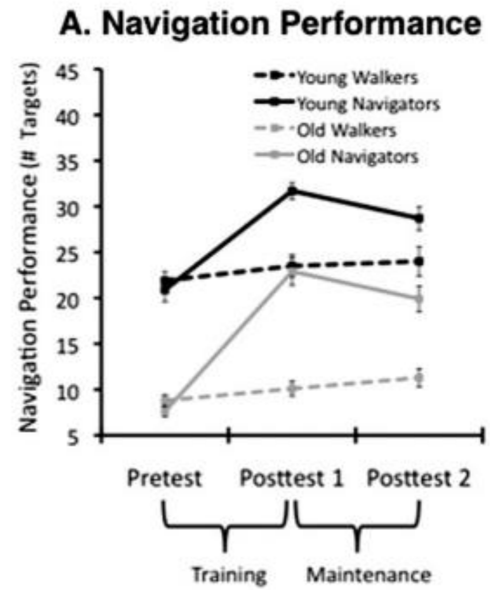
NEUROBIOLOGY OF AGING

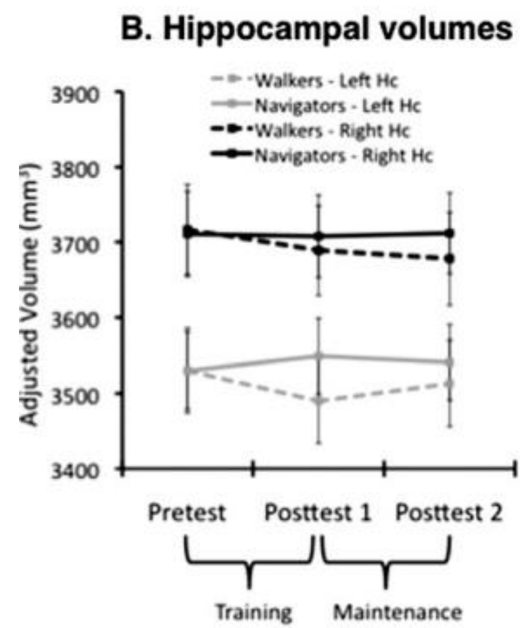
www.elsevier.com/locate/neuaging

Spatial navigation training protects the hippocampus against age-related changes during early and late adulthood

Martin Lövdén[a,b,c,*], Sabine Schaefer[a], Hannes Noack[a], Nils Christian Bodammer[a], Simone Kühn[d,e], Hans-Jochen Heinze[f,g], Emrah Düzel[f,g,h], Lars Bäckman[a,c], Ulman Lindenberger[a]

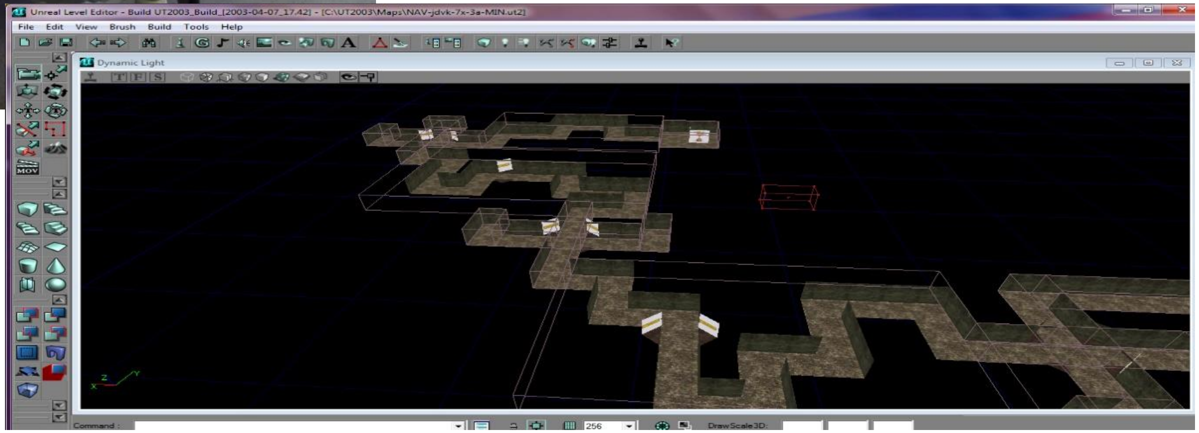






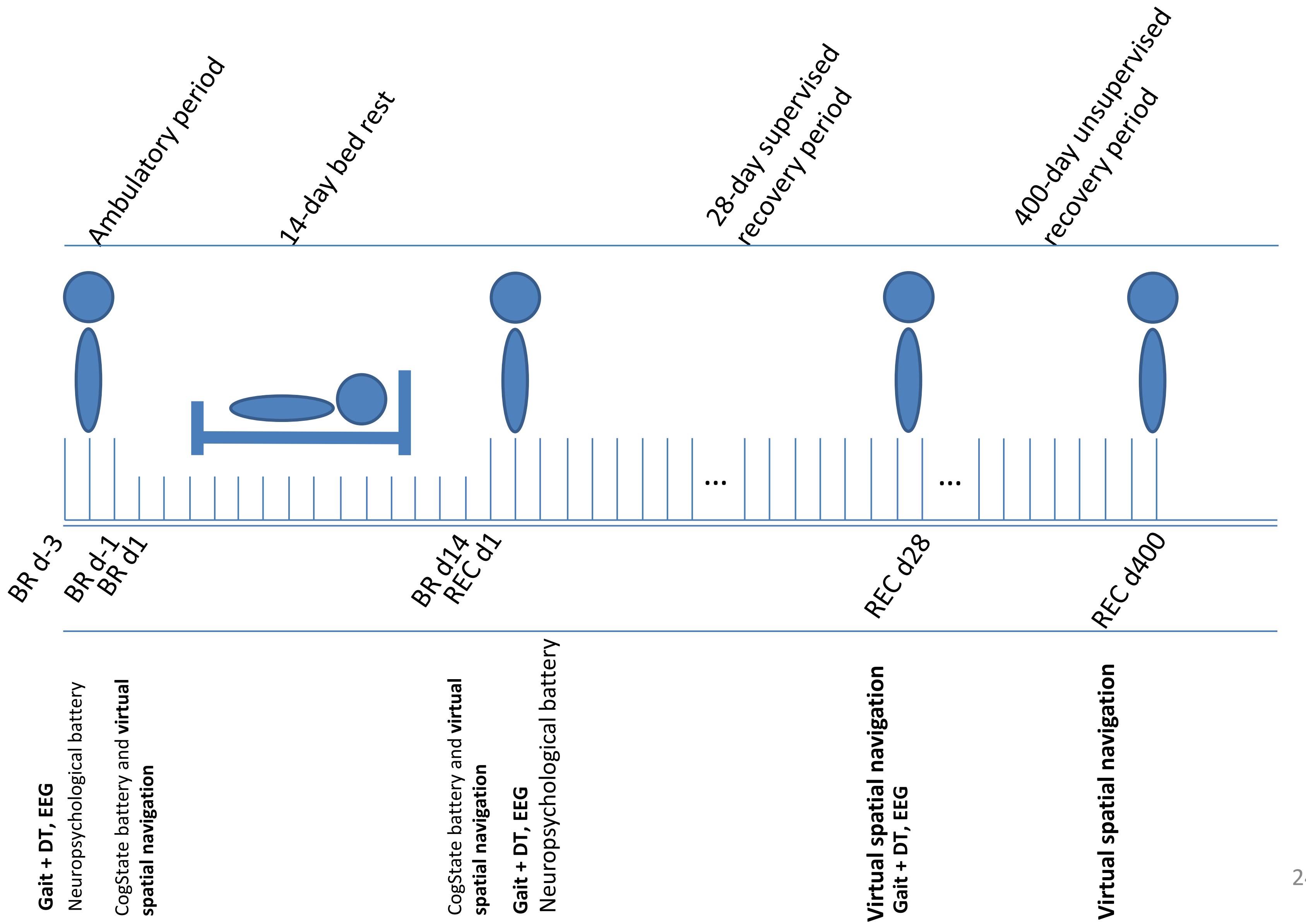
BED REST Valdoltra 2012

- RM random design
- Intervention and control group
- 14-day bed rest study at the Valdoltra Hospital, University of Primorska, Ankaran, Slovenia.



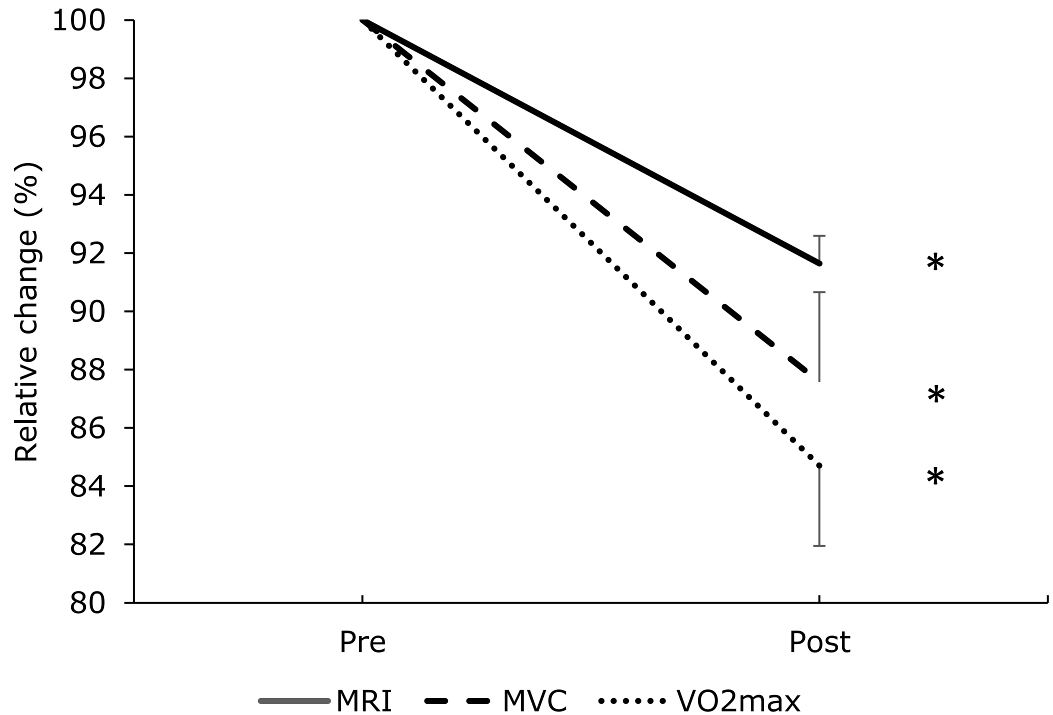
16 healthy participants: Intervention (N=8) and Control group (N=8)

- matched in terms of BMI, age, level of education and usage of computer
- Randomized into 2 groups: CCT or watching documentaries



CCT during bed rest

- ↓Muscle volume, function, and aerobic capacity [1]
  - *No interaction between Intervention and Control group (p > 0.05)!!*



1 Pisot, Marusic et al., 2016

CCT during bed rest

AGING, NEUROPSYCHOLOGY, AND COGNITION, 2016
http://dx.doi.org/10.1080/13825585.2016.1263724

Routledge
Taylor & Francis Group

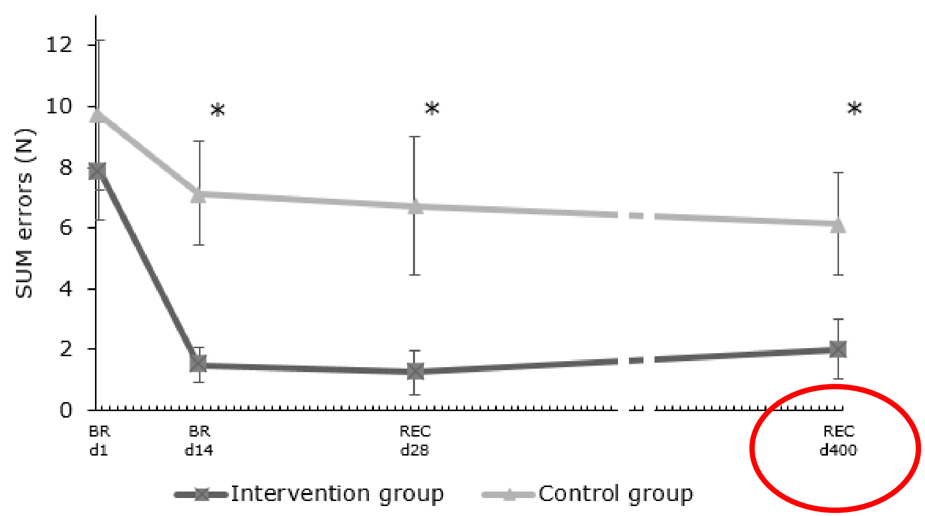
Computerized cognitive training during physical inactivity improves executive functioning in older adults

Uros Marusic[a], Bruno Giordani[b], Scott D. Moffat[c], Mojca Petrič[d], Petra Dolenc[d], Rado Pišot[a] and Voyko Kavcic[e]

[a]Institute for Kinesiology Research, Science and Research Centre, University of Primorska, Koper, Slovenia; [b]Departments of Psychiatry, Neurology, and Psychology and School of Nursing, University of Michigan, Ann Arbor, MI, USA; [c]School of Psychology, Georgia Institute of Technology, Atlanta, GA, USA; [d]Faculty of Education, University of Primorska, Koper, Slovenia; [e]Institute of Gerontology, Wayne State University, Detroit, MI, USA

Close and far transfer!

- Specifically trained cognitive functions (EF) (Marusic et al., 2016)



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[a]Institute for Kinesiology Research, Science and Research Centre, University of Primorska, Koper, Slovenia; [b]Departments of Psychiatry, Neurology, and Psychology and School of Nursing, University of Michigan, Ann Arbor, MI, USA; [c]School of Psychology, Georgia Institute of Technology, Atlanta, GA, USA; [d]Faculty of Education, University of Primorska, Koper, Slovenia; [e]Institute of Gerontology, Wayne State University, Detroit, MI, USA

Close and far transfer!

- Specifically trained cognitive functions (EF) (Marusic et al., 2016)
- Far transfer to a distal untrained domain – mobility (Marusic et al., 2015)

CCT during bed rest

Psychology and Aging
2015, Vol. 30, No. 2, 334–340

0882-7974/15/$12.00 http://dx.doi.org/10.1037/pag0000021

Computerized Spatial Navigation Training During 14 Days of Bed Rest in Healthy Older Adult Men: Effect on Gait Performance

Uros Marusic
University of Primorska and Vrije Universiteit Brussel

Voyko Kavcic
Wayne State University

Bruno Giordani
University of Michigan

Mitja Gerževič
University of Primorska

Romain Meeusen
Vrije Universiteit Brussel and James Cook University

Rado Pišot
University of Primorska

Table 1
Table of Pre- and Post-BR Gait Measurements and Significance Level for Interaction Effect

	Normal pace walking			Fast pace walking		
Variables	Pre	Post	$p_{\text{INTERACTION}}$ (η^2)	Pre	Post	$p_{\text{INTERACTION}}$ (η^2)
Gait speed (m/s)			.490			.466
Intervention group	1.20 ± .22	1.04 ± .15		1.83 ± .35	1.52 ± .21	
Control group	1.36 ± .19	1.27 ± .17		1.94 ± .19	1.76 ± .17	
Gait speed DT (m/s)			.276			.452
Intervention group	1.06 ± .18	1.14 ± .15		1.51 ± .27	1.42 ± .20	
Control group	1.29 ± .23	1.25 ± .15		1.71 ± .22	1.54 ± .19*	
Gait speed DTE (%)			**<.001 (.674)**			**.033 (.305)**
Intervention group	−11.53 ± 7.28	9.22 ± 6.59**		−16.51 ± 9.63	−6.74 ± 8.87	
Control group	−5.07 ± 5.04	−1.13 ± 5.77		−11.48 ± 8.38	−12.25 ± 8.52	
Swing time variability (s)			.464			.909
Intervention group	.014 ± .004	.019 ± .005		.012 ± .002	.018 ± .010	
Control group	.011 ± .003	.014 ± .003		.011 ± .002	.017 ± .012	
Swing time variability DT (s)			.137			**.003 (.496)**
Intervention group	.026 ± .012	.020 ± .007		.017 ± .005	.015 ± .003	
Control group	.018 ± .011	.021 ± .012		.013 ± .005	.021 ± .009*	
Swing time variability DTE (%)			.146			**.009 (.424)**
Intervention group	92.96 ± 87.17	6.11 ± 19.68		41.80 ± 26.75	4.58 ± 36.41*	
Control group	67.79 ± 105.04	49.87 ± 76.83		26.49 ± 37.16	57.18 ± 66.93	

Note. BR = bed rest; DT = dual-task walking condition. DTE = calculated dual-task effect (negative value represents dual-task costs while positive values represents dual-task benefits). Boldface indicates a significant interaction effect ($p < .05$). All values are means ± *SD* unless otherwise stated.
* Significantly different from pre-BR at $p < .01$. ** Significantly different from pre-BR at $p < .001$.

DOI: 10.20419/2021.30.536
CC: 2340, 2500
UDK: 159.95:159.91

Psihološka obzorja / Horizons of Psychology, 30, 55–61 (2021)

Znanstveni empiričnoraziskovalni prispevek / Scientific empirical article

Higher neural demands on stimulus processing after prolonged hospitalization can be mitigated by a cognitively stimulating environment

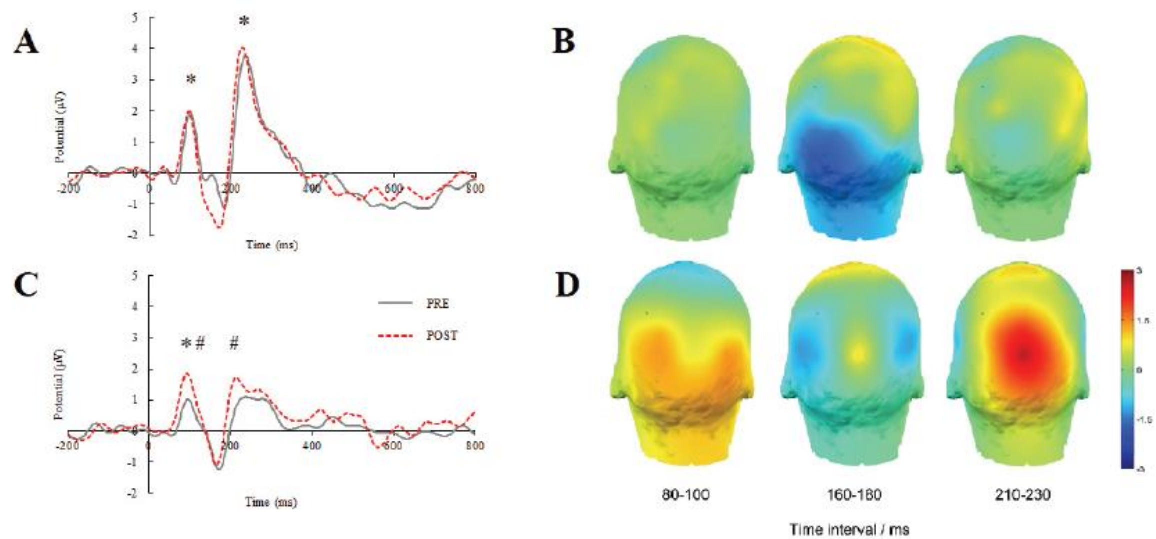
Uroš Marušič[1,2,*], Rado Pišot[2] and Vojko Kavčič[3,4]
[1]Science and Research Centre Koper, Slovenia
[2]Alma Mater Europaea – European Centre Maribor, Slovenia
[3]Institute of Gerontology, Wayne State University, Detroit, Michigan, USA
[4]International Institute of Applied Gerontology, Ljubljana, Slovenia

Limitations:

- Only static EEG
- Pre-post bed rest while sitting

Figure 1

Visual Evoked Potentials for CCT (A) and Control Group (C), and Topographic Maps of Post-Pre Difference for CCT (B) and Control Group (D)



Notes: The solid gray line represents the data from pre-bed rest, while the dashed red line represents post-bed rest data. * marks a significant decrease in latency at the end of bed rest. # marks a significant increase in amplitude at the end of bed rest. The topographic maps are shown from posterior view.

Does non-physical training improve mobility?

Does non-physical training improve mobility?

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JAMDA
journal homepage: www.jamda.com

Review Article

Cognitive-Based Interventions to Improve Mobility: A Systematic Review and Meta-analysis

Uros Marusic PhD [a,b,*], Joe Verghese MD [c,d], Jeannette R. Mahoney PhD [c]

frontiers | Frontiers in Aging Neuroscience
ORIGINAL RESEARCH
published: 23 May 2022
doi: 10.3389/fnagi.2022.845825

Check for updates

Does Cognitive Training Improve Mobility, Enhance Cognition, and Promote Neural Activation?

Uros Marusic [1,2], Joe Verghese [3,4] and Jeannette R. Mahoney [3]*

[1] Institute for Kinesiology Research, Science and Research Centre Koper, Koper, Slovenia, [2] Department of Health Sciences, Alma Mater Europaea—ECM, Maribor, Slovenia, [3] Department of Neurology, Albert Einstein College of Medicine, Bronx, NY, United States, [4] Department of Medicine, Albert Einstein College of Medicine, Bronx, NY, United States

Hindawi
Neural Plasticity
Volume 2018, Article ID 5651391, 9 pages
https://doi.org/10.1155/2018/5651391

Hindawi

Research Article

Motor Imagery during Action Observation of Locomotor Tasks Improves Rehabilitation Outcome in Older Adults after Total Hip Arthroplasty

Uros Marusic [1,2] Sidney Grosprêtre,[3] Armin Paravlic,[1] Simon Kovač,[4] Rado Pišot,[1] and Wolfgang Taube[5]

BED REST 2023

Bed rest 2023

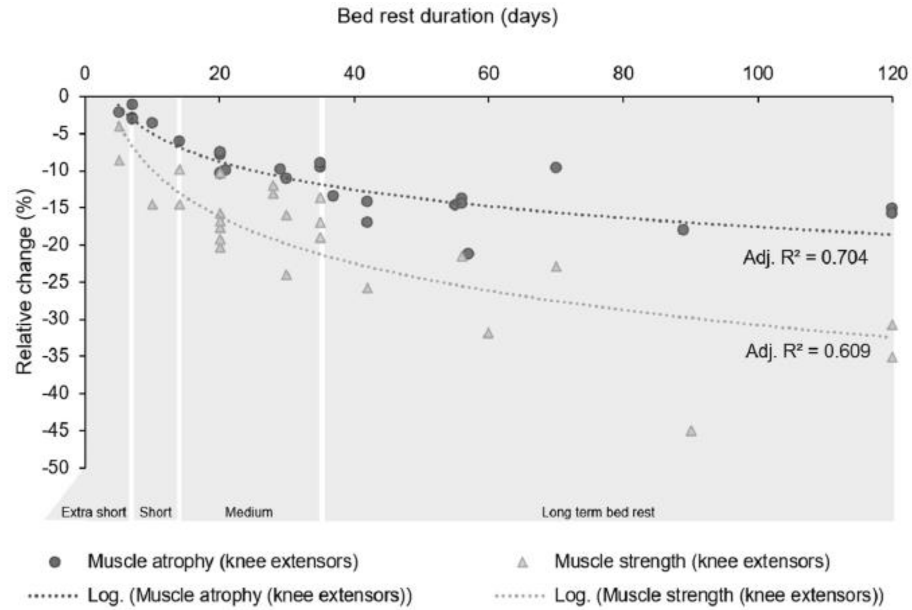
J Appl Physiol 131: 194–206, 2021.
First published March 11, 2021; doi:10.1152/japplphysiol.00363.2020

american physiological society | JOURNAL OF APPLIED PHYSIOLOGY

SYSTEMATIC REVIEW

Nonuniform loss of muscle strength and atrophy during bed rest: a systematic review

Uros Marusic,[1,2] Marco Narici,[1,3] Bostjan Simunic,[1] Rado Pisot,[1] and Ramona Ritzmann[4]



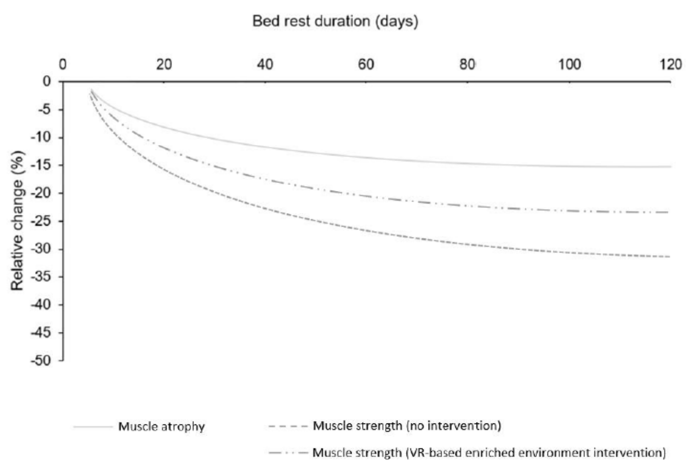


FIGURE 2. Speculative decline in muscle strength following XR intervention in conjunction with non-physical intervention: Adapted from Marusic et al. (Marusic et al., 2021)

Šlosar et al., 2023 Front Aging Neurosci

Bed rest 2023

10-day horizontal bed rest

X_BRAIN GROUP EX (N=10)

- 10 MI+AO (KI) Training days on the "VR leg press machine"
- Increase in difficulty (additional weights every day)
- Daily increase in muscle volume (impression of improvement)
- From 25 to 30 min/day
- No muscle contraction allowed
- *Specific diet, pre-training*

BEDREST GROUP E (N=10)

- 10- passive training (in the VR environment without a specific task)
- From 25 to 30 minutes/day

MRI: Quads muscle CSA50% (time x group int.: p=0.031):

- E = -4.49% *
- EX = -1.84% *

MViC (time x group int.: p=0.006):

- E = -14% *
- EX = -7% (n.s.)

ARRS J7-4601

arrs
SLOVENIAN RESEARCH AGENCY

- Title: Adaptation and sensorimotor processing during increased gravity gradients
- 3-year national project: 1. 10. 2022 - 30. 9. 2025
- Basic project
- Total budget: 150.000€
- PI: Uros Marusic, PhD

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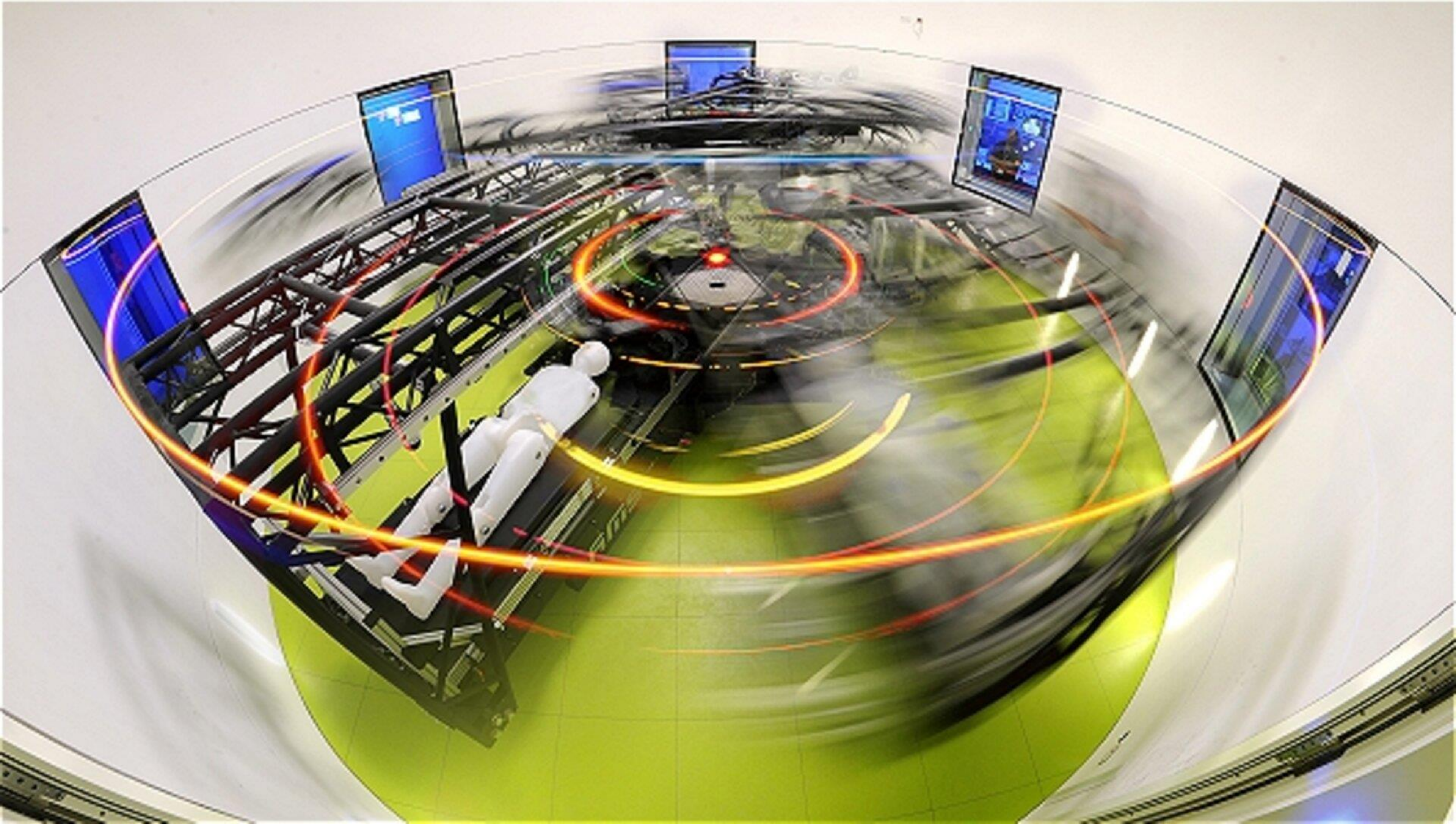
ARISTOTLE UNIVERSITY OF THESSALONIKI

Human centrifuge for medical purposes

VITALISE
Virtual health and Wellbeing Living Lab Infrastructure

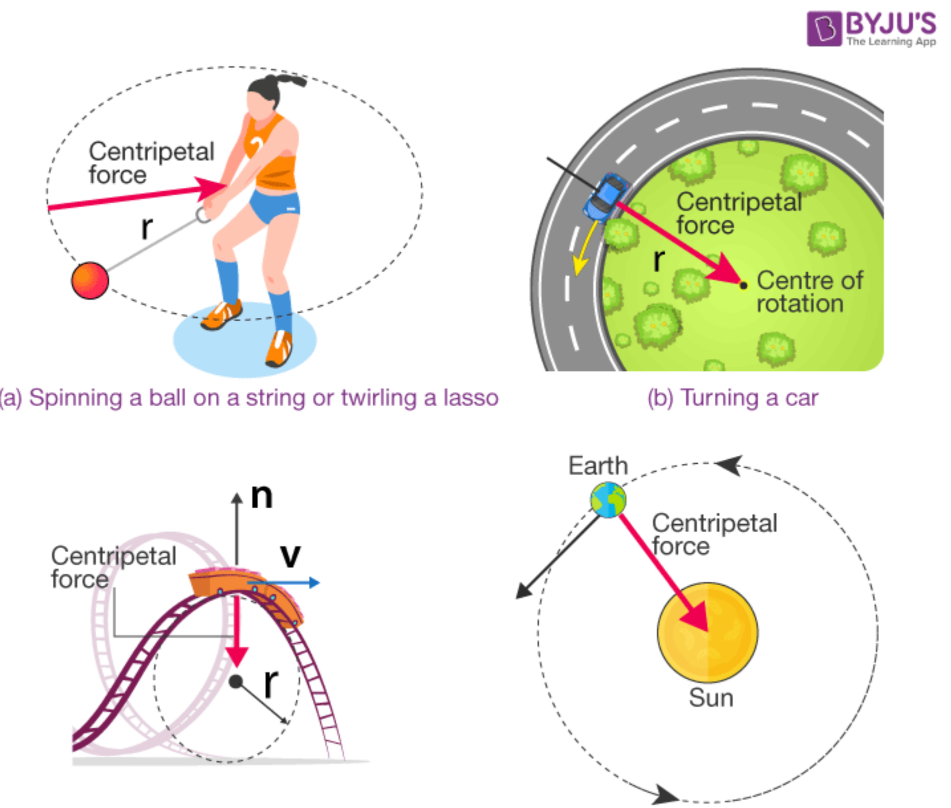
This project has received funding from European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 101007990.



Principle of Centrifuges

What is a Centrifuge?

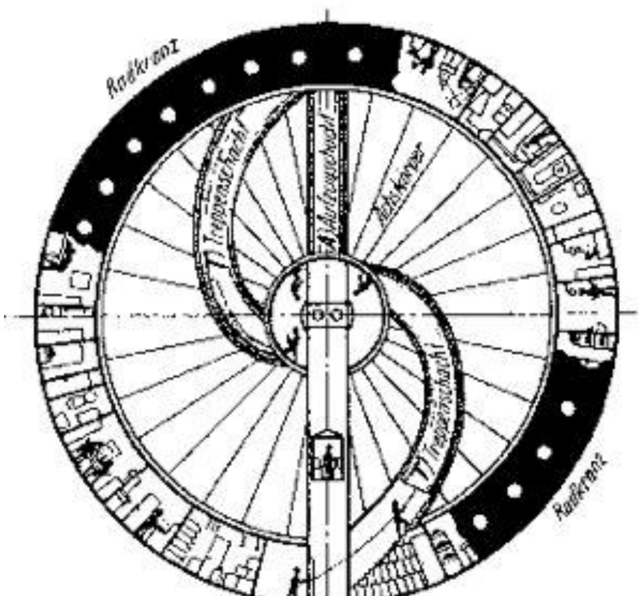
- A centrifuge is a scientific device that is used to separate fluids, gasses, or liquids based on the density of the subject. The separation is acquired by spinning a container with the material at a very high speed. The resulting forces created will then cause the heavier materials to travel to the bottom of the container.

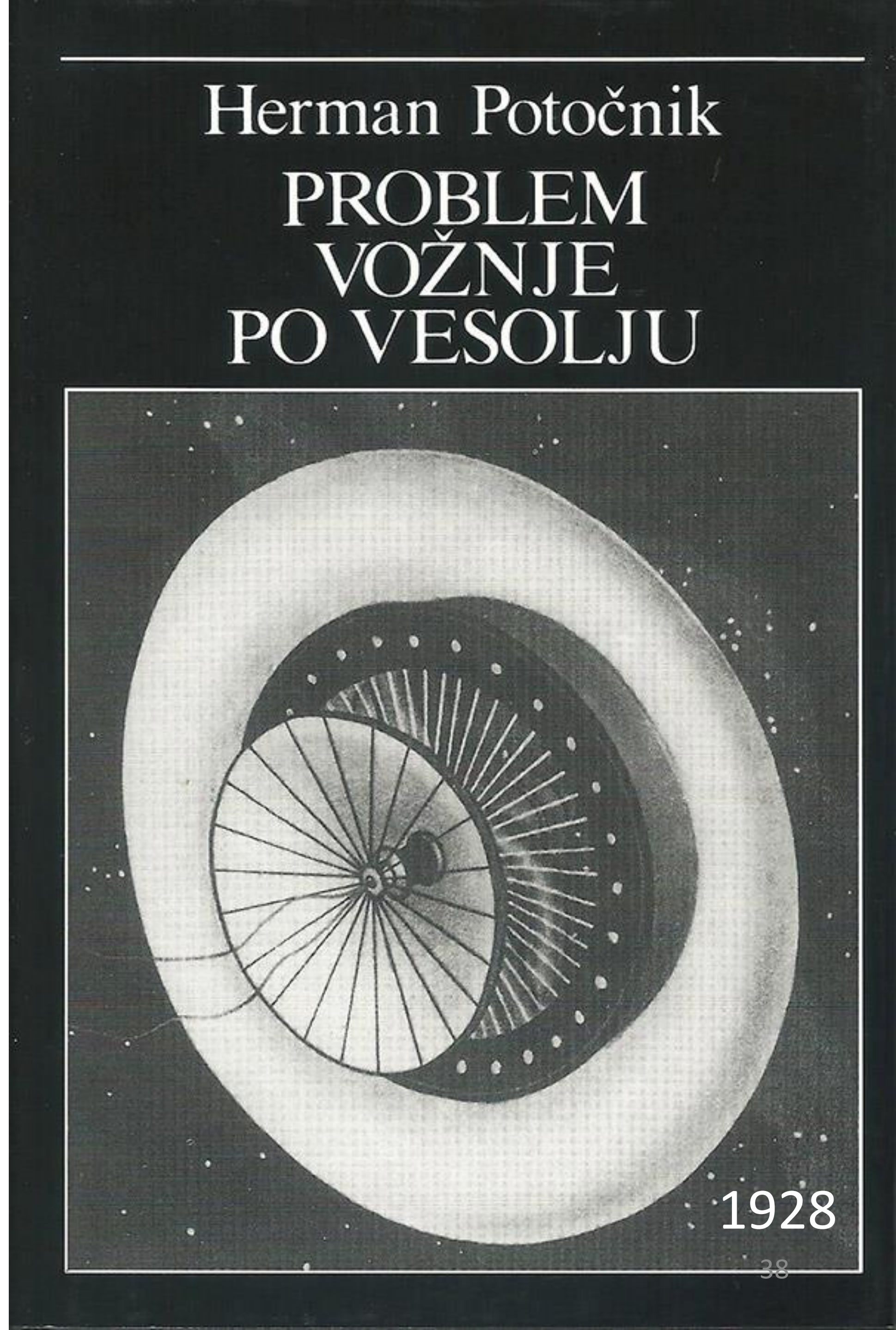


(a) Spinning a ball on a string or twirling a lasso (b) Turning a car (c) Going through a loop on a roller coaster (d) Planets orbiting around the Sun

FIGURE 5
Some examples of short arm centrifuges used in treatment and in support of various space flight programs as countermeasure against microgravity related pathologies. **(A)** One-person gravity therapy centrifuge at the Samara State Medical University, Russia (Orlov and Koloteva, 2017). **(B)** Upgraded SAHC from European Space Agency, ESA, at the Olympic Sport Centre Planica, Slovenia (image ESA & Jozef Stefan Institute Slovenia/ ©K. Bidovec & A. Hodalič). **(C)** Centrifuge at: Department of Health Technology, Space Institute of Southern China, Shenzhen, Guangdong, China. **(D)** NASA short radius centrifuge currently being re-installed at Texas A&M University, United States (Arya et al., 2007). **(E)** Short arm centrifuge at the Institute for Biomedical Problems, IMBP, Moscow, Russia. **(F)** Human Centrifuge at the:envihab center of the German space agency, DLR near Cologne, Germany (Frett et al., 2014).


HERMAN POTOČNIK NOORDUNG

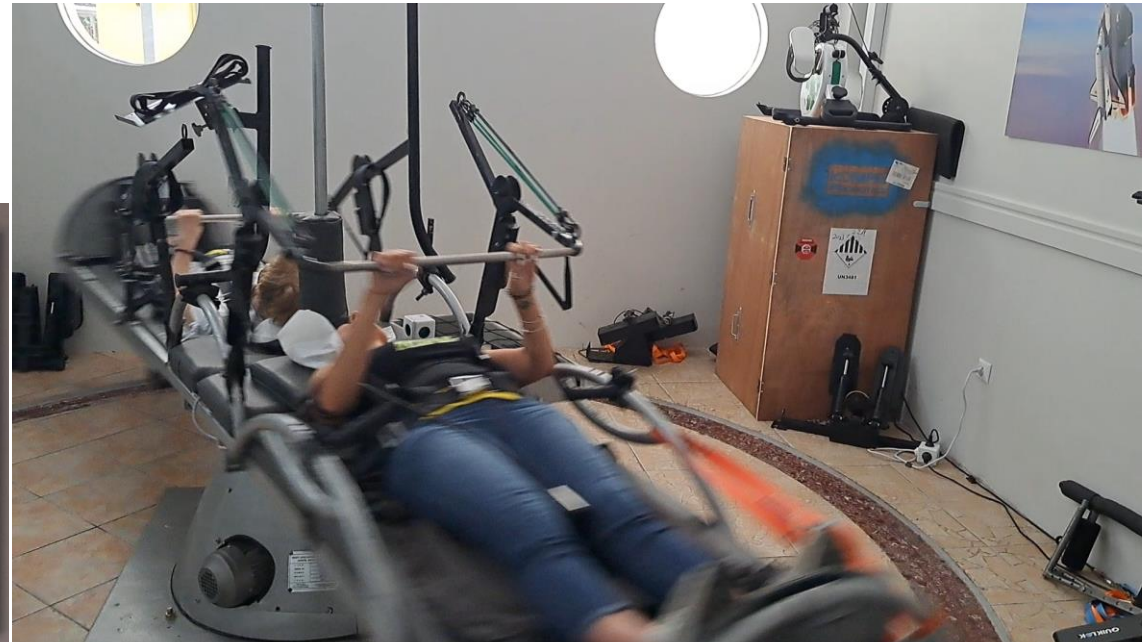

Radkranz
Radkranz


Herman Potočnik
PROBLEM
VOŽNJE
PO VESOLJU

1928

Human centrifuge

- physiological deconditioning of the human body exposed to microgravity and simulated microgravity environments (bed rest and dry immersion) is well understood today (Williams et al., 2009; Stenger et al., 2012; Blaber et al., 2013; Hargens et al., 2013).
- Artificial gravity generated by spinning on a short-arm human centrifuge is a valuable countermeasure (Clement & Pavy-Le Traon, 2004; Clement et al., 2015).
- Centrifugation: improved orthostatic tolerance time, attenuated plasma volume, and increased exercise capacity (Evans et al., 2004; Evans et al., 2015; Clement et al., 2015).



METHODS article

Front. Neurol., 04 January 2022
Sec. Neurorehabilitation
Volume 12 - 2021 | https://doi.org/10.3389/fneur.2021.746832

Therapeutic Benefits of Short-Arm Human Centrifugation in Multiple Sclerosis—A New Approach

Chrysoula Kourtidou-Papadeli[1,2,3,4†] Christos A. Frantzidis[1,2*†] Christos Bakirtzis[5] Anatoli Petridou[6] Sotiria Gilou[1] Aliki Karkala[2] Ilias Machairas[1] Nikolaos Kantouris[2] Christiane M. Nday[1] Emmanouil V. Dermitzakis[4] Eleftherios Bakas[3] Vassilis Mougios[6] Panagiotis D. Bamidis[1,2‡] Joan Vernikos[2,7‡]


ANGEL


Playback
Alarm
SETTING
INFO
Logout
2023-02-10 11:37:23
esa
10.59.180.220_2_4017Kbps_M

Preliminary (single-subject) data:

Healthy male, 35y, BMI=22

Centrifugation:

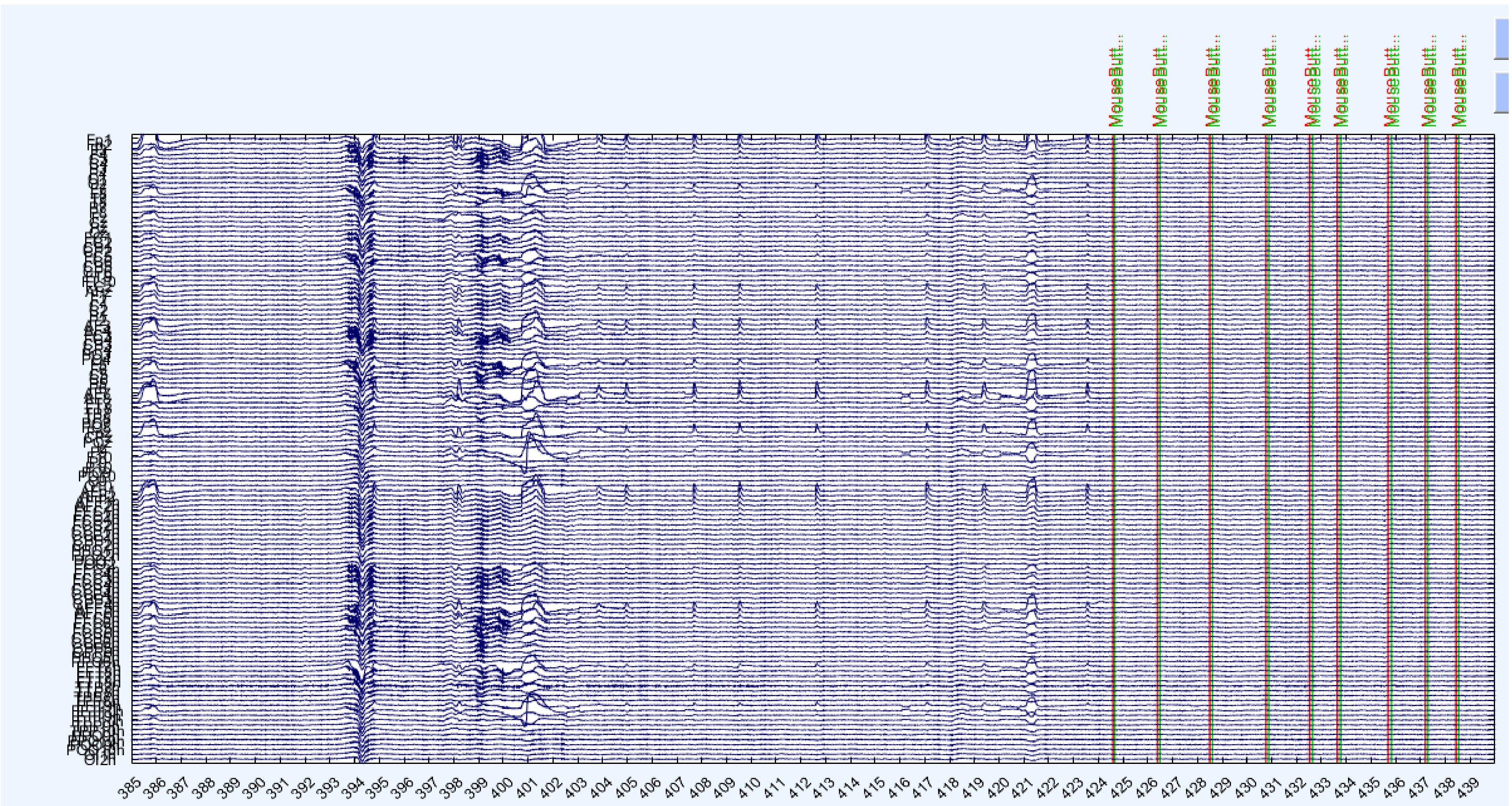
- 0.7G
- 1.4G

Increased HR:

- 56 bpm – resting supine
- 63 bpm – 0.7G
- 123 bpm – 1.4G
- 168 bpm – 1.4G + squads

Preliminary (single-subject) data:

EEG/ERP

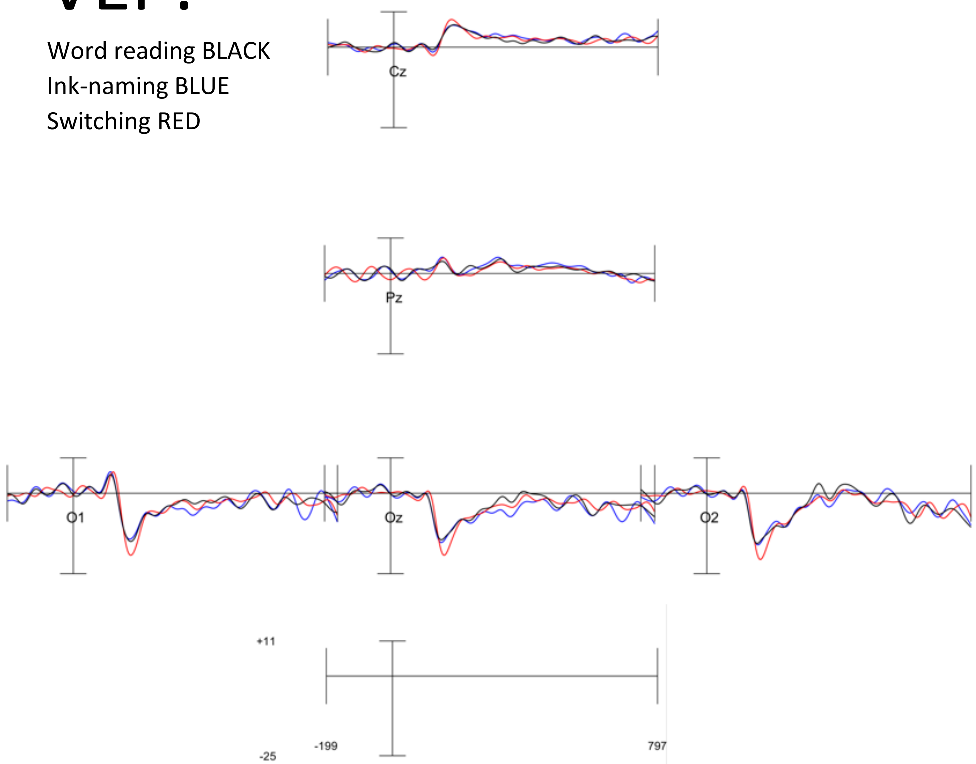


Preliminary (single-subject) data:

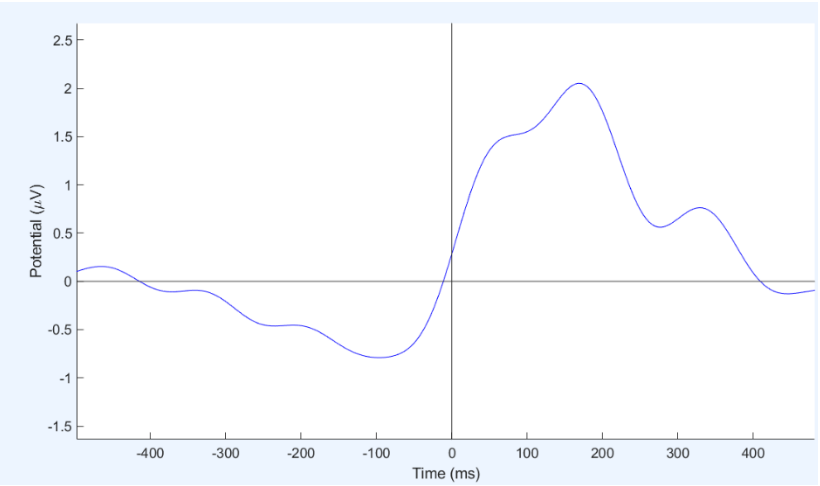
EEG/ERP

VEP:

Word reading BLACK
Ink-naming BLUE
Switching RED



MRCP:



Measurements in SEPT 2024!

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uros.marusic@zrs-kp.si

All studies shown so far…

1. Behavioral/biomechanical outcomes only
   and/or
2. Neuroplasticity metrics during static
   conditions

Time for Mobile Brain/Body Imaging (MoBI)?

- „**Mobile brain/body imaging (MoBI)** is a method to record and analyze brain dynamics and motor behavior under naturalistic conditions“ (Jungnickel, Gehrke, Klug & Gramann, 2019).

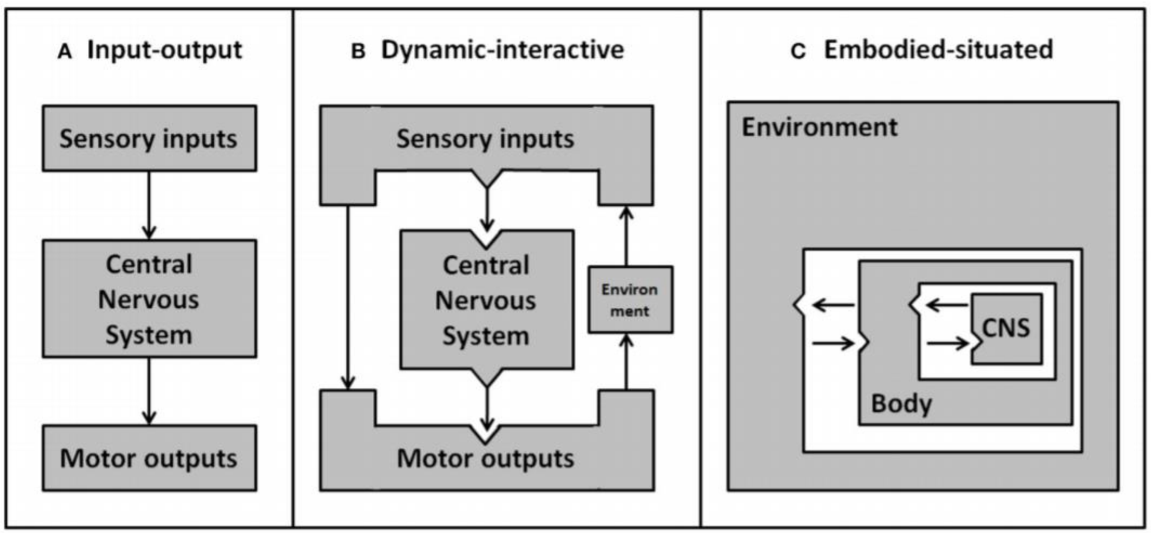
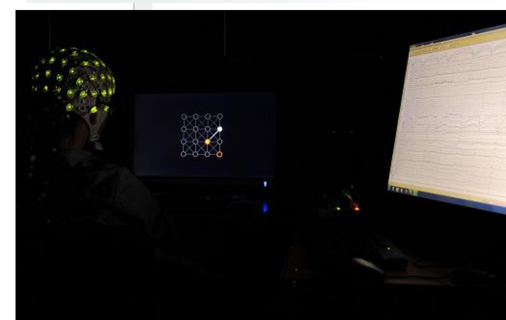


FIGURE 1 | Development of psychological models about the interactions between environment, body and central nervous system. Early simple input-output models **(A)** ignore the environment and represent sensory inputs as being processed discretely to produce motor outputs. More sophisticated dynamic-interactive models **(B)** include environmental factors. By this account, direct feedback from motor output can interact with, and act on, the environment—resulting in a change to future sensory inputs. In embodied-situated models **(C)** the nervous system is embedded within the environment through the body. From this perspective input and output systems are integrated rather than discrete separable elements, and the nervous system is inherently linked with the environment—as parts of a dynamic system. Adapted from Chiel and Beer (1997).

Time for Mobile Brain/Body Imaging (MoBI)?

- ***Ecological validity?!***

behind the screen. During the motion onset experiment the room was completely darkened according to the recommendation of Kremlacek, Kuba, Kubova & Chlubnova (2004). Participants were seated in a comfortable chair and their hands were placed on the table with about 90° in the elbow joint. A stepless high-adjustable chin rest was used to keep the participants' head level with the centre of the screen. Subjects were instructed to avoid head movement and eye blinks during the experiment. Earplugs were used to avoid disturbance from environmental noise. All visual stimuli were presented during a practice period before starting the experiment. For both, the pattern reversal (experiment 1) and motion onset (experiment 2) visual stimuli, the protocol lasted for about 15 minutes. During both experiments participants were instructed to keep their gaze on a fixation point at the centre of the screen.



TWINning the BRAIN with machine learning for neuro-muscular efficiency

„TwinBrain“

Horizon 2020 Twinning widespread-05-2020

1.11.2020-31.1.2024

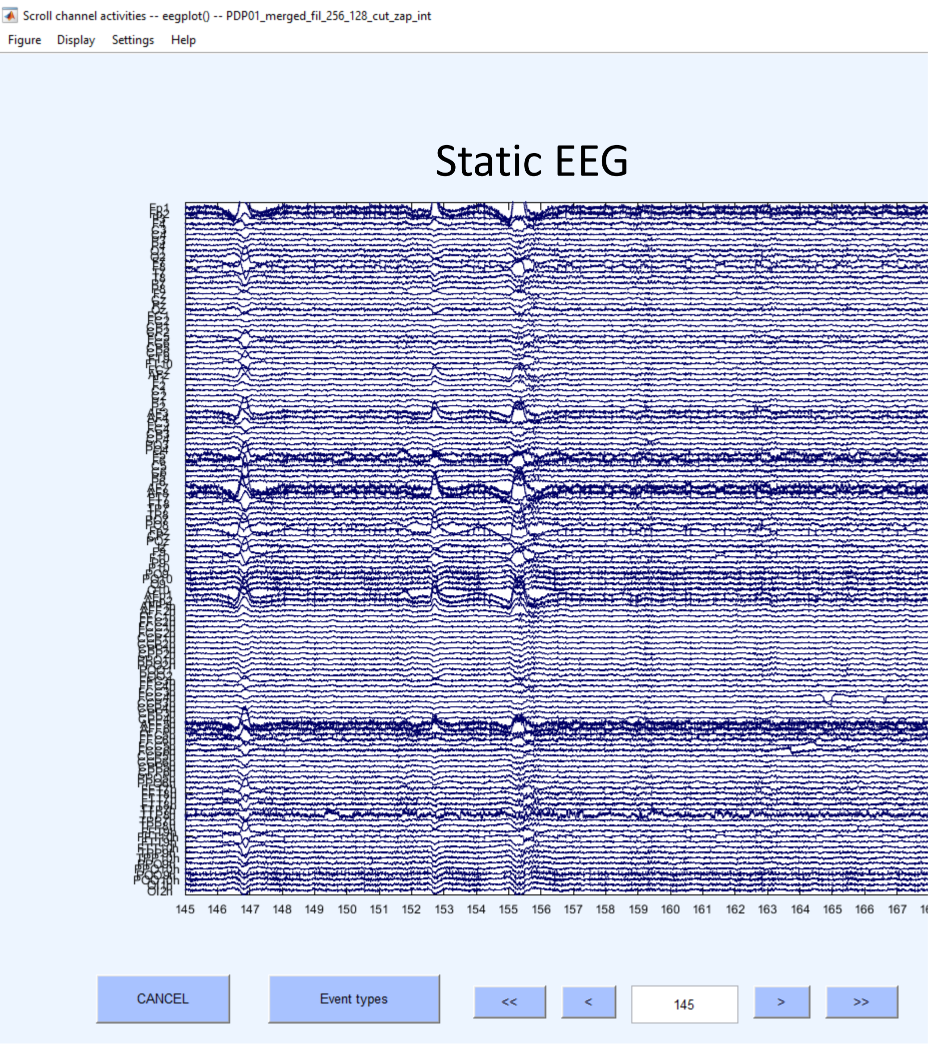
PI: Uros Marusic, PhD
Partner institutions:
Budget: 0.9 M€

www.twinbrain.si
https://cordis.europa.eu/project/id/952401

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952401

Static EEG

Dynamic EEG



IOP Publishing J. Neural Eng. 19 (2022) 011004 https://doi.org/10.1088/1741-2552/ac542c

Journal of Neural Engineering

OPEN ACCESS

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REVISED
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ACCEPTED FOR PUBLICATION
8 February 2022

PUBLISHED
28 February 2022

TOPICAL REVIEW

Removal of movement-induced EEG artifacts: current state of the art and guidelines

Dasa Gorjan[1], Klaus Gramann[2], Kevin De Pauw[3,4] and Uros Marusic[1,5,*]

[1] Science and Research Centre Koper, Institute for Kinesiology Research, Koper, Slovenia
[2] Biological Psychology and Neuroergonomics, Technische Universitaet Berlin, Berlin, Germany
[3] Human Physiology and Sports Physiotherapy Research Group, Vrije Universiteit Brussel, Brussels, Belgium
[4] Brussels Human Robotics Research Center (BruBotics), Vrije Universiteit Brussel, Brussels, Belgium
[5] Department of Health Sciences, Alma Mater Europaea—ECM, Maribor, Slovenia
[*] Author to whom any correspondence should be addressed.

List of abbreviations

AMICA	adaptive mixture independent component analysis
ASR	artifact subspace separation
BCI	brain–computer interface
BSS	blind source separation
CCA	canonical correlation analysis
EEG	electroencephalography
EEMD	ensemble empirical mode decomposition
ICA	independent component analysis
MoBI	mobile brain/body imaging
ORICA	online recursive independent component analysis
PCA	principal component analysis
RELICA	reliable independent component analysis

Biological Psychology 178 (2023) 108543

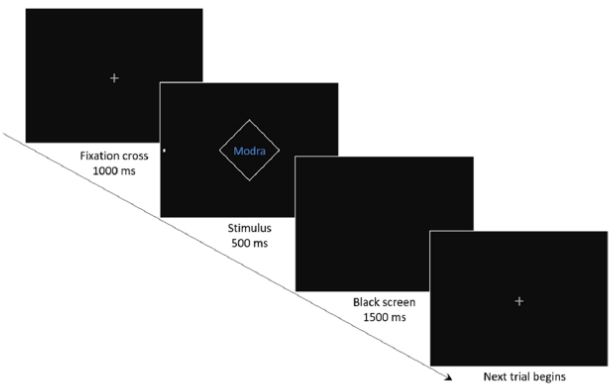
Contents lists available at ScienceDirect

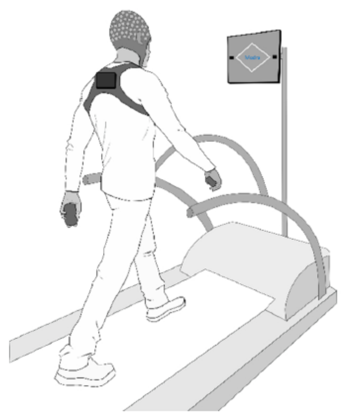
Biological Psychology

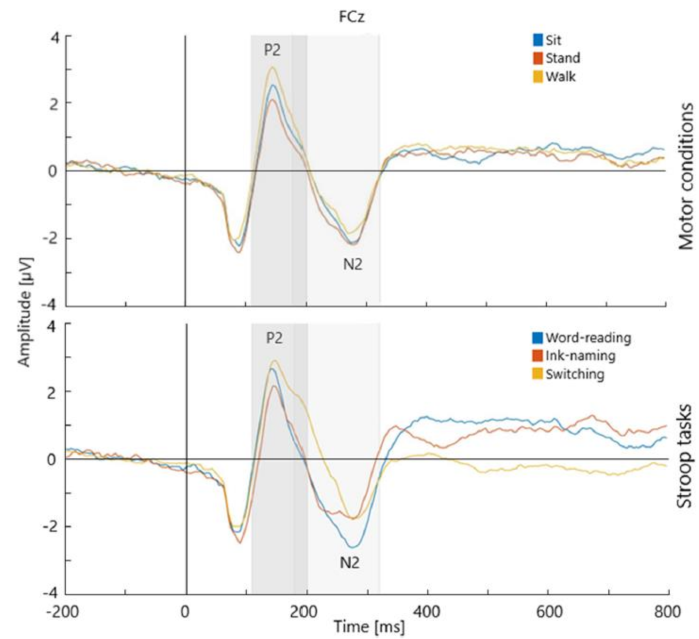
journal homepage: www.elsevier.com/locate/biopsycho

Stroop in motion: Neurodynamic modulation underlying interference control while sitting, standing, and walking

Manca Peskar [a,b,*], Nina Omejc [a,c,d], Maja Maša Šömen [a,e], Aleksandar Miladinović [f], Klaus Gramann [b], Uros Marusic [a,g]







TwinBrain Clinical Trial:

Current – Neuromuscular assessment in PD

TWINBRAIN

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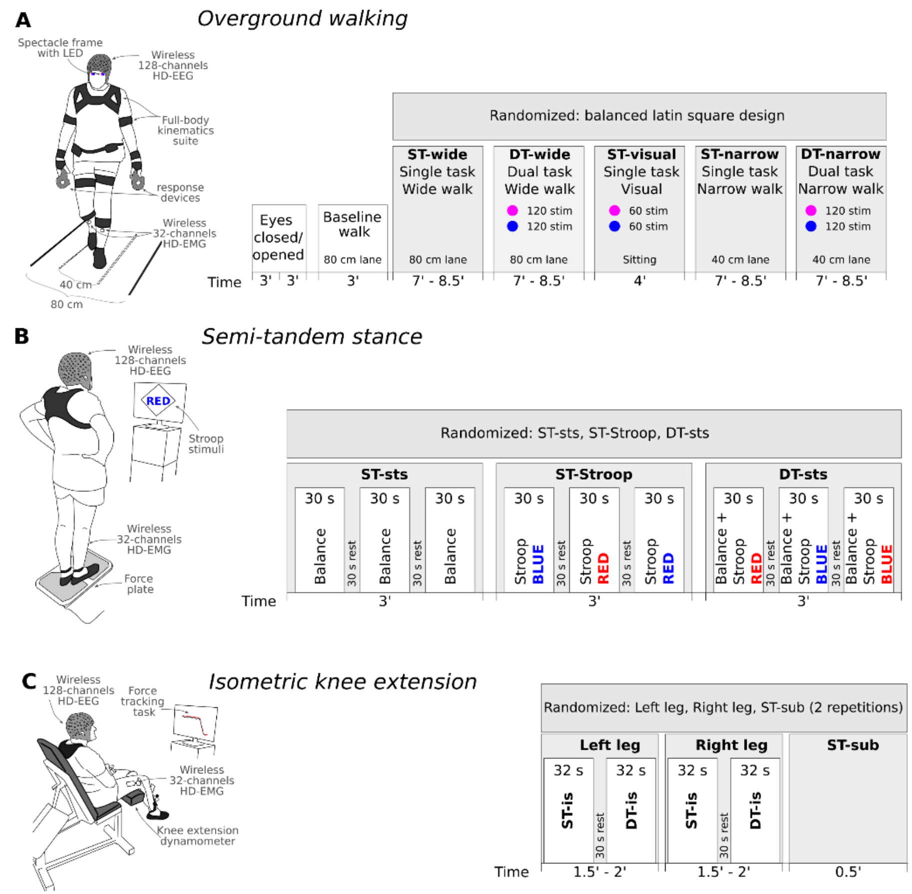
Home › Articles › Neuromuscular assessment of force development, postural, and gait ...

STUDY PROTOCOL

Neuromuscular assessment of force development, postural, and gait performance under cognitive-motor dual-tasking in healthy older adults and early Parkinson's disease patients: Study protocol for a cross-sectional Mobile Brain/Body Imaging (MoBI) study [version 1; peer review: awaiting peer review]

Uros Marusic, Manca Peskar, Maja Maša Šömen, Miloš Kalc, Ales Holobar, Klaus Gramann, Bettina Wollesen, Anna Wunderlich, Christoph Michel, Aleksandar Miladinović, Mauro Catalan, Alex Buoite Stella, Milos Ajcevic, Paolo Manganotti



Methods:

128-channel Mobile EEG

2x 32-channel wireless hdEMG

Whole-body kinematics

VivePro controlers

LSL

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952401

Home › Articles › Neuromuscular assessment of force development, postural, and gait ...

STUDY PROTOCOL

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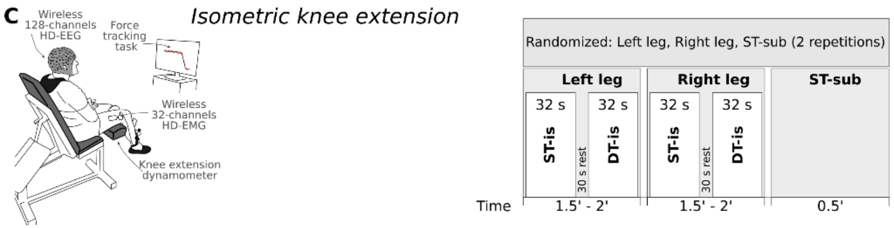

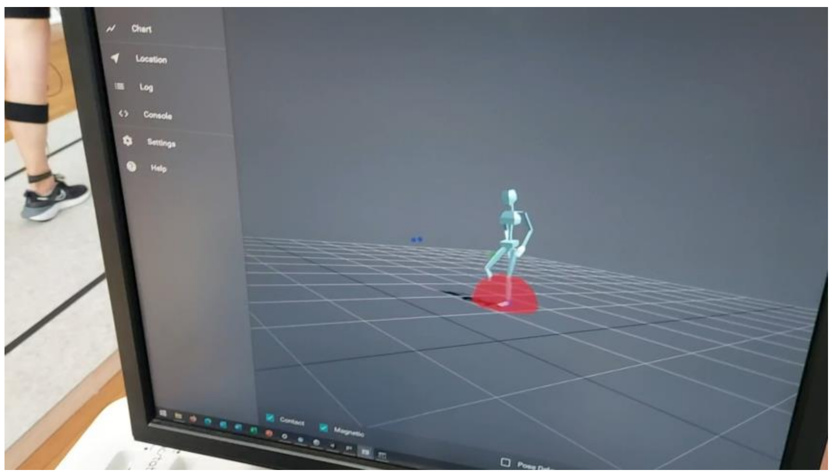
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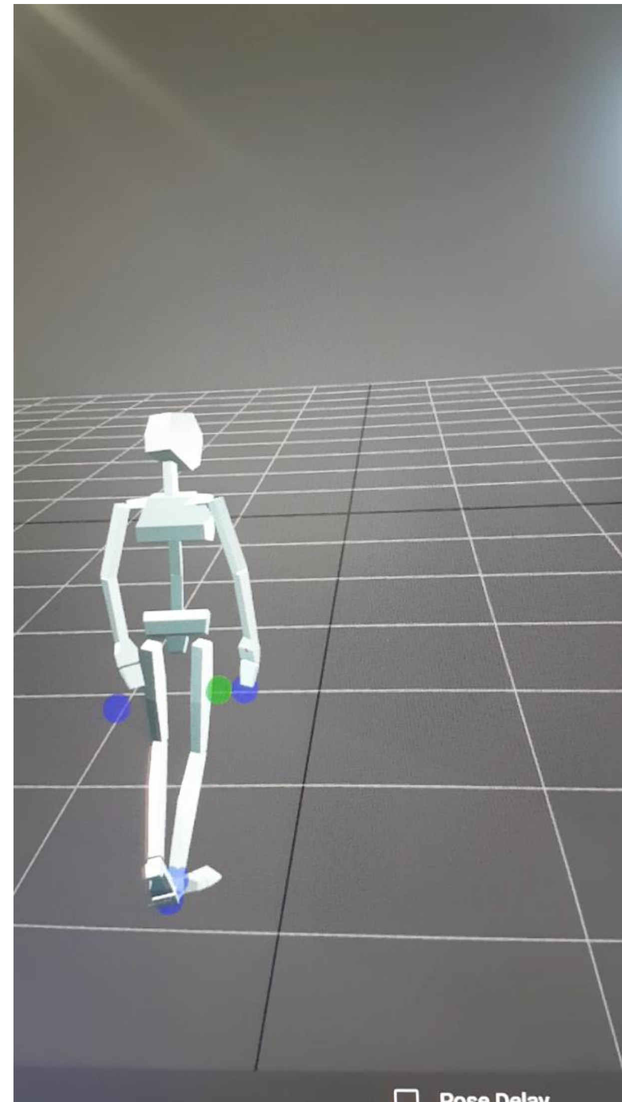
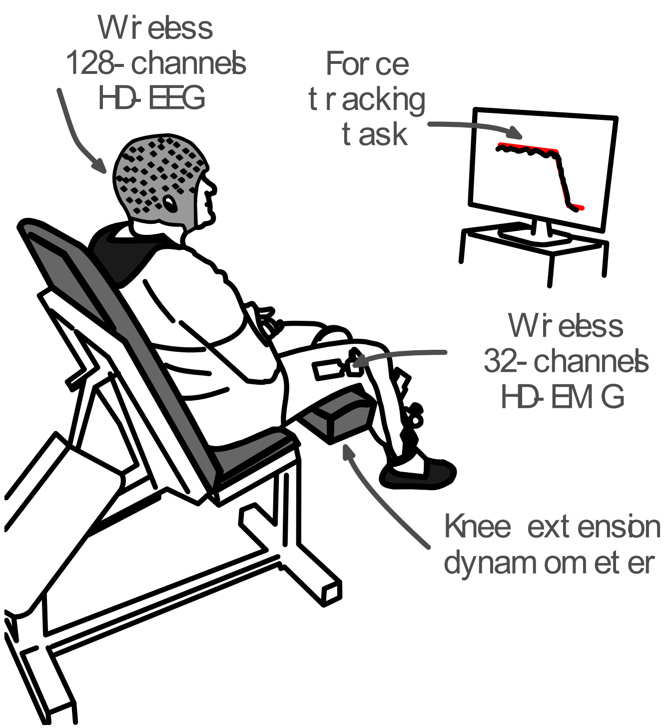
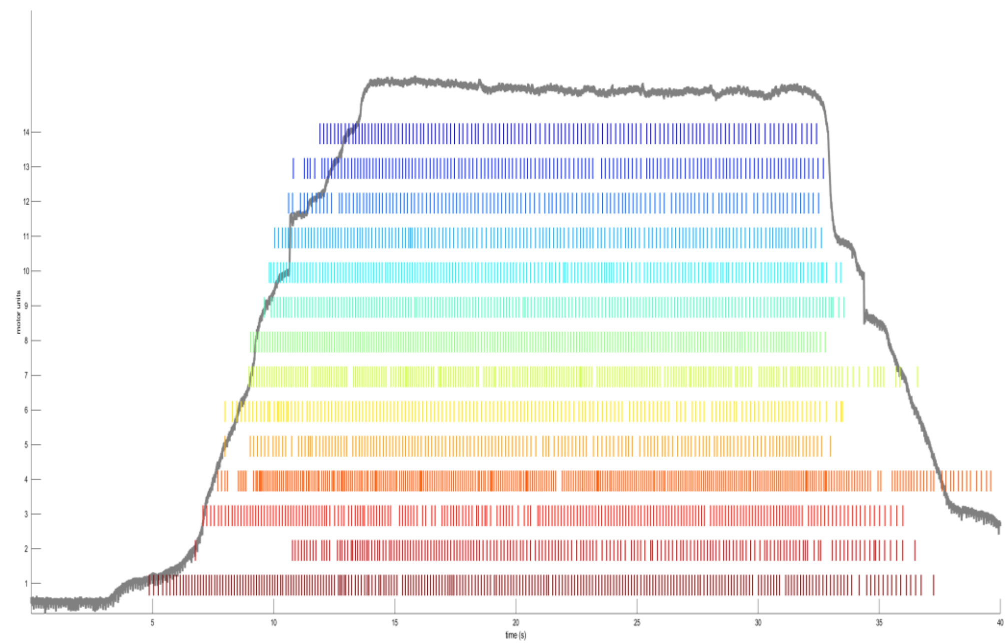

Pose Delay

Force tracking task (hdEMG)

Kalc et al., in preparation

- 30% MVC ramp





TWINBRAIN

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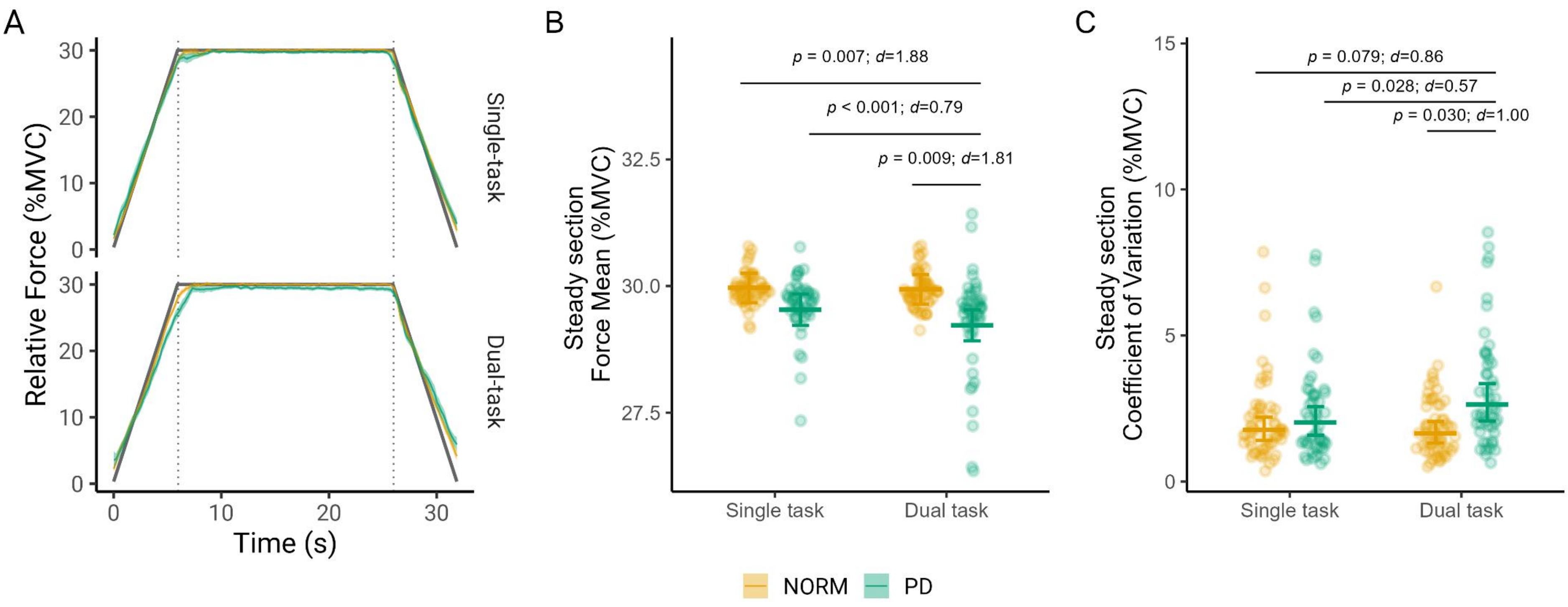
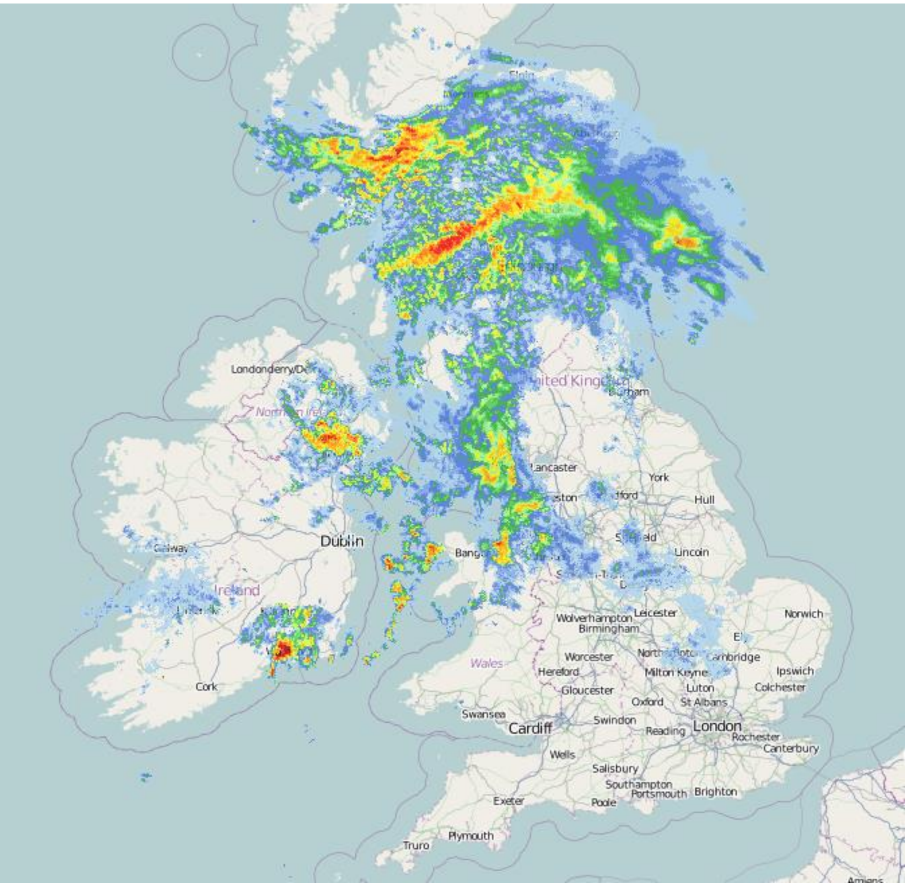
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952401

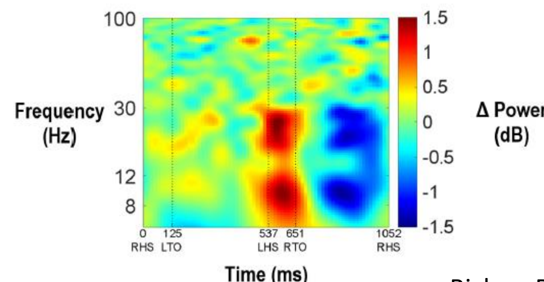
Mean and Coefficient of Variation of the Relative Force (%MVC)

Comparison between **NORM** and **PD** patients in a Single- or Dual-task



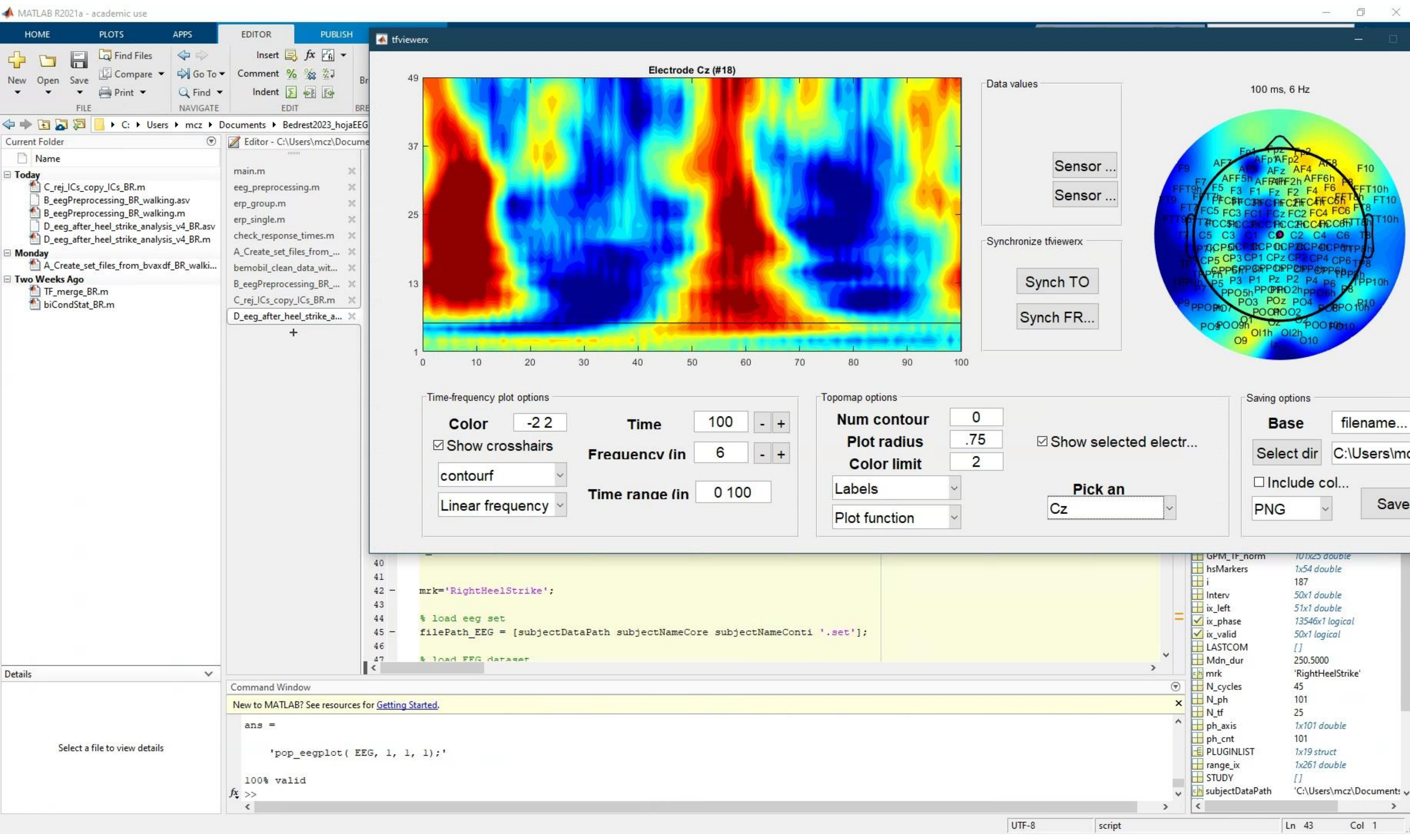


Gait-phase spectral modulation:



Richer, Bradford & Ferris (2024)

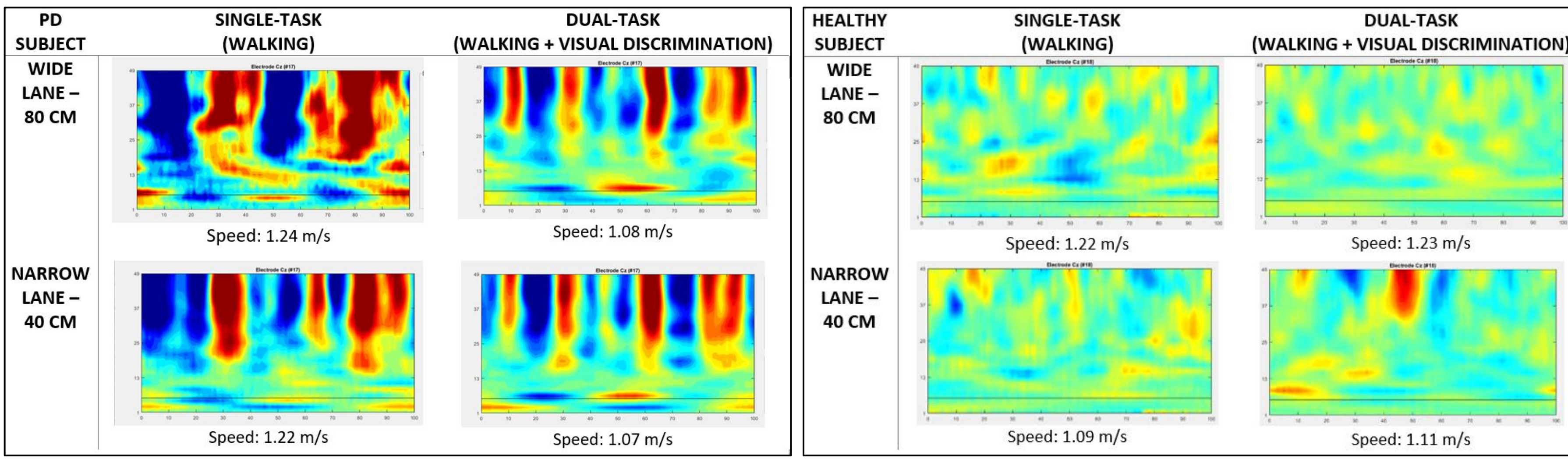
Individual responses



Peskar et al., in preparation

TwinBrain Clinical Trial:

Analyses approaches: time-freq. gait-phase modulation



Decoding cortical biomarkers in Parkinson‘s Disease during overground walking

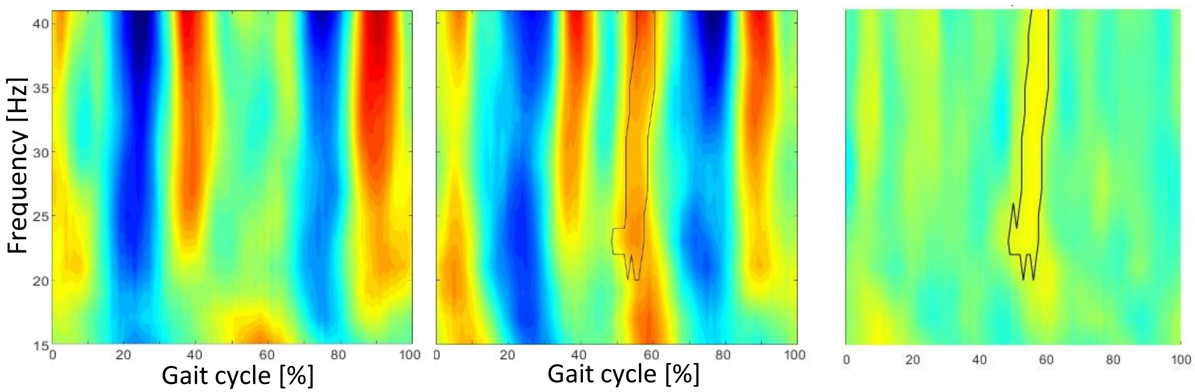
Gait-phase spectral modulation:

Peskar et al., in preparation

- PD patients show similar cortical activity to HC during walking but exhibit signs of movement inefficiency when dual-tasking.
- In PD patients, dual-tasking triggers high-frequency synchronization during specific gait phases, suggesting increased cognitive load.
- These findings highlight that cognitive demands can hinder movement in PD, offering insights for interventions and fall prevention strategies.

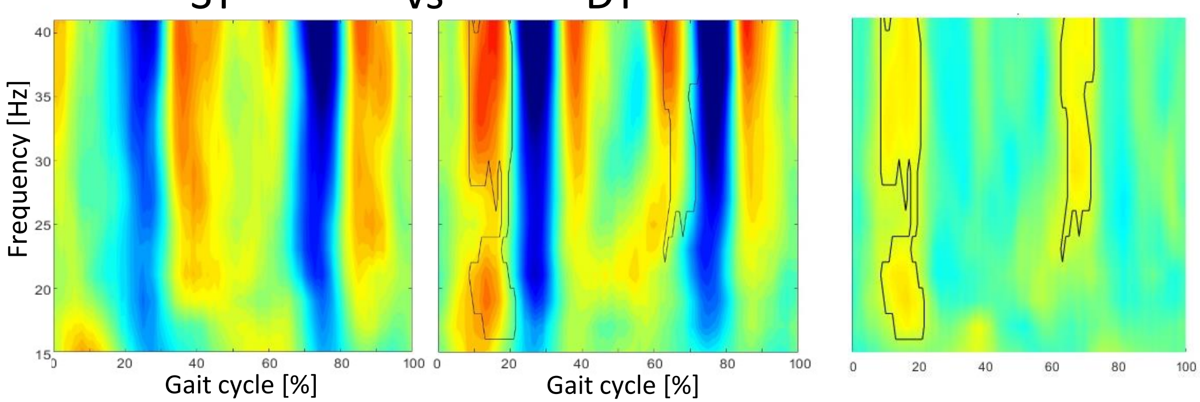
PD wide Lane:

ST vs DT



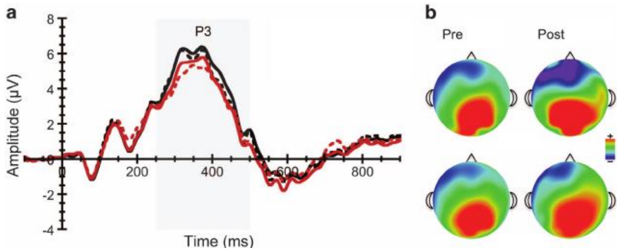
PD narrow Lane:

ST vs DT



Biomarkers of movement efficiency?

- Biomechanical parameters
- Beta suppression
- c-c, c-m coherence
- attentional reserve can be assessed by ERP
  - ↓ P3 amplitudes for the most challenging condition



Gait research in PD

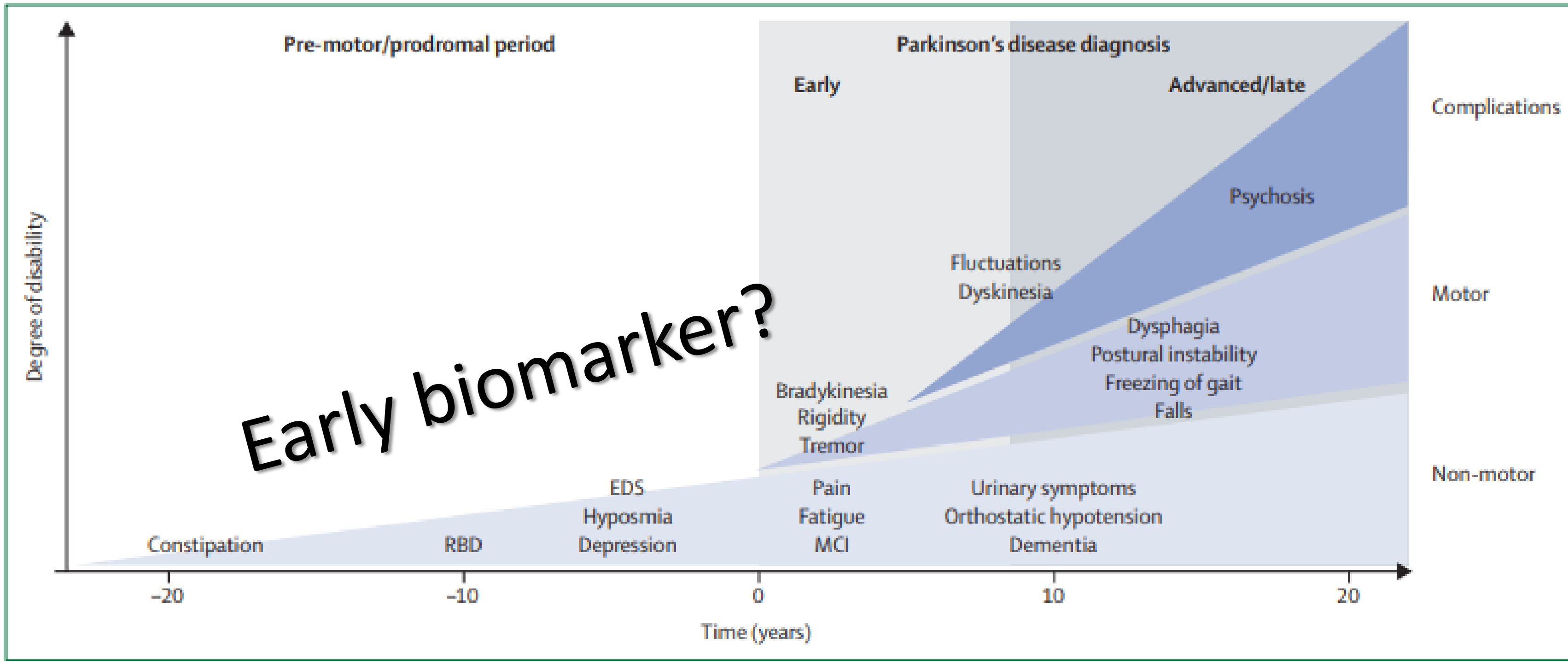


***Figure 1*: Clinical symptoms and time course of Parkinson's disease progression**
Diagnosis of Parkinson's disease occurs with the onset of motor symptoms (time 0 years) but can be preceded by a premotor or prodromal phase of 20 years or more. This prodromal phase is characterised by specific non-motor symptoms. Additional non-motor features develop following diagnosis and with disease progression, causing clinically significant disability. Axial motor symptoms, such as postural instability with frequent falls and freezing of gait, tend to occur in advanced disease. Long-term complications of dopaminergic therapy, including fluctuations, dyskinesia, and psychosis, also contribute to disability. EDS=excessive daytime sleepiness. MCI=mild cognitive impairment. RBD=REM sleep behaviour disorder.

Kalia & Lang, 2015;
Lancet

Invitation

TBrainBoost Summer School 1.0: Leveraging Neuroscientific Discoveries for Neurorehabilitation Products and Services **16th - 20th July 2024**

No registration fee!

Students (Masters and PhD) and post docs across various disciplines including kinesiology, physiotherapy, psychology, cognitive (neuro)science, biomedical engineering, business, management, and more.

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European Commission
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Questions?

Funded by
the European Union

UK Research
and Innovation

This project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement no. 101079392 and from the UK Research and Innovation (UKRI) government's Horizon Europe funding guarantee scheme under grant agreement no. 10052152.