THIRD INTERNATIONAL MOTOR IMPAIRMENT CONFERENCE

SYDNEY, AUSTRALIA
20-21-22 NOVEMBER 2023

PROGRAMME + ABSTRACTS

NeuRA
Discover — Conquer — Cure

Gold Sponsor
The Journal of Physiology

Silver Sponsor
SDR SCIENTIFIC
EQUIPMENT · SUPPORT · RESULTS

PROGRAMME

DAY 1: MONDAY 20 NOVEMBER

8:00am-8:45am Registration Desk Open	
8:45am-9:00am Welcome & Opening Remarks	**Simon Gandevia** Neuroscience Research Australia, Australia

9:00am-11:00am
D1 Session 1: Spinal Cord Injury and Novel Therapies

Chairpersons: Claire Boswell-Ruys & Liz Bye (Neuroscience Research Australia, Australia)

9:00am-9:30am Spinal Cord Injury: Are we optimizing our rehabilitative therapies enough?	**Monica Perez** Shirley Ryan Ability Lab, USA
9:30am-10:00am Motor training above, at and below the level of the injury: What we know from clinical trials.	**Lisa Harvey** University of Sydney, Australia
10:00am-10:15am The effect of acute intermittent hypoxia on voluntary activation of hand and leg muscles in people with chronic incomplete spinal cord injury	**Anandit Mathew** Neuroscience Research Australia, Australia
10:15am-10:30am Conventional vs kHz transcutaneous spinal stimulation: Differences in threshold intensity and pain for single pulses and trains of stimulation	**Martin Héroux** Neuroscience Research Australia, Australia
10:30am-10:45am Monophasics and biphasics and carriers, oh my(!); carrier frequency markedly influences recruitment thresholds of human axons	**David Collins** University of Alberta, Canada
10:45am-11:00am Revitalizing neural circuits in complete spinal cord injured rats with intermittent theta burst stimulation (iTBS): A promising therapeutic paradigm	**Gunjan Sharma** All India Institute of Medical Sciences, India

11:00am-11:30am – Morning Tea

11:30am-12:45pm
D1 Session 2: Respiratory Motor Control

Chairpersons: David Berlowitz & Nicole Sheers (University of Melbourne, Australia)

11:30am-12:00pm Respiratory motor impairment in ageing, respiratory disease and spinal cord injury.	**Jane Butler** Neuroscience Research Australia, Australia
12:00pm-12:30pm Resilience of mitochondrial remodeling: Role in respiratory motor impairment	**Gary Sieck** Mayo Clinic, USA
12:30pm-12:45pm Graded pattern of human parasternal intercostal muscle activity recorded with surface electromyography.	**Anna Hudson** Flinders University, Australia

DAY 1: MONDAY 20 NOVEMBER (Continued)

12:45pm-1:45pm – Lunch

01:45pm-3:15pm – Posters

2:45pm-3:15pm – Afternoon tea

3:15pm-4:45pm
D1 Session 3: Motoneurones and Movement

Chairpersons: John Rothwell (UCL Queen Square Institute of Neurology, UK)
& Jane Butler (Neuroscience Research Australia, Australia)

3:15pm-3:45pm NeuroMechanics of human movement: A motor neurone centric view	**Dario Farina** Imperial College London, UK
3:45pm-4:00pm Effect on human motor unit firing rates during recovery from fatigue: Competing effects of prolonged low-frequency force depression and post-activation potentiation	**Alexander Zero** University of Western Ontario, Canada
4:00pm-4:15pm Longitudinal changes in the contribution of persistent inward currents to motoneuron self-sustained firing are dependent on Amyotrophic Lateral Sclerosis (ALS) disease progression.	**Gabriel Trajano** Queensland University of Technology, Australia
4:15pm-4:30pm Descending drive to spinal motoneurones is necessary for 5-HT_2 modulation of motoneurone excitability in humans	**Tyler Henderson** Griffith University, Australia
4:30pm-4:45pm Subcortical control of human reaching?	**Timothy Carroll** University of Queensland, Australia

5:00pm-6:45pm – Welcome Drinks & Pizza Event at Baccomatto Osteria
(162-164 Barker Street, Randwick 2031 –across the road from the conference venue)

DAY 2: TUESDAY 21 NOVEMBER

8:30am-9:00am - Registration Desk Open

9:00am-10:30am
D2 Session 1: ALS and Parkinson's Disease

Chairpersons: Martin Héroux (Neuroscience Research Australia, Australia)
& Graham Kerr (Queensland University of Technology, Australia)

9:00am-9:30am Amyotrophic lateral sclerosis: Update on current concepts and management	**Steve Vucic** University of Sydney, Australia
9:30am-10:00am Parkinson's disease - a clinical perspective	**Carolyn Sue** University of New South Wales, Australia
10:00am-10:15am The impact of aerobic exercise and/or photobiomodulation compared to usual care on non-motor symptom severity of Parkinson's Disease: A pilot randomised crossover study	**Joyce Ramos** Flinders University, Australia
10:15am-10:30am Early treatment of auricular electro-acupuncture on motor behavioral deficits with 6- hydroxydopamine-induced Parkinson's disease in rats	**Huong T.M. Nguyen** China Medical University, Taiwan

10:30am-11:00am – Morning Tea

11:00am-12:15pm
D2 Session 2: Research Quality, Motor Control & More

Chairpersons: Simon Gandevia (Neuroscience Research Australia, Australia)
& Gary Sieck (Mayo Clinic, USA)

11:00am-11:30am Hippocrasy - how doctors are betraying their oath	**Rachelle Buchbinder** Monash University, Australia
11:30am-11:45am Avoid hypocrisy and improve the reproducibility of research	**Simon Gandevia** Neuroscience Research Australia, Australia
11:45am-12:00pm Quantifying muscle activation asymmetry in Adolescent idiopathic Scoliosis	**Kylie Tucker** University of Queensland, Australia
12:00pm-12:15pm Sensory and motor responses to burst-modulated, kilohertz carrier frequency stimulation of a peripheral nerve	**Billy Luu** Neuroscience Research Australia, Australia

12:15pm-6:30pm – Lunch then Free Time to explore Sydney

6:30pm-10:00pm – Conference Dinner at Museum of Contemporary Art
140 George Street, The Rocks NSW 2000

DAY 3: WEDNESDAY 22 NOVEMBER 2023

9:00am-9:30am - Registration Desk Open

9:30am-10:45am
D3 Session 1: Falls & More

Chairpersons: Annie Butler & Yoshi Okubo (Neuroscience Research Australia, Australia)

9:30am-10:00am Motor strategies of older adults for avoiding head injury during falls: Evidence from video footage of real-life falls in long-term care facilities	**Steve Robinovitch** Simon Fraser University, Canada
10:00am-10:15am The adaptability and transfer of muscular responses following treadmill and walkway perturbation training	**Steven Phu** Neuroscience Research Australia, Australia
10:15am-10:30am Normative data and predictive value of daily-life mobility indicators for older adults: Insights from UK Biobank	**Lloyd Chan** Neuroscience Research Australia, Australia
10:30am-10:45am Real-time video analysis and motivation of eating behaviour system in people with motor disorders	**Yupeng Zhang** University of Sydney, Australia

10:45am-11:15am – Morning Tea

11:15am-12:30pm
D3 Session 2: Vestibular disorders and Multiple Sclerosis

Chairpersons: Jasmine Menant & Phu Hoang (Neuroscience Research Australia, Australia)

11:15am-11:45am Capturing vestibular disorders by event monitoring	**Miriam Welgampola** University of Sydney, Australia
11:45am-12:00pm The effect of postural demand on cortical and motoneuronal excitability	**Paige Copeland** University of British Columbia, Canada
12:00pm-12:15pm The interaction between metaplastic neuromodulation and fatigue in Multiple Sclerosis	**Simran Sidhu** University of Adelaide, Australia
12:15pm-12:30pm Fatigue-related deficits in muscle activation in people with Multiple Sclerosis	**Justin Kavanagh** Griffith University, Australia

12:30pm-1:30pm – Lunch

1:30pm-3:00pm
D3 Session 3: Falls and other neurological conditions

Chairpersons: Kylie Tucker (University of Queensland, Australia)
& Anna Hudson (Flinders University, Australia)

1:30pm-2:00pm Falls in different neurological conditions	**Jasmine Menant** Neuroscience Research Australia, Australia

DAY 3: WEDNESDAY 22 NOVEMBER 2023 (Continued)

2:00pm-2:15pm Relationship between proprioceptive ability and function in people with stroke, Parkinson's disease and Multiple Sclerosis – A systematic review	**Lucy Robertson** Neuroscience Research Australia, Australia
2:15pm-2:30pm Functional neuroimaging of the effects of tDCs on balance control in Parkinson's disease: A randomized double-blind sham-controlled study	**Graham Kerr** Queensland University of Technology, Australia
2:30pm-2:45pm Effects of a telehealth program on the risk of falling in older people with dementia	**Carolina Tsen** Federal University of Sao Carlos, Brazil
2:45pm-3:00pm Muscle- and sex-specific volumes of lower leg muscles in children with cerebral palsy	**Bart Bolsterlee** Neuroscience Research Australia, Australia
3:00pm-3:15pm Final remarks and prizes	**Simon Gandevia** Neuroscience Research Australia, Australia

3:15pm-3:45pm – Afternoon tea

END OF CONFERENCE

ABSTRACTS (in Programme order)

MONDAY 20 NOVEMBER 2023
SESSION 1: Spinal Cord Injury and Novel Therapies
Chairpersons: Claire Boswell-Ruys & Liz Bye
Neuroscience Research Australia

Spinal Cord Injury: Are we optimizing our rehabilitative therapies enough?

Perez M [1]

1. Northwestern University, Chicago, USA

Translational research is an essential topic in rehabilitation and neuroscience. However, despite decades of research, new rehabilitation therapies and technologies have had limited impact on functional restoration from neurological disorders and injury. I will discuss the need for work on optimizing our rehabilitative therapies and provide an example of how this effort can contribute to improving functional outcomes. Spinal cord injury (SCI) leads to damaged synaptic connections between corticospinal axons and motor neurons that innervate muscles, resulting in devastating paralysis. Injuries in humans are mostly anatomically incomplete with spared axons having malfunctioning synaptic connections. Throughout life, synapses can be modified by Hebbian plasticity (e.g., “neurons that fire together, wire together”) suggesting that this principle could be used to strengthen residual connections. We have optimized a noninvasive Hebbian stimulation protocol over the years to target in parallel multiple upper- and lower- limb muscles to promote functional restoration of grasping and walking in humans with SCI. Moving from

(a) proof of principle studies showing differences in how to target connections to upper- and lower-limb muscles, (b) randomized clinical trials highlighting the need for finding the optimal dose to reach the minimal clinically important difference, (3) the need to develop an animal model to continue to work on protocol optimization to improve functional restoration. Overall, our findings suggest that the optimization of Hebbian stimulation, informed by the physiology of the corticospinal system, represents an effective strategy to promote functional recovery following SCI.

Motor training above, at and below the level of the injury: What we know from clinical trials

Harvey LA [1, 2] and Glinsky JV [1, 2], on behalf of their students and collaborators

1. Kolling Institute, Faculty of Medicine and Health, The University of Sydney, Sydney, Australia
2. John Walsh Centre for Rehabilitation Research, Northern Sydney Local Health District, St Leonards, Sydney, Australia

The inability to perform motor tasks following spinal cord injury (SCI) has profound implications on a person's quality of life and ability to live independently. Motor training is a form of physiotherapy widely used to improve people's ability to move. Motor training comprises strength- and task-specific training. It is used to target muscles above, at and below the level of the injury, but what do we know about its effectiveness? Our team has completed 9 clinical trials on motor training. We have looked at the effectiveness of task-specific training directed above the level of injury in people with AIS A lesions, as well as at- and below the level of injury in people with AIS C and D lesions [1]. We have also looked at the effectiveness of different types of strength training for muscles innervated below the level of injury. All of our trials, in combination with what we know from other large trials, raise many as yet unanswered questions. These have led us to our current trial titled: *Early and Intensive Motor Training to Enhance Neurological Recovery in People with SCI* (The SCI-MT Trial) [2]. In this trial we are looking at the effectiveness of an individualised and intensive motor training program for people with recent SCI, and is specifically directed at muscles innervated at- and below- the level of injury. In all, this talk will summarise what we know, and what we are currently doing, to better understand the effectiveness of motor training for people with SCI.

References

1. Harvey LA, Dunlop SA, Churilov L and Galea MP. Spinal Cord Injury Physical Activity Hands On Trial Collaborators (2016) Early intensive hand rehabilitation is not more effective than usual care plus one-to-one hand therapy in people with sub-acute spinal cord injury ('Hands On'): a randomised trial. Journal of Physiotherapy. 62:88-95.
2. Harvey LA, et al. Early and intensive motor training to enhance neurological recovery in people with spinal cord injury: trial protocol. (2023). Spinal Cord. 61:521-527.

The effect of acute intermittent hypoxia on voluntary activation of hand and leg muscles in people with chronic incomplete spinal cord injury

Mathew AJ [1, 2], Finn H.T [1, 2], Prajnadewie C [1, 2], Boswell-Ruys C [1, 2], Gandevia SC [1, 2] and Butler JE [1, 2]

1. Neuroscience Research Australia, Sydney, Australia
2. University of New South Wales, Sydney, Australia

A single session of acute intermittent hypoxia (AIH) may improve limb muscle strength (1) in people with chronic incomplete spinal cord injury (iSCI) possibly by increasing motoneuron excitability (2). We investigated the influence of AIH on strength and voluntary activation (VA) of hand and leg muscles in people with iSCI. Thirteen adult males with chronic iSCI (cervical-11, thoracic-2) completed two 30-minute interventions at least 2 weeks apart AIH (15 cycles 0.09 FiO_2/0.21 FiO_2) and SHAM (30 minutes 0.21 FiO_2). Maximal voluntary contractions (MVC), VA, and resting twitch (RT) were measured in adductor pollicis (n=7) and quadriceps (n=6) at baseline and every 4 minutes from 8-80 minutes post-interventions. Mean±SD are reported. AIH reduced SpO_2 to 85.5±3.6% and increased ventilation and heart rate by 9.1±9.4% and 8.0±3.7% respectively. For adductor pollicis, VA was reduced by 6.25% (95%CI: -8.74 to -3.76, $p = 0.014$) after AIH compared to SHAM, but MVC did not change ($p = 0.282$). RT decreased with time after both interventions (by -14.23±13.03%, $p < 0.001$) with no difference between interventions ($p= 0.747$). For quadriceps, there was no difference in VA, MVC or RT between interventions ($p = 0.322$, $p = 0.77$, $p = 0.546$, respectively). Quadriceps RT did not decline over time ($p=0.715$). There was no evidence of motor facilitation induced by AIH in chronic iSCI participants despite a similar AIH paradigm to previous studies. Moreover, adductor pollicis VA was slightly reduced after AIH. Although AIH activated the carotid body, the dose may be insufficient to facilitate motor pathways.

References

1. Trumbower RD, Jayaraman A, Mitchell GS and Rymer WZ. *Neurorehabil Neural Repair* 26: 163–172, 2012. doi: 10.1177/1545968311412055.
2. Christiansen L, Chen B, Lei Y, Urbin MA, Richardson MSA, Oudega M, Sandhu M, Rymer WZ, Trumbower RD, Mitchell GS and Perez MA. *Experimental Neurology* 335: 113483, 2021. doi: 10.1016/j.expneurol.2020.113483.

Conventional vs kHz transcutaneous spinal stimulation: Differences in threshold intensity and pain for single pulses and trains of stimulation

Héroux ME [1, 2], van Geijt W [1], Finn H [1, 2], Gandevia SC [1, 3] and Butler JE [1, 2]

1. Neuroscience Research Australia, Sydney, Australia
2. School of Biomedical Sciences, University of New South Wales, Sydney, Australia
3. School of Clinical Medicine, University of New South Wales, Sydney, Australia

Transcutaneous spinal cord stimulation (TSS) is an emerging non-invasive intervention used to increase spinal motoneuron excitability and help restore voluntary movement in people with a spinal cord injury. Different forms of TSS are used and, to date, their relative effectiveness and tolerability have not been systematically investigated. We determined the effect of different TSS parameters on participant discomfort and the amount of electrical current required to evoke spinally-evoked motor response (sEMR). Able-bodied adults (n=15) participated in the study. Single pulses and trains of stimulation were administered across four forms of TSS: conventional monophasic, conventional biphasic, kHz monophasic and kHz biphasic. sEMR threshold intensities for single pulses and trains of stimulation were determined. For trains of stimulation, pain ratings were determined when stimulation was provided at threshold intensity; we also determined the stimulation intensity associated with a 7/10 rating. For both kHz and conventional waveforms, threshold intensities were, on average, 9-15% lower for biphasic stimulation. Overall, conventional stimulation was slightly less painful than kHz stimulation. For trains of stimulation at threshold intensity, there was little to no effect of polarity on pain, and this for both kHz and conventional stimulation. However, participants tolerated higher stimulation intensities for trains of stimulation with monophasic stimulation; on average, 9% higher for kHz stimulation and 14% higher for conventional stimulation.

Monophasics and biphasics and carriers, oh my(!); carrier frequency markedly influences recruitment thresholds of human axons

Collins DF [1], Leverett JA [1], Miskiewicz-Tomaszyk A [1], McDonald A [1], Gupta J [1], Jones KE [1] and Vette AH [2]

1. Faculty of Kinesiology, Sport, and Recreation, University of Alberta, Edmonton, Canada.
2. Glenrose Rehabilitation Hospital, Faculty of Engineering, University of Alberta, Edmonton, Canada.

Functional electrical stimulation (FES) and transcutaneous spinal cord stimulation (tSCS) use pulses of electrical stimulation to depolarize axons. FES targets motor axons in peripheral nerves to produce contractions. tSCS targets sensory axons in the dorsal roots to modulate neural circuits.

Presently we investigate the effect of pulse parameters (monophasic, biphasic, carrier frequency) on recruitment of the target axons. We hypothesized: 1) no difference in recruitment between monophasic and biphasic pulses and, 2) recruitment efficacy would decrease as carrier frequency increased. Ten individuals with no neurological impairments participated. Recruitment efficacy was identified as the current that produced a threshold response in target muscles (recruitment threshold; RT) during stimulation over the tibial nerve (FES) and T12/L1 (tSCS). RTs for M-waves and H-reflexes reflected recruitment of motor and sensory axons, respectively. RTs for dorsal root reflexes (DRRs) reflected recruitment of sensory axons. Six pulses were compared; 1&2) no carrier, 0.5ms monophasic and 1.0ms biphasic, 2&3) 4.8kHz carrier frequency, 1ms mono- and biphasic and, 5&6) 9.8kHz carrier frequency, 1ms mono- and biphasic. With few exceptions, there were no differences in RTs between mono- and biphasic pulses when compared between pulses 1&2 and at equal carrier frequencies. Without exception, RTs were lowest for pulses with no carrier and increased as carrier frequency increased. For soleus, RTs for M-waves, H-reflexes and DRRs were 3.7x, 4.2x and 3.2x higher, respectively, using 9.8kHz carrier frequency pulses compared to no carrier. Carrier frequency markedly influences recruitment of human axons and this should be considered when using FES and tSCS.

Revitalizing neural circuits in complete spinal cord injured rats with intermittent theta burst stimulation (iTBS): A promising therapeutic paradigm

Sharma G [1], Hariprasad G [2], Kochhar KP [1], Kumar N [3] and Jain S [1]

1. Department of Physiology, All India Institute of Medical Sciences, Delhi
2. Department of Biophysics, All India Institute of Medical Sciences, Delhi
3. Department of Psychiatry, All India Institute of Medical Sciences, Delhi

Introduction: Spinal cord injury (SCI) is a distressing neurotraumatic condition, resulting in loss of movement, sensations, autonomic dysfunction and high mortality rates. Non-invasive brain stimulation techniques like intermittent theta burst stimulation (iTBS) have the potential to target and minimize the etiology of the disease. However, there is a need to determine the functional outcomes of iTBS in SCI animal models before it can be taken to bedside.

Aim and objectives: to assess the efficacy of iTBS administration at motor cortex on electrophysiological, locomotor and autonomic functions

Methods: rats were randomly divided into following groups: control, sham SCI, SCI, SCI+iTBS(MC) & SCI+sham stimulation. In treatment group iTBS was administered at 50Hz frequency twice a day for 5 consecutive days. Motor thersholds (MT), motor evoked potential (MEPs), BBB scoring and urinary bladder function was recorded before and after the intervention.

Results:

- **a)** The locomotor score shows increase in trend post-iTBS treatment compared to sham group.
- **b)** MT was decreased in the iTBS treatment group when compared to control while the MEP amplitude was comparatively increased in the intervention group.
- **c)** There was no significant improvement in urinary bladder function in SCI + iTBS groups over SCI group.

Conclusion: the administration of iTBS in complete spinal cord injured rats holds tremendous potential as a therapeutic intervention for enhancing motor recovery and promoting neuroplasticity.

ABSTRACTS (in Programme order)

MONDAY 20 NOVEMBER 2023
SESSION 2: Respiratory Motor Control
Chairpersons: David Berlowitz & Nicole Sheers
University of Melbourne, Australia

Respiratory motor impairment in ageing, respiratory disease, and spinal cord injury

Butler JE [1, 2]

1. Neuroscience Research Australia, Sydney, Australia
2. School of Biomedical Sciences, University of New South Wales, Sydney, Australia.

This presentation will give an overview of some of our work looking at neural drive to breathe in ageing, chronic obstructive pulmonary disease (COPD), and after spinal cord injury (SCI). I will present results using two different techniques to assess drive to breathe in humans. First, using single motor unit recordings made from the diaphragm during resting breathing, we have shown increased drive to breathe in people with moderate to severe COPD and chronic cervical SCI reflected by increased motor unit firing frequency (~18 Hz for both groups compared with ~12 Hz in control participants). In contrast during ageing, we showed no change in firing rates across young, middle-aged and older adults (14-15 Hz), despite known changes in muscle mechanics. In addition, the single motor unit studies revealed that motor unit action potentials increased in duration and area in older adults, evident even from middle age, suggesting motor unit reorganisation after motoneurone cell death. Second, using EEG to identify Bereitshcaftspotentials (readiness potentials) during resting breathing in older adults, and people with COPD and SCI, we showed that they were present in COPD and ageing, despite the lack of increase in neural drive evident in older adults, and absent in people with SCI, despite their increased drive to breathe. I will discuss some of our interpretations of the data and implications for the control of breathing.

Resilience of mitochondrial remodeling: Role in respiratory motor impairment

Sieck GC [1]

1. Department of Physiology & Biomedical Engineering, Mayo Clinic, Rochester, USA

Breathing is accomplished by the recruitment of smaller phrenic motor neurons (PhMNs) that innervate more fatigue resistant diaphragm muscle (DIAm) fibers. Larger PhMNs innervate more fatigable DIAm fibers that are recruited for higher force expulsive behaviors. Thus, smaller PhMNs are highly active whereas larger PhMNs are infrequently active. These differences in PhMN activity are reflected by differences in mitochondrial volume density (MVD), and the extent of mitochondrial fragmenation. Smaller PhMNs have signficantly higher MVD and less fragmented mitochondria compared to larger PhMNs. In older rats, we found that larger PhMNs are lost. We hypothesized that with aging survival of larger PhMN is impaired due to the withdrawl of BDNF/TrkB signaling. In younger rats, we showed that in PhMNs, BDNF/TrkB signaling mediates phosphorylation of pCREB^{s133}, that targets PGC1□ and mitochondrial biogenesis, and effect that is absent in older rats. Mitochondrial fragmentation in larger PhMNs worsened in old age. We also found evidence of enhanced mitophagy in larger PhMNs, including recruitment of PINK1 to mitochondria, phosphorylation of pParkin^{s65}, increased protein ubiquitination and increased lysosome formation. In younger rats, we found similar effects on mitochondria and PhMN loss when TrkB kinase was inhibited using a chemogenetic model with a knockin allele sensitive to 1NMPP1. Together, these results suggest that larger PhMNs are more vulnerable to the impact of aging, perhaps due to a diminshed influence of BDNF/TrkB signaling on mitochondrial biogenesis, Importantly, smaller PhMNs are resilient to the impact of aging, perhaps due to their frequent activation with breathing.

Graded pattern of human parasternal intercostal muscle activity recorded with surface electromyography.

Hudson AL [1, 2, 3], Luu BL [2], Gandevia SC [2, 3] and Butler JE [2, 3]

1. Flinders Health and Medical Research Institute, Flinders University, Adelaide, Australia
2. Neuroscience Research Australia, Sydney, Australia
3. University of New South Wales, Sydney, Australia.

Introduction: Intramuscular recordings of electromyographic activity (EMG) reveal a rostrocaudal gradient of neural drive to the human parasternal intercostal muscles with earlier onset of muscle activity in the rostral interspaces compared to the caudal spaces (1). We determined if this gradient of neural drive can be evaluated with surface recordings of EMG.

Methods: In 20 healthy participants (10 females, age 21-49 years), EMG over the 1^{st}-to-5^{th} right parasternal intercostal muscles was measured with bipolar surface electrodes. Participants breathed with and without inspiratory resistive loads that doubled 'effort' (10 minutes/condition). Off-line EMG recordings were filtered to remove electrocardiogram artefact and the onset of inspiratory EMG was measured from waveform averages (range 44 - 165 breaths). Inspiratory onsets were assessed independently by 2 of the investigators who were blinded to the interspace.

Results: The agreement between assessors was excellent (ICC=0.8). The onset of inspiratory activity differed with interspace ($p<0.001$) and sex ($p<0.05$), but not condition ($p=0.3$). The mean (SEM) onset of inspiratory activity was earliest in the first interspace after 1.9 (1.6) % inspiratory time (T_I) and latest in the fifth space after 22.8 (2.2) $\%T_I$. Overall, onset of inspiratory activity was 8 $\%T_I$ earlier in females compared to males.

Conclusions: Surface recordings are a feasible method to measure the gradient of neural drive to the human parasternal intercostal muscles and reveal sex-differences in neural drive, as previously reported during exercise (2). This non-invasive method may be particularly useful in vulnerable populations such as chronic lung disease and spinal cord injury.

References

1. Gandevia SC, et al, (2006) J Physiol 573, 263-75.
2. Molgat-Seon Y, et al, (2018) Med Sci Sports Exerc 50, 1882-1891.

ABSTRACTS (in Programme order)

MONDAY 20 NOVEMBER 2023
SESSION 3: Motoneurones and Movement
Chairpersons: John Rothwell & Jane Butler
University College London, UK / Neuroscience Research Australia, Australia

---

NeuroMechanics of human movement: A motor neurone centric view

Farina D [1]

1. Neurorehabilitation Engineering, Department of Bioengineering, Imperial College London, UK

Neuromechanics is the field of research that highlights how behaviour emerges as a combination of the structure of the musculoskeletal system, the external mechanical requirements, and neural control. Our main limitation and challenge in neuromechanics is our poor ability to record in vivo from a sufficiently large number of neural cells to understand population behaviours and to associate a functional meaning to the cellular mechanisms that ultimately determine a movement. This limitation can now be partly overcome, at least at the last stage of neural processing of movement, that is at the level of alpha spinal motor neurons. Motor neurons receive synaptic inputs that they convert into the neural drive to muscles. The spiking activity of motor neurons can be identified from recordings of electrical activity of muscles using either wearable (non-invasive) or minimally invasive sensors. These technologies provide a practical interface with the output of the spinal cord. Moreover, modern methods allow us to decode a relatively large proportion of the active motor neurons during behavioural tasks and therefore to make a direct link with function with neuro-musculoskeletal models. The talk will overview the technologies for motor neuron interfacing, and their use in the study of neural control of movement and neuromechanics. I will specifically discuss the motor neurone synergy theory of motor control, as an extension of the classic muscle synergy view.

Effect on human motor unit firing rates during recovery from fatigue: Competing effects of prolonged low-frequency force depression and post-activation potentiation

Zero AM [1], Fanous J [1] and Rice CL [1, 2]

1. School of Kinesiology, Faculty of Health Sciences, The University of Western Ontario, London, Canada
2. Department of Anatomy and Cell Biology, Schulich School of Medicine, and Dentistry, The University of Western Ontario, London, Canada

The purpose was to investigate the effect of inducing post-activation potentiation (PAP) during prolonged low-frequency force depression (PLFFD) on motor unit (MU) firing rates following a sustained high-intensity fatiguing contraction. We hypothesized that inducing PAP during PLFFD would reduce MU firing rates. In 10 participants, firing rates of 2292 MUs from the tibialis anterior were recorded with tungsten microelectrodes. Pre-fatigue MU firing rates at 25% isometric maximal voluntary contraction (MVC) were ~14 Hz. Fatigue was induced with a sustained 1-min dorsiflexion MVC, in which torque and maximal MU firing rates (~45 Hz) declined ~49% and ~40% (both $P<0.001$), respectively. Following task-termination, firing rates at 25% pre-fatigue MVC and torque in response to electrical (1, 10 and 50 Hz) stimulation were assessed pre and post a 5s MVC (to induce PAP) every 10-min for 60-min. From 10 to 60-min at pre-MVC time points, 1:50 and 10:50 Hz torque ratios were depressed relative to pre-fatigue values by ~30% ($P<0.001$), indicating PLFFD. Furthermore, firing rates were higher relative to pre-fatigue by ~15% at pre-MVC (i.e., PLFFD) time points ($P<0.001$). Inducing PAP during PLFFD increased the 1:50 and 10:50 Hz ratios ~200% and ~135%, respectively ($P<0.001$) and firing rates were lower by ~18% relative to PLFFD rates ($P<0.001$). Inducing PAP during PLFFD resulted in rates that were ~6% lower than pre-fatigue values ($P<0.001$). Therefore, firing rates are highly responsive in making compensatory adjustments to competing influences of contractile state history and the lower rates subsequent to PAP may mitigate PLFFD.

Longitudinal changes in the contribution of persistent inward currents to motoneuron self-sustained firing are dependent on Amyotrophic Lateral Sclerosis (ALS) disease progression.

Trajano GS [1], Orssatto LBR [2], McCombe PA [3], Rivlin W [3] and Henderson RD [3]

1. School of Exercise and Nutrition Sciences, Faculty of Health, Queensland University of Technology (QUT), Brisbane, Australia
2. Institute for Physical Activity and Nutrition (IPAN), School of Exercise and Nutrition Sciences, Deakin University, Geelong, Australia
3. Department of Neurology, Royal Brisbane & Women's Hospital, Brisbane, Australia

The mechanisms underpinning the ALS-related degeneration of the motoneurons are still poorly understood. Animal studies (1) show increased persistent inward currents (PICs) amplitude in pre-symptomatic genetically modified SOD1 mice models of ALS that reverses to a large reduction in PIC amplitude at symptomatic. In humans, it is not possible to measure PIC amplitudes, but it is possible to estimate the PIC contribution to motoneuron firing frequency hysteresis by calculating the delta frequency (ΔF) using the paired motor unit technique. We hypothesise that ΔFs would 1) increase before the disease manifestation in the pre-symptomatic limbs; and 2) reduce with disease progression in the symptomatic limb. Forty-three individuals diagnosed with ALS volunteered to this study. Participants were assessed in two distinct occasions ~17 weeks apart. Tibiallis anterior High-density electromyograms were recorded during submaximal dorsiflexion (40% of maximal EMG) ramped contractions, followed by muscle strength test via Medical Research Council's scale (MRC scale). MRC scale score was also used to classify the tested limb as symptomatic (score >5 in at least one visit) and pre-symptomatic (score =5 in both visits). ΔF reduced 0.55 (95%CI 0.240, 0.854) pps on the symptomatic limb ($p<0.001$) and increased 0.42 (95%CI 0.036, 0.799) pps on the pre-symptomatic limbs ($p = 0.032$) between the two visits. This study shows for the first time in humans, confirming the findings of studies using SOD1 mice (1) that the contribution of PICs to motoneuron firing hysteresis increases in pre-symptomatic stages of the disease before progressively decreasing as the disease progresses and muscle weakness exacerbates.

Reference

1. Huh S, Heckman CJ & Manuel M (2021). Time course of alterations in adult spinal motoneuron properties in the SOD1 (G93A) mouse model of ALS. *ENeuro*, *8*.

Descending drive to spinal motoneurones is necessary for 5-HT_2 modulation of motoneurone excitability in humans

Henderson TT [1], Taylor JL [2, 3], Thorstensen JR [4] and Kavanagh JJ [1]

1. Menzies Health Institute Queensland, Griffith University, Gold Coast, Australia
2. Centre for Human Performance, School of Medical and Health Sciences, Edith Cowan University, Perth, Australia
3. Neuroscience Research Australia, Sydney, Australia
4. School of Biomedical Sciences, The University of Queensland, Brisbane, Australia

Serotonin (5-HT) has a neuromodulatory role within the motor circuits that drive muscle, whereby 5-HT_2 receptors on motoneurones facilitate persistent inward currents (PICs) to enhance motoneurone excitability. These neuromodulatory effects at motoneurones are dependent on descending drive to the motoneurone pool. The purpose of this study was to examine the effects of a 5-HT_2 antagonist (cyproheptadine) on cortico-motoneuronal excitability in humans. Twelve individuals (mean ± SD, aged 24 ± 4yr) participated in a double-blind, placebo-controlled crossover study, whereby participants ingested a single oral dose (8mg) of cyproheptadine. Transcranial magnetic stimulation (TMS) of the motor cortex was used to elicit motor evoked potentials (MEPs) and electrical cervicomedullary stimulation evoked cervicomedullary motor evoked potentials (CMEPs) in the biceps brachii at rest and during elbow flexions at different percentages of maximal torque. Evoked potentials were also obtained 100ms after a conditioning TMS pulse to produce conditioned MEPs and CMEPs. When normalized to baseline, cyproheptadine reduced maximal torque (-6% ± 3%, $p = 0.004$), unconditioned MEP amplitude (-39% ± 46%, $p = 0.003$) at rest, and conditioned MEP amplitude at rest (-39% ± 32%, $p = 0.033$) and during contraction (-16% ± 3%, $p = 0.020$). Cyproheptadine also increased unconditioned CMEP amplitude during voluntary contraction (4% ± 3%, $p = 0.041$) but not at rest. Overall, 5-HT_2 antagonism decreased maximal motor output and increased long-interval intracortical inhibition. Complex changes in evoked potentials are consistent with reduced motoneurone PIC amplitude, causing a compensatory increase in descending drive to the motoneurone pool during submaximal contractions.

Subcortical control of human reaching?

Contemori S [1], Divakar R [1], Yang C [1], Loeb GE [2], Corneil BD [3, 4, 5], Wallis G [1] and **Carroll TJ** [1]

1. Centre for Sensorimotor Performance, The University of Queensland, Brisbane, Australia
2. Department of Biomedical Engineering, University of Southern California, Los Angeles, USA
3. Department of Physiology and Pharmacology, Western University, London, Canada
4. Department of Psychology, Western University, London, Canada
5. Robarts Research Institute, London, Canada

Conventional theories assume that control of visually-guided movements occurs primarily in the cerebral cortex, and involves target detection in visual cortex, integration of target location and body configuration in parietal cortex, and command signal generation in motor cortex that drives motoneurons and thereby muscles. Here we present an alternative perspective on human visually-guided movement, inspired by the fact that the capacity to produce fast and accurate visually-guided movements emerged at a primitive stage of animal evolution [1]. Indeed, despite lacking a cerebral cortex, vertebrates such as frogs and archerfish can produce impressive feats of spatially accurate, visually-guided targeting of prey. Critically, the core subcortical brain structures used for prey capture by lower vertebrates have been phylogenetically conserved in humans. This presentation will describe our recent work that documents reaching behaviour that is strikingly suggestive of subcortical control. We show that target-directed and coordinated activation of multiple muscles can occur within 100 ms of target presentation, that this rapid muscle activation is enhanced by multisensory inputs and task predictability, and that the activity is associated with modulation of corticospinal excitability within 70 ms of target presentation. We propose that these observations are the signature of a fast, subcortical visuomotor pathway through the superior colliculus and brainstem reticular formation that bypasses motor cortex. The functional properties of the responses suggest the possibility that subcortical circuits represent the core hub of the reach control system, which integrates cortical and sensory sensory inputs to generate control outputs to the spinal interneurons and motoneurons.

Reference

1. Cisek P (2020) Philos Trans R Soc Lond B Biol Sci 377, doi: 10.1098/rstb.2020.0522.

ABSTRACTS (in Programme order)

TUESDAY 21 NOVEMBER 2023
SESSION 1: ALS and Parkinson's Disease
Chairpersons: Martin Héroux & Graham Kerr
Neuroscience Research Australia / Queensland University of Technology, Australia

---

Amyotrophic lateral sclerosis: Update on current concepts and management

Vucic S [1]

1. Northcott Chair of Neurology, Director Brain and Nerve Research Center, The University of Sydney, Australia

Amyotrophic lateral sclerosis (ALS) is a progressive neurodegeneration disorder of the motor neurons characterised by presence of upper and lower motor neuron signs. The pathophysiological mechanisms underlying ALS are complex, mediated by a complex interaction of genetic, molecular, and environmental factors. Moreover, a multi-step process has also been established, with six steps required for development of ALS. Cortical hyperexcitability, along with impaired proteostasis, mitochondrial dysfunction, oxidative stress, dysfunctional axonal transport systems and increased metabolism have all been implicated in pathogenesis. This enhanced understanding of pathogenic mechanisms has resulted in development of novel therapeutic approaches, resulting in effective treatments, as well as innovative trial designs. This presentation will provide an update on current advances in ALS diagnosis and pathogenesis, along with novel treatments.

Parkinson’s disease - a clinical perspective

Sue CM [1, 2, 3]

1. Neuroscience Research Australia, Sydney, Australia
2. Faculty of Medicine, University of New South Wales, Sydney, Australia
3. Department of Neurology, Prince of Wales Hospital, Sydney, Australia

Parkinson’s disease affects 10 million people worldwide. It is the most rapidly growing neurodegenerative disorder that causes motor disability in our population. Impairment of motor function clinically manifests as tremor, rigidity, gait abnormalities and postural instability. These motor features are largely due to the loss of dopaminergic neurons in the substantia nigra. Insights into the pathogenic disease process have been advanced by the identification of Parkinson’s disease associated gene mutations that confirm mitochondrial dysfunction, impaired protein clearance and α-synuclein aggregation contribute to the neurodegenerative process. Investigation of these Parkinson’s disease-related genes has improved our understanding of the molecular mechanisms that underpin the disease process and has led to the development of new therapeutic strategies that are neuroprotective and bring the hope of modifying disease progression.

The impact of aerobic exercise and/or photobiomodulation compared to usual care on non-motor symptom severity of Parkinson's Disease: A pilot randomised crossover study

Ramos JS [1], Charkraborty R [1], Dalton J [2] and Nassaris O [2]

1. Caring Futures Institute, College of Nursing and Health Sciences, Flinders University
2. Brain and Body Fitness Studio, The Hospital Research Foundation Parkinson's, Adelaide, SA, Australia

Background: Parkinson's disease (PD) is the most common movement disorder that affects ~150,000 people in Australia. Interestingly, non-motor symptoms (NMS) develop before the appearance of cardinal motor signs of PD and are better predictors of quality of life. Aerobic exercise (AE) can ameliorate NMS in PD patients, but long-term exercise adherence in this population is low. Photobiomodulation(PBM) may also be considered an exercise mimetic, but more work is required to confirm this hypothesis. We hypothesised that the combined use of these treatment paradigms could induce more NMS severity amelioration in PD.

Method: This study included 20 participants(40-80 years) with idiopathic PD. Participants were randomised into four groups:i)Group-A-B-C-D(n=5);ii)Group-B-D-A-C(n=5);iii)Group-C-A-D- B(n=5);iv)Group-D-C-B-A(n=5), where A,B,C, and D represents 8-week PBM,AE,PBM+AE, and SHAM, each separated by 4-week wash-out. The PBM+AE group was only prescribed ≤50% of the exercise sessions/week relative to the AE group. The non-motor symptom scale(NMSS) was used to measure NMS severity, with a greater score representing higher severity.

Results: Our preliminary analysis included 17 participants who have completed at least one treatment period. Participants exposed to SHAM(n=4) showed a trend towards a greater NMS severity from pre-to-post-8 weeks (+5±10) relative to the treatment groups. Participants exposed to our treatments revealed either a trend towards favorable changes or maintenance in NMSS total score from pre-to-post intervention as follows: i)Aerobic Exercise (n=4,-23±27);ii) PBM (n=5,+1 ± 9); iii) PBM+AE (n=4,-16±24). There was no significant difference between-groups(p=0.18).

Conclusion: Our preliminary results suggest that AE+PBM may be as efficacious as AE, despite only requiring ≤50% of the weekly prescribed AE.

Early treatment of auricular electro-acupuncture on motor behavioral deficits with 6- hydroxydopamine-induced Parkinson's disease in rats.

Nguyen TMH [1], Lee DY [2] and Hsieh CL [1, 3, 4]

1. Graduate Institute of Acupuncture Science, China Medical University, Taichung, Taiwan
2. Graduate Institute of Integrated Medicine, China Medical University, Taichung, Taiwan
3. Department of Chinese Medicine, China Medical University Hospital, Taichung, Taiwan
4. Chinese Medicine Research Center, China Medical University, Taichung, Taiwan

Parkinson's disease (PD) is the second most common neurodegenerative disease [1]. Currently, PD treatment is symptomatic and involves the use of dopamine-based therapies, however, it also includes side effects such as wearing-off phenomenon, symptom worsening, and dyskinesia [2]. Thus, this study investigated the effect of auricular acupuncture on motor behaviours in rats with 6 hydroxydopamine (6-OHDA)-induced PD.

A PD rat model was established by bilaterally injecting 6-OHDA into the lateral dorsal striatum. Then, 2- or 15-Hz auricular electroacupuncture (EA) was applied to the CO15 and CO12 points bilaterally. EA was applied for 20 minutes three times a week for a total of 4 weeks, followed by behavior tests to assess motor function.

Both the rotarod test time and rest time in the open field test were greater in the EA15 group (treatment with 15-Hz auricular EA) than in the 6-OHDA group (no EA treatment). However, there was no significant difference in other parameters among the four groups. Tyrosine hydroxylase (TH) positive cells were more prominent in the substantia nigra (SN) and dorsolateral striatum in the EA15 group compared to the 6-OHDA group. The L-DOPA level in the striatum was higher in the EA15 group than in the 6-OHDA group, while the dopamine level significantly increased after the 6-OHDA injection. Besides, the striatal glutamate level was lower in the two EA groups compared to both the control and 6-OHDA groups.

The study findings have revealed that auricular EA plays a neuroprotective role in rats with 6-OHDA-induced PD.

References

1. Elbaz A., et al., *Epidemiology of Parkinson's disease.* Revue neurologique, 2016. **172**: p. 14- 26.
2. Armstrong MJ and Okun MS, *Diagnosis and treatment of Parkinson disease: a review.* JAMA, 2020. **323**: p. 548-560.

ABSTRACTS (in Programme order)

TUESDAY 21 NOVEMBER 2023
SESSION 2: Research Quality, Motor Control & More
Chairpersons: Simon Gandevia & Gary Sieck
Neuroscience Research Australia / Mayo Clinic USA

Hippocrasy – how doctors are betraying their oath

Buchbinder R [1]

1. Musculoskeletal Health and Wiser Health Care Units, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia

While many medical students take the Hippocratic Oath or a similar pledge before graduating (reciting lines like *first, do no harm*) we've ended up with a healthcare system that's one of the greatest threats to human health. This talk will describe the problem of too much medicine as outlined in the book Hippocrasy – how doctors are betraying their oath, that I cowrote with Professor Ian Harris and published in October 2021. It was written with the benefit of a Rockefeller writing residence at the Rockefeller Center in Bellagio, Italy in 2018. The book was written based upon our own experiences as doctors and researchers. It highlights that much of medicine doesn't do what it's supposed to do: improve health. Modern medical care is designed to maximise the number of encounters with the system, constantly prescribing, operating, testing and scanning, and prioritising business over science. It's a system rife with perverse incentives and unintended consequences, producing health care without necessarily improving the health of the recipients of that care. The problem threatens the delivery of efficient and effective health care, wastes money, and causes harm both to the recipient of the low-value care and to others via its effect on the environment.

Avoid hypocrisy and improve the reproducibility of research

Gandevia SC [1, 2]

1. Neuroscience Research Australia, Sydney, Australia
2. University of New South Wales, School of Medicine, Sydney Australia

Serious concern exists across the sciences about the reproducibility of research results. Far from abating, evidence of a low-level of reproducibility continues to grow (1). Despite this evidence and simple steps that can enhance research quality and reproducibility, there may be an anchor slowing progress. The profile and profitability of Academic Institutions can rise and fall on multiple international rankings based, in no small part, on the number of publications and their citation. They benefit directly (including financially) from the pressure on their scientists to publish more and to be cited more. On the other hand, they often try to act positively on the evidence of poor reproducibility. Publishers and journals have an even more overt driver – money.

Some steps to improve research reproducibility are obvious: for example, preregister study plans, mandate correct statistical reporting, and avoid unjustified spin of results. We have introduced a simple checklist (Quality Output Checklist and Content Assessment, QuOCCA) that quantifies key aspects of research transparency, research guidelines and research reporting in publications. It is being applied to all NeuRA publication from 2017 on (2). We wait to see what effect it and other initiatives will have.

References

1. Cobey et al (2023), bioRxiv, 10.1101/2023.09.18.558287.
2. Héroux et al (2022), BMJ Open 12:e060976.

Quantifying muscle activation asymmetry in Adolescent idiopathic Scoliosis

Tucker K [1], Ng PTT [1, 2], c P [1], Claus A [4], Izatt MT [3, 4, 7], Pivonka P [4, 6], Labrom RD [3, 4, 7] and van den Hoorn W [1 ,6]

1. School of Biomedical Sciences, The University of Queensland, Australia
2. KK Women's and Children's Hospital, Singapore
3. Biomechanics and Spine Research Group, Centre for Children's Health Research, Australia
4. School School of Mechanical, Medical and Process Engineering, Queensland University of Technology, Australia.
5. Royal Brisbane and Women's Hospital, Australia,
6. ARC Training Centre for Joint Biomechanics, Queensland University of Technology (QUT), Australia
7. Queensland Children's Hospital, Australia

Adolescent idiopathic scoliosis (AIS) is characterized by an atypical 3D spinal curvature that develops/progresses between 10-18 years of age. Asymmetrical forces applied by paraspinal muscles may contribute to progression of asymmetrical vertebral form during this period of rapid growth.

Aim: To quantify the asymmetry in superficial paraspinal muscle activation [surface electromygraphy, collected ~2cm lateral to vertebral levels: C7, T9/scoliosis-curve apex, T12, L5] in AIS, and determine if the asymmetry differs to that observed in controls. Hypothesis: Muscle activation asymmetry is greater in AIS than controls, particularly at the level of T9/scoliosis-curve apex.

Methods: 19 females with *right-convex thoracic* AIS [Cobb angle: 38±16°; age: 13.7±1.5 years]; and 13 controls [age: 13.6±1.9 years] participated. Maximal activation was first facilitated during both maximal *superwoman* and *superwoman-resisted back extensions*. Then participants performed 3*20s *submaximal superwoman back extensions*, at ~between 10-30% max-activation of their T9 paraspinal muscles. Feedback was provided as the mean of bilateral activation at T9. An asymmetry index of activation: ln(right/left), was calculated at each vertebral level.

Results/Conclusion: Asymmetry in muscle activation was greater at T9/curve apex ($p<0.01$); and T12 ($p<0.01$) in AIS (T9:0.40±0.55; T12:0.17±0.41) compared to controls (T9:-0.09±0.50; T12:-0.18±0.26), with greater activation on the convex side of the spine in girls with AIS. No difference in asymmetry was observed between groups at C7 ($p=0.82$) or L5 ($p=0.60$). Superficial paraspinal muscles provide stability to the spine and impact vertebral loading during growth. The asymmetry of paraspinal muscle activation, with greater convex-side activation, may be important to consider in the progression of AIS.

Sensory and motor responses to burst-modulated, kilohertz carrier frequency stimulation of a peripheral nerve

Luu BL [1], Trinh T [1, 2], Finn HT [1, 2], Héroux ME [1, 2], Gandevia SC [1, 2, 3] and Butler JE [1, 2]

1. Neuroscience Research Australia, Sydney, Australia
2. Faculty of Medicine and Health, University of New South Wales, Sydney, Australia
3. Prince of Wales Hospital, Randwick, Australia

Neuromuscular electrical stimulation with a kilohertz carrier frequency is a promising therapeutic technique to improve motor function in people with spinal cord injury (1). The reason for using a kilohertz, opposed to conventional (<100 Hz), frequency is that it is believed to be less painful at higher intensities (2). However, any purported benefits have not been shown unequivocally. Here, we compared sensory, motor, and pain responses from the left hand in 12 naïve participants. The ulnar nerve was stimulated transcutaneously with either a single, 1-ms burst of biphasic pulses with a carrier frequency of 1 (conventional), 5, and 10 kHz, or a 1-second train of pulses burst-modulated at 20 Hz (i.e., 20, 1-ms bursts in 1 second). Stimulus intensity was increased until no longer tolerable with pulse widths adjusted to match electric charge across frequencies. Participants tolerated higher current amplitudes with 5-kHz and 10-kHz carrier frequencies than conventional stimulation for single bursts and trains. However, more current was required to reach sensory, motor, and perceptual thresholds, and to obtain maximum motor response, with 5-kHz and 10-kHz carrier frequencies than conventional stimulation. When pain tolerance was normalised to the current amplitude at maximum motor response to account for differences in effectiveness, relative pain tolerance was not better with kilohertz than conventional stimulation. Although kilohertz frequencies produce less discomfort at the same current amplitudes, there is no benefit in using kilohertz frequencies to reduce the discomfort of electrical stimulation as these frequencies are less effective at activating sensory and motor axons.

References

1. Bye et al. (2022) Spinal Cord 60, 491-497.
2. Inanici et al. (2018) IEEE Trans Neural Syst Rehabil Eng 26(6): 1272–1278.

Lunch (at NeuRA), then

Explore Sydney

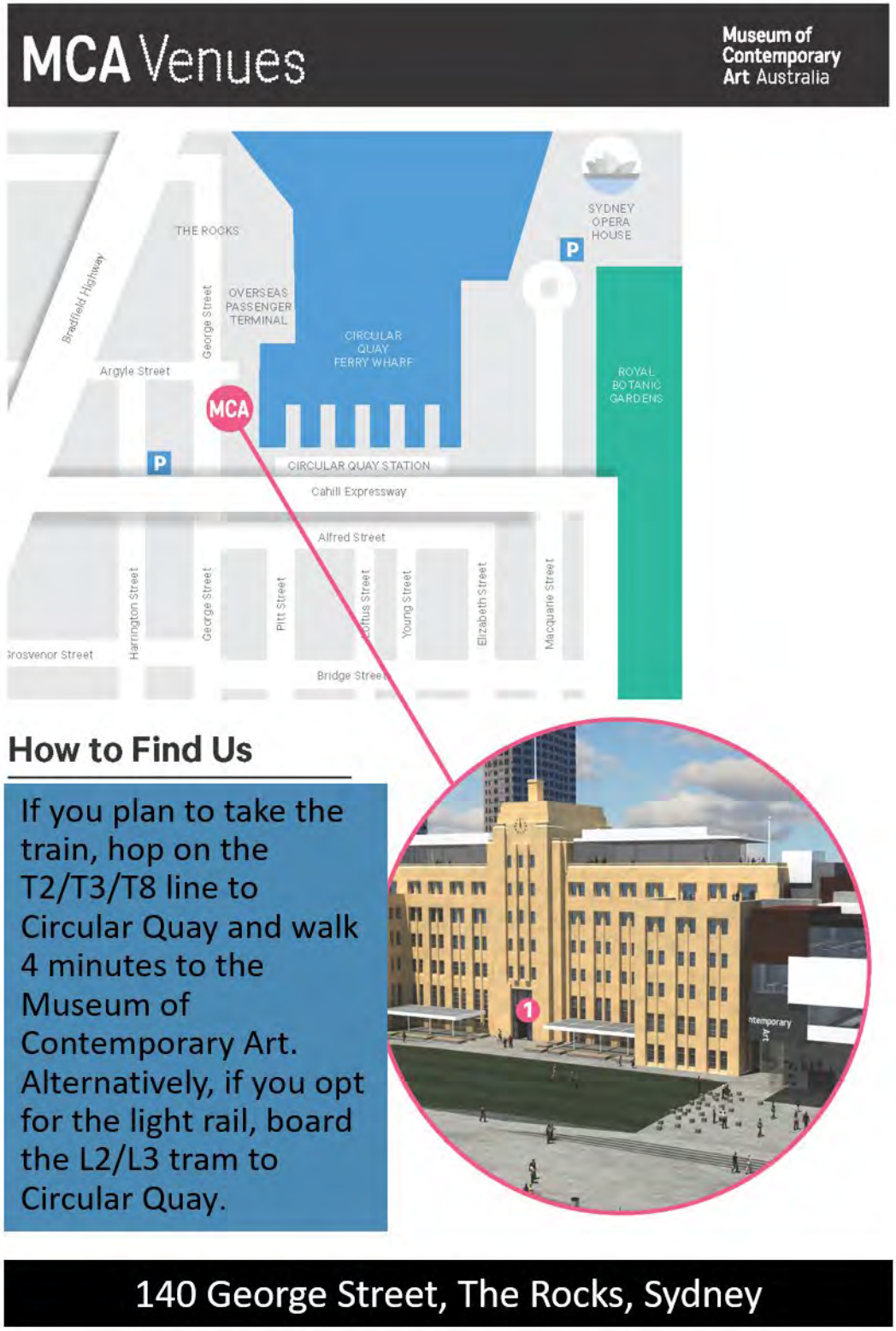
12.15pm – 6.30pm

Explore the heart of Sydney's charm by checking out its must-see spots! Be amazed by the stunning Sydney Opera House and stroll across the iconic Sydney Harbour Bridge for breathtaking views of the harbour. Head up the Sydney Tower Eye and enjoy a panoramic look at the city or hit the beautiful Bondi Beach and take a leisurely walk along the Bondi to Coogee coastal path. This walk treats you to stunning views of Sydney's beaches and coastline. Or visit Circular Quay, take a stroll through the historic charm of The Rocks or through the greenery of the Royal Botanic Gardens to the Art Gallery of New South Wales. And if you're up for more, dive into the lively atmosphere of Darling Harbour before making your way to the Museum of Contemporary Art for dinner.

Conference Dinner
Museum of Contemporary Art
Sculpture Terrace (Level 4)

(Use MCA Entrance 1, Follow the corridor to your right and take the lifts to Level 4)

6.30pm – 10.00pm



ABSTRACTS (in Programme order)

WEDNESDAY 22 NOVEMBER 2023
SESSION 1: Falls & More
Chairpersons: Annie Butler & Yoshi Okubo
Neuroscience Research Australia

Motor strategies of older adults for avoiding head injury during falls: Evidence from video footage of real-life falls in long-term care facilities

Robinovitch SN [1]

1. Department of Biomedical Physiology and Kinesiology, Simon Fraser University, Canada

How do older adults protect their head when they fall? 60% of older adults in long-term care will fall at least once per year (1). Any fall from standing height onto a rigid surface has the potential to cause traumatic brain injury. Yet less than 1% of falls result in TBI (2). Risk for head injury during falls may depend on protective strategies for avoiding or minimizing the severity of head impacts. We tested this hypothesis by linking injury patterns to video footage of 2388 falls experienced by 658 residents (of mean age 84) of two long-term care homes in Vancouver, Canada. Injuries occurred in 38% of falls, and 35% of injuries were to the head. 4% of falls caused injuries treated in hospitals. From video analysis, the head was nearly as likely to impact an object as it was to impact the floor. However, there was a higher odds for head injury when the head struck the floor. Holding weight-bearing objects and reaching to grasp objects reduced the odds for head injury. Upper limb bracing did not affect the odds for head impact and injury (perhaps due to age-related declines in muscle strength). In forward falls, rotated during descent to land sideways or backward decreased the odds for head injury, but increased their odds for hip fracture. These results show that risk for head injury during falls in older adults depends on protective responses that are tailored to physical capacity and the situational and environmental context of the fall.

References

1. Kuhnow J et al. (2022) Can Geriatr J. 25(4):328-335.
2. Robinovitch SN et al. (2022), Age Ageing. 51(12).

The adaptability and transfer of muscular responses following treadmill and walkway perturbation training

Phu S [1,2], Sturnieks DL [1, 2], Song PYH [1, 2], Lord SRL [1, 2] and Okubo Y [1, 2]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Australia
2. Faculty of Medicine and Health, University of New South Wales, Australia

Background: Perturbation-based balance training (PBT) on a treadmill is commonly used to improve reactive balance in older people but its neuromuscular adaptation is unknown. In this study, we tested the hypothesis that (i) treadmill PBT will induce neuromuscular adaptations, but (ii) adaptations obtained during treadmill PBT will not transfer to a walkway trip.

Methods: This study involved 38 older people (65+ years) who underwent two sessions of PBT consisting of 11 treadmill belt accelerations on a treadmill and 11 trips on a walkway. Whilst the perturbation timing and locations were random, the first (T1), fourth (T4), seventh (T7) and eleventh (T11) perturbations occurred on the left leg for analysis. Muscular responses were measured using surface electromyography on the rectus femoris (RF), tibialis anterior (TA), semitendinosus (ST) and gastrocnemius medial head (GM). Pre-trip muscle activity, and post-trip onset latency, peak magnitude, time to peak and co-contraction index (CCI) were measured.

Results: Walkway PBT reduced onset latencies of the right TA and ST (T1 vs T11, $P<0.05$). In contrast, treadmill PBT reduced peak magnitude for the left RF, TA and ST and right ST and GM (T1 vs T11, $P<0.05$). No adaptations observed during treadmill PBT transferred to the walkway trip ($P>0.05$).

Conclusions: Walkway PBT resulted in faster initiation of muscles responsible for recovery steps. In contrast, treadmill PBT resulted in a decline in peak muscle activity of major leg muscles during the recovery steps. PBT on a treadmill may not sufficiently train neuromuscular adaptations against unexpected trips in older people.

Normative data and predictive value of daily-life mobility indicators for older adults: Insights from UK Biobank

Chan LLY [1, 2], Brodie MA [3] and Lord SR [1, 2]

1. Falls, Balance & Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. School of Population Health, the University of New South Wales, Sydney, Australia
3. School of Biomedical Engineering, the University of New South Wales, Sydney, Australia

Impaired daily-life mobility has significant implications for individuals, including decreased well-being, limited functional independence, and increased mortality. This study aims to provide valuable insights into normative data and cut-off values for various aspects of daily-life walking, such as speed, quality, and quantity, stratified by sex and age. By analyzing data from 78,822 participants in the UK Biobank who wore a wrist accelerometer for seven days, we were able to establish normative data for maximal daily-life walking speeds, step-time variability, step count, and other digital gait biomarkers. Furthermore, we explored the associations between these mobility indicators and demographic and socio-economic factors. To identify values that best predict ten-year mortality, we defined cut-off scores.

The results reveal notable differences in daily-life mobility between individuals aged 60 and over compared to their younger counterparts. Specifically, the older age group exhibited slower maximal walking speed (1.7% difference), lower step count (9.9% difference), and higher step time variance (25.4% difference). Importantly, these variables were found to be associated with 10-year mortality. The optimal cut-off value for maximal walking speed, determined by its ability to differentiate ten-year mortality, was identified as 1.22 m/s.

In conclusion, this study highlights the variations in wrist-sensor-measured daily-life mobility among older residents (aged ≥ 50 years) in the United Kingdom and demonstrates its predictive value for 10-year mobility. These findings provide a framework for assessing normal and abnormal walking performance in clinical settings and research studies.

Real-time video analysis and motivation of eating behavior system in people with motor disorders

Zhang YU [1], McEwan AL [2] and Sun JI [2]

1. School of Electrical and Information Engineering, The University of Sydney, Sydney, Australia
2. School of Biomedical Engineering, The University of Sydney, Sydney, Australia

Motor disorders impact an individual's ability, specifically in children with Cerebral Palsy (CP), to perform essential tasks involving eating activity. These disorders often lead to diminished muscle control, coordination, and reflexes, causing difficulties in grasping utensils, and controlling hand-to-mouth movements (1). Interventions encouraging self-feeding on these people, are vital for promoting self-reliance and alleviating caregiver burden. This study aims to develop a Real-Time Video Analysis and Motivation System prototype to address this necessity. Utilizing advanced open-source machine learning models such as OpenPose or Convolutional Neural Networks (CNN), this system is designed to identify and analyze key eating activities, including chewing and swallowing by extracting crucial facial landmarks (2). The system operates by providing real-time feedback and motivational encouragement, aimed to improve self-feeding ability and prevent the development of aversion, thereby reducing dependence on caregivers. The development of this system required intricate software engineering skills to construct both the frontend and backend portions of the application. Real-time video input streaming from both embedded and external cameras are integral to the system, which supplies data into the machine learning models for detection. A pilot survey involving potential end-users and clinical professionals yielded constructive feedback on the system's user interface (UI). In response, improvements have been redesigned to enhance interaction mechanisms within the software, with features such as clear indicators for camera calibration completion and real-time display of the child's eating status. Future research will continue validate these findings, complete the prototype, and assess the system's wider applicability and performance during clinical trials.

References

1. Arvedson JC (2013). Feeding children with cerebral palsy and swallowing difficulties. European Journal of Clinical Nutrition, 67(S2), S9-S12.
2. Tufano M, Lasschuijt M, Chauhan A, Feskens EJM & Camps G (2022). Capturing Eating Behavior from Video Analysis: A Systematic Review. Nutrients, 14(22), 4847.

ABSTRACTS (in Programme order)

WEDNESDAY 22 NOVEMBER 2023
SESSION 2: Vestibular disorders and Multiple Sclerosis
Chairpersons: Jasmine Menant & Phu Hoang
Neuroscience Research Australia

Capturing vestibular disorders by event monitoring

Welgampola MS [1, 2], Young AS [1, 2], Wang C [1, 2] and Nham B [1]

1. Department of Neurology RPA Hospital, Camperdown, Sydney, Australia
2. Department of Medicine, Central Clinical School, University of Sydney Australia

Vertigo and imbalance present with "ictal" nystagmus that points to the underlying vestibular disorder. Benign Positional Vertigo, Vestibular Migraine and Menieres Disease represent three common causes of recurrent vertigo. Vestibular Neuritis and stroke are two major causes of acute vestibular syndrome in the emergency-room.

Patient initiated vestibular event-monitoring was undertaken by 117 vertigo sufferers [1]. Menieres Disease was characterized by high-velocity spontaneous horizontal-nystagmus (median slow-phase velocity [SPV] 39.7°/s). In contrast Vestibular Migraine demonstrated low-velocity (4.2°/s) spontaneous horizontal, vertical or torsional-nystagmus. An SPV >12°/s had a sensitivity and specificity of 95.3% and 82.1% for separating Menieres Disease from Vestibular Migraine. Nystagmus direction-change within 12 hours was highly specific (95.7%) for MD. Vertical-nystagmus was highly specific (93.0%) for VM. Recurrent positional-vertigo from BPV was characterized by absent spontaneous-nystagmus and paroxysmal positional-nystagmus; the median time for peak SPV to halve (T50) was 19 seconds. A T50 <47.3s had a sensitivity and specificity of 100% and 77.8% for separating BPV from its central and peripheral mimics.

In the emergency-room, 44% of 101 patients presenting with posterior-circulation stroke demonstrated no nystagmus, while 44, 8 and 4% had low-amplitude horizontal, vertical and torsional-nystagmus[2]. In contrast, 98% of vestibular neuritis demonstrated horizontal-unidirectional-nystagmus; an SPV ≥ 5.8 °/s separated VN from stroke with sensitivity and specificity of 91.2% and 83.0%. Absent nystagmus, gaze-evoked nystagmus, and vertical-torsional nystagmus were highly specific for stroke (100%, 100% and 98.1%). Vestibular event monitoring offers the opportunity of early diagnosis and targeted treatment of specific vestibular disorders.

References

1. Young et al. (2019) Neurology 92: e2743-e2753.
2. Nham et al. (2023) J Neurol 270: 632-641.

The effect of postural demand on cortical and motoneuronal excitability

Copeland PV, Bennett EC, Debenham MIB, Ha PL, McNeil CJ, Dalton BH

School of Health and Exercise Sciences, University of British Columbia Okanagan, Kelowna, British Columbia, Canada

Compared to sitting, standing led to increased corticospinal excitability (motor evoked potential, MEP) and decreased spinal excitability (H-reflex) for the soleus, even when electromyographic (EMG) activity was matched. The H-reflex has many caveats as a measure of spinal excitability and cannot be used to distinguish between cortical and spinal contributions to the MEP. The aim of this study was to investigate the effect of postural demand on cortical and spinal excitability by obtaining a more direct measure of motoneuronal excitability (thoracic motor evoked potential, TMEP) alongside the MEP and the maximal M-wave (Mmax). Currently, data have been collected from seven participants. Transcranial magnetic, electric thoracic spine, and electric tibial nerve stimulation were used to elicit the MEP, TMEP, and Mmax, respectively. While seated, stimulation intensities were set to produce MEPs and TMEPs of ~10% Mmax during a contraction targeting soleus integrated EMG (iEMG) recorded at ~20% of maximal voluntary isometric plantar flexion torque. Participants maintained ~20% iEMG for ~5s while standing or sitting, and the three stimulations were delivered at 1.5-s intervals. The evoked potential area was used to evaluate cortical (MEP/TMEP), motoneuronal (TMEP/Mmax), and peripheral (Mmax) excitability. Cortical (standing: 1.40±0.52 and sitting: 1.05±0.16; p=0.123) and motoneuronal (standing: 0.10±0.03 and sitting: 0.08±0.01; p=0.107) were not different between conditions. Peripheral excitability was lower while standing (0.04±0.01mV·s) than sitting (0.05±0.01mV·s; p=0.022). Contrary to previous work, our current results indicate that cortical and motoneuronal excitability are not altered by changes in postural demand.

The interaction between metaplastic neuromodulation and fatigue in Multiple Sclerosis

Sidhu SK [1], Xian C [1], Barbi C [2], Goldsworthy MR [1, 3, 4] and Venturelli M [2]

1. Discipline of Physiology, School of Biomedicine, The University of Adelaide, Australia
2. Department of Neurosciences, Biomedicine and Movement Sciences, University of Verona, Italy
3. Hopwood Centre for Neurobiology, Lifelong Health Theme, South Australian Health and Medical Research Institute (SAHMRI), Adelaide, Australia
4. Behaviour-Brain-Body Research Centre, Justice and Society, University of South Australia, Australia

Neuromuscular fatigue contributes to decrements in quality of life in Multiple Sclerosis (MS), yet available treatments demonstrate limited efficacy. Transcranial direct current stimulation (tDCS) is a non-invasive brain stimulation technique which presents promise in managing fatigue, possibly related to its capacity to modulate corticospinal excitability. There is evidence for capitalising on metaplasticity using tDCS for improving motor learning and skill acquisition (1). However, this remains to be explored with fatigue in people with MS (pwMS). Given the neural abnormalities related to MS, we hypothesised that pwMS are less likely to receive the priming benefits of cathodal tDCS (ctDCS) to augment excitability of the brain and ameliorate the magnitude of fatigue with subsequent application of anodal tDCS (atDCS) during a fatiguing task (2). 15 pwMS and 15 healthy controls completed fatiguing exercise whilst receiving either ctDCS or sham (stDCS) primed atDCS to the motor cortex. We assessed change in contraction force and motor evoked potential (MEP) amplitude across time to represent changes in fatigue and corticospinal excitability. ctDCS primed atDCS induced MEP elevation in healthy participants but not in pwMS, possibly indicating impaired metaplasticity in pwMS. No tDCS-mediated change in the magnitude of fatigue was observed, implying that development of fatigue may not rely on changes in corticospinal excitability. These findings expand understanding of tDCS effects in pwMS, highlighting differences that may be relevant in the disease pathophysiology.

References

1. Fujiyama, H., M. R. Hinder, A. Barzideh, C. Van de Vijver, A. C. Badache, C. M. Manrique, P. Reissig, X. Zhang, O. Levin, J. J. Summers and S. P. Swinnen (2017). Neurobiol Aging 51: 31-42.
2. Xian C, Barbi C, Goldsworthy MR, Venturelli M, Sidhu SK (2023) J Neurol Sci 444:120521.

Fatigue-related deficits in muscle activation in people with Multiple Sclerosis

Kavanagh JJ [1], Brotherton EJ [1] and Sabapathy S [1]

1. Menzies Health Institute Queensland, Griffith University, Gold Coast, Australia

People with Multiple Sclerosis (MS) typically exhibit greater levels of exercise-induced fatigue compared to healthy individuals. However, it is unknown if voluntary muscle activation is affected over a range of contraction forces in people with MS who have exercise-induced fatigue. This study used transcranial magnetic stimulation (TMS) to examine muscle activation during exercise-induced fatigue. Ten people with relapsing-remitting MS (39 ± 7 years) and 10 healthy controls (40 ± 5 years) performed elbow flexions at 25%, 50%, 75%, 90%, and 100% MVC while electromyography (EMG) of the biceps brachii was recorded. Sustained elbow flexion MVCs were then performed until force declined to 60% of baseline MVC, and the target contraction intensities were once again examined. Voluntary activation was calculated from superimposed twitches obtained during target contraction intensities. Exercise-induced fatigue caused greater reductions in motor cortical voluntary activation ($p < 0.01$) and biceps EMG amplitude ($p < 0.01$) for the MS group compared to the control group for all contraction intensities. The MS Fatigue Severity Scale was higher for the MS group ($p < 0.01$) but was not correlated to voluntary muscle activation ($r^2 = 0.18$, $p = 0.61$). Instead, the duration of disease was significantly correlated to voluntary activation ($r^2 = -0.76$, $p = 0.01$). These findings suggest MS-related fatigability is due, in part, to an inability of the motor cortex to drive the muscle. Although the Fatigue Severity Scale is commonly used to assess MS fatigue it did not align with neural activity in motor pathways.

ABSTRACTS (in Programme order)

WEDNESDAY 22 NOVEMBER 2023
SESSION 3: Falls and other neurological conditions
Chairpersons: Kylie Tucker & Anna Hudson
University of Queensland, Australia / Flinders University, Australia

---

Falls in different neurological conditions

Menant JC [1]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, Australia

It is well established that falls can lead to injuries, disability, hospitalisation, institutionalisation, fear of falling and depression; devastating sequelae that are costly and severely reduce quality of life. Falls resulting from a loss of balance are frequent events for people with cognitive and motor impairments, and are often associated with neurological conditions. Many Australians live with postural instability secondary to neurological conditions, such as Parkinson's disease (>80, 000), Multiple Sclerosis (>23,000), or Chemotherapy-Induced Peripheral Neuropathy (CIPN) (40% of cancer survivors). These individuals are at increased risk of falls: 40% to 60% experience at least one fall per year with many falls resulting in injuries. With few existing disease-modifying therapies and the proportion of people affected by neurological disorders on the rise, there is an urgent need to identify interventions to improve balance and reduce falls and ensuing injuries in these clinical groups.

This presentation will provide an overview of laboratory-based studies and randomised controlled trials undertaken in discrete neurological groups, namely Parkinson's disease, Multiple Sclerosis and CIPN to: (i) identify mechanisms underlying fall risk with a particular focus on cognitive-motor interactions during balance tasks; (ii) test interventions of cognitive-motor training to improve functional mobility and prevent falls.

Relationship between proprioceptive ability and function in people with stroke, Parkinson's disease and Multiple Sclerosis – A systematic review

Robertson LS [1, 2], Fisher G [1, 5], Diong J [1, 4], Butler AA [1, 3], Gandevia SC [1, 2] and Héroux ME [1, 3]

1. Neuroscience Research Australia, Randwick, Australia
2. School of Clinical Medicine, University of New South Wales, Sydney, Australia
3. School of Biomedical Sciences, University of New South Wales, Sydney, Australia
4. School of Medical Sciences, Faculty of Medicine and Health, University of Sydney, Camperdown, Australia
5. Australian Institute of Health Innovation, Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, Australia

Proprioception is commonly impaired in people with stroke, Parkinson's disease (PD) and multiple sclerosis (MS). The relationship between proprioception and function is commonly assessed to investigate aetiology of functional deficits and guide rehabilitation. We aimed to evaluate the magnitude of association between assessments of proprioceptive ability and physical function in people with stroke, PD or MS and to determine whether the type of proprioception test, the body part assessed, and sample size influence the magnitude of the association between proprioceptive ability and physical function. Medline, Embase, CINAHL, Web of Science and Scopus databases were searched from inception to July 2023 for eligible studies that reported a statistical association between proprioceptive ability and physical function in people with stroke, PD or MS. Two reviewers independently identified studies, extracted data, and assessed study quality using the Appraisal for Cross-Sectional Studies (AXIS) tool. Forty-eight studies with 318 measures of association were included in the review. The magnitude of the associations ranged from -0.31 to 0.69 (r and rho), with 94% being positive i.e., better proprioceptive abilities associated with better physical function. The type of proprioception test, the body part assessed, or the study sample size did not systematically influence the magnitude of associations.

When measures of association were discussed, 63% of studies used language which implied causality. Moreover, the evidence to inform aetiology of functional deficits and guide rehabilitation in these conditions is limited given that these are simple measures of association that do not consider possible causal paths. Future studies should investigate the aetiology of proprioception and physical function under a causal framework.

Functional neuroimaging of the effects of tDCs on balance control in Parkinson's disease: A randomized double-blind sham-controlled study.

Kerr GK [1], Qi J [1], Meinzer, M, [2], Smith S [3] and Sullivan K [4]

1. School of Exercise & Nutrition Sciences, Movement Neuroscience, Queensland University of Technology, Brisbane, Australia
2. Dept Neurology, University Medicine Greifswald, Germany
3. Institute for Social Science Research, University of Queensland, Brisbane, Australia
4. School of Psychology & Counselling, Queensland University of Technology, Brisbane, Australia

In Parkinson's disease (PD) reduced executive function is associated with increased balance and gait disturbance. Neural circuits involving dorsolateral prefrontal cortex (DLPFC) and involved in executive function are critical for control of balance and gait. This study aimed to determine the effects of transcranial direct current stimulation (tDCS) on balance and DLPFC activation.

16 people with PD (age 65.4±9.7yrs; Hoehn-Yahr 1.6±0.7; 10 males) undertook a standing balance task (force plate, 30s) on firm and foam surfaces under single and dual task (7 subtraction) conditions. For each condition, separated by 1 week, either real or sham tDCS stimulation (1mA) was applied with anode and cathode placement over left DLPFC and right supraorbital area, respectively [1]. Bilateral DLPFC alterations in concentration of oxy-(O_2Hb) and deoxy-haemoglobin (HHb) in cerebral microcirculation blood vessels were recorded pre and post stimulation using fNIRS.

For standing balance, path length (centre of pressure distance) was greater for foam vs firm surfaces and for dual vs single task conditions for both stimulation conditions ($p<.001$). Real stimulation produced greater path length than sham stimulation on the firm ($p<.001$) but not the foam surface ($p>.05$). Performance on the 7-subtraction task improved with real stimulation on both surfaces ($p<.001$). O_2Hb was increased bilaterally: 1. in the dual task relative to the single task on both firm and foam surfaces ($p<.001$); 2. under real relative to sham stimulation on the firm surface ($p=.019$).

tDCS improved performance on the cognitive task but not the balance task. DLPFC activation inferred from O_2Hb changes may indicate improved executive function from tDCS.

Reference

1. Zhou D, et al. (2015). Exp Brain Res 233:2401–2409.

Effects of a telehealth program on the risk of falling in older people with dementia

Tsen C [1], Pelicioni PHS [2, 3], Neto DB [1] and Andrade LP [1]

1. Department of Physiotherapy, Federal University of São Carlos, São Carlos, São Paulo, Brazil.
2. School of Health Sciences, University of New South Wales, Randwick, Australia
3. Neuroscience Research Australia, Randwick, Australia

Background and aim: Telehealth is an alternative to delivering physical activity for people with motor impairments. Physical activity is a well known to reduce the risk of falling in people with dementia. Due to the COVID-19 pandemic, we planned a telehealth physical activity program to reduce the risk of falling among older people with dementia.

Methods: eighty participants with mild and moderate dementia were randomized into two groups: a telehealth training group (TTG) or a control group (CG). The TTG performed systematic physical and cognitive exercises, while the CG received non-systematized guidance for 12 weeks (1). Participants were evaluated at baseline (PRE), immediately after the three-month intervention (POST) and with a 12-week follow-up (FU). Participants had their risk of falling assessed via the *"Timed up and Go"* (TUG) and the 30 Second Sit to Stand Test (30CST). Program effects were calculated through mixed linear models using repeated measures of MANOVA, and a significance level of 5% was adopted ($p \leq 0.05$).

Results: We did not observe any interactions, nor main group effects ($p>0.05$). However, we observed condition effect for 30CST ($p>0.05$) where both groups showed reduced sit-to-stand repetitions in FU when compared to POST ($p=0.035$) and PRE ($p=0.005$).

Conclusions: The physical activity program delivered via telehealth did not reduce fall risk measured by TUG and 30CST in older people with dementia. Surprisingly, both groups showed worse 30CST results, which could have happened because of the strict social isolation due to the COVID-19 pandemic, therefore leading these participants to become incidentally inactive.

Reference

1. Tsen C, Andreatto CADA, Aily JB, Pelicioni PHS, Neto DB, Mattiello SM, Gomes GAO and de Andrade LP (2023) Physiother Res Int 28, e1981.

Muscle- and sex-specific volumes of lower leg muscles in children with cerebral palsy

Yu J [1, 3], Chow VY [1, 3], Herbert RD [1, 3], **Bolsterlee B** [1, 2], and the MUGgLE study investigators

1. Neuroscience Research Australia, Sydney, Australia
2. Graduate School of Biomedical Engineering, University of New South Wales, Sydney, Australia
3. School of Biomedical Sciences, University of New South Wales, Sydney, Australia

Muscles in children with cerebral palsy (CP) are typically smaller than in typically developing children (1, 2). Previous studies in children with CP either evaluated only one muscle (1), or investigated multiple muscles on a small sample of children (2). Therefore it is largely unknown if cerebral palsy impairs growth equally across muscles.

In this study, volumes of ten lower leg muscles/muscle groups were obtained through artificial intelligence-assisted segmentation of mDixon and T1-weighted MRI scans of the lower legs of 208 typically developing (TD) children (121 boys and 87 girls, including 8 infants aged 0.14 to 0.26 and 200 children aged 5 to 15 years) and 79 children with CP (49 boys and 30 girls, age 5 to 15; 59% Gross Motor Functional Classification System (GMFCS) 1, 34% GMFCS2, 6% GMFCS3). Muscle volumes of TD boys and girls were regressed against age using quantile regression with B- spline basis functions to obtain “muscle growth charts” for typical muscle development. Muscle volumes of children with CP were expressed as percentiles from the distributions of typically developing children.

The median percentile of total lower leg muscle volume for children with CP was 5 for boys and 8 for girls. The tibialis anterior (boys: 1, girls: 3), flexor digitorum longus (boys: 4, girls: 6) and medial gastrocnemius muscles (boys: 4, girls: 11) had the lowest percentiles and the popliteus muscle the highest (boys: 24, girls: 30).

In conclusion, CP affects growth of all lower leg muscles, but some muscles appear more affected than others.

References

1. Herskind A et al. (2016) DMCN 58, 485-91.
2. Handsfield GG et al. (2016) Muscle Nerve 53, 933-4.

POSTERS (on display throughout the meeting)

PRESENTERS TO REMAIN BESIDE THEIR POSTER FOR THE DURATION OF THE POSTER SESSION

MONDAY 20 NOVEMBER 2023 1:45PM-3:15PM

P01 Impact of respiratory muscle training on sleep disordered breathing in tetraplegia: A secondary analysis of a randomised controlled trial

Boswell-Ruys CL [1, 2, 3], Lewis RHC [1, 2, 3], McBain RA [1], Gandevia SC [1, 2, 3] and Butler JE [1, 2]

1. Neuroscience Research Australia, Randwick, Sydney, Australia
2. University of New South Wales, Sydney, Sydney, Australia
3. Prince of Wales Hospital, Randwick, Sydney, Australia

Sleep disordered breathing (SDB) is prevalent in people with tetraplegia (up to 80% (1)). Studies have shown promising effects of respiratory muscle training (RMT) in people without a spinal cord injury. Our primary investigation (2) showed that RMT increased inspiratory muscle strength in people with tetraplegia. We hypothesised that six weeks of RMT also improves parameters of SBD and reduces daytime sleepiness.
Sixty-two adults with tetraplegia underwent six weeks of supervised RMT. The active group trained the respiratory muscles through progressive threshold loading whereas the sham group experienced the same training protocol but their device had a fixed load at 3.6cmH2O. Measures of SDB were obtained before and after six weeks of intervention using full overnight polysomnography and daytime sleepiness using the Epworth Sleepiness Score (ESS).

Forty-eight participants completed two polysomnography assessments. Maximal inspiratory pressure (primary outcome) increased more after active intervention than sham, between-group difference 11.8cmH2O (95%CI, 5.2 to 18.4, p=0.001). No between group differences were found for any SDB prarameter (p=0.173 to p=0.935; i.e. apnoe-hypopnea index baseline to 6 week scores: active 46±21 (mean±SD) to 45±22; sham 44±25 to 40±25; p=0.553), nor was there significant difference between groups on the ESS (baseline to 6 week scores: active 9.4±5.7 to 9.2±6.7; sham 10.4±5.9 to 10.1±5.7; p=0.995).
Despite significant increases in inspiratory muscle strength, no changes in SDB or daytime sleepiness were observed in this study. Six weeks of RMT at the intensity of 50% maximal inspiratory pressure may not be effective at reducing the severe SDB in this sample of people with tetraplegia.

References

1. Graco M, McDonald L, Green SE et al. Spinal Cord 59, 474–84 (2021).
2. Boswell-Ruys CL, Lewis CRH, Wijeysuriya NS et al. Thorax 75, 279-88 (2020).

P02 The suitability of the Hypoxico Hyp123 Altitude Generator as a low oxygen delivery method for therapeutic acute intermittent hypoxia research trials

Sheers NL [1, 2], Clohessy T [2, 3] and Berlowitz DJ [1, 2, 3]

1. School of Health Sciences, The University of Melbourne, Victoria, Australia
2. Institute for Breathing and Sleep, Heidelberg, Victoria, Australia
3. Department of Physiotherapy, Austin Health, Heidelberg, Victoria, Australia

Introduction: Therapeutic acute intermittent hypoxia (tAIH) is a novel treatment which may stimulate hypoxia-induced neuroplasticity, strengthen motor neuron output and improve motor function in people with spinal cord injury (SCI) (1). Commercially available "altitude generators" have been used to deliver the short periods of low oxygen ($\%O_2$) air needed, but $\%O_2$ and flow rates have not been thoroughly tested. Study aims were to test the suitability of an altitude generator for a tAIH clinical trial, specifically the step-change response time, $\%O_2$ variability and flow characteristics.

Methods: Bench-tests using a Hyp123 Altitude Generator (Hypoxico Altitude Training Systems), sampling air output using a pneumotachograph (Model 3700A, Hans Rudolph) and digital optical oxygen sensor (FDO2, PyroScience). Five trials of switching between room air ($21\%O_2$) and $9\%O_2$ were conducted, and the T_{90} response time calculated. The $\%O_2$ and airflow variability (coefficient of variation (CV)) were calculated once at steady-state $9\%O_2$ over a five-minute period.

Results: The altitude generator's mean response time (T_{90}) was 81.7±3.8 seconds. Minimal variability (CV=0.01) was observed at steady-state $9\%O_2$ target ($9.0\pm0.1\%O_2$ [range 8.2 – 9.3%]). A sinusoidal airflow wave was generated at $9\%O_2$ (2.5 second period) with trough and peak flow rates of 2.0 to 70.9 L/min (mean 34.9±17.8 L/min).

Conclusion: The altitude generator generated low $\%O_2$ air with minimal variability, however flow was not constant. Commercially available altitude generators may not be suitable for generating low $\%O_2$ air required for tAIH research and translation to clinical environments. Alternative systems for delivering tAIH should be investigated.

Reference

1. Gonzalez-Rothi EJ, Lee K, Dale EA, Reier PJ, Mitchell GS, Fuller DD (2015) J App Physiol 119, 1455-1465.

P03 The effect of acute intermittent poikilocapnic hypoxia (AIH) and acute intermittent normoxic hypercapnia (AIC) on voluntary activation of the adductor pollicis in humans

Mathew AJ [1, 2], Finn HT [1, 2], Prajnadewie C [1, 2], Gandevia SC [1, 2] and Butler JE [1, 2]

1. Neuroscience Research Australia, Sydney, NSW 2031, Australia
2. University of New South Wales, Sydney, NSW 2052, Australia

The effectiveness of AIH is variable, but combining it with hypercapnia can improve motor outcome[1]. This study examined the impact of acute intermittent poikilocapnic hypoxia (AIH) and acute intermittent normoxic hypercapnia (AIC) on muscle strength and voluntary activation in humans. Thirteen participants (5 males) received three 30-minute interventions: AIH (15 cycles of 0.09 FiO_2 and 0.21 FiO_2), AIC (15 cycles of 0.05-0.07 $FiCO_2$ and 0.21 FiO_2), and SHAM (30 minutes of 0.21 FiO_2), in a randomized crossover design. Adductor pollicis maximal voluntary contraction (MVC), voluntary activation (VA), and resting twitch (RT) were measured at baseline, every 4 minutes after intervention. Results are expressed as mean±SD. MVC decreased over time after all interventions (AIH: -11.3±18.2%, p=0.008; AIC: -5.6±10.4%, p=0.008; SHAM: -12.6±14.2%), with no difference between AIH and SHAM (p=0.212), but a smaller reduction in force after AIC than SHAM (p=0.007). VA after the interventions did not differ from SHAM (AIH: p=0.683, AIC: p=0.164). RT decreased with time after all interventions (AIH: -11.1±16.8%, p<0.001; AIC: -14.7±12.7%, p<0.001; SHAM: -10.1±16.4%), with no significant difference between AIH and SHAM (p=0.55), but a greater reduction after AIC than SHAM (p=0.025). While there were no changes in MVC, VA, and RT after AIH compared to SHAM, MVC was reduced less after AIC, despite a larger reduction in RT. These conflicting findings suggest that AIC may affect peripheral muscle differently for low frequency vs high frequency muscle activation during fatigue.

Reference

1. Welch JF, Nair J, Argento PJ, Mitchell GS, Fox EJ. Acute intermittent hypercapnic-hypoxia elicits central neural respiratory motor plasticity in humans. *Journal of Physiology* n/a, 2022. doi: 10.1113/JP282822.

P04 Body composition and reactive stepping impairment in older people

Okubo Y* [1, 2], Le C* [1, 2], Phu S [1, 2], Birzniece V [2], Lord SR [1, 2] and Sturnieks DL [1, 2]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. Faculty of Medicine and Health, University of New South Wales, Sydney, Australia

*Dual first authors

Background: Reactive stepping impairment and obesity are significant fall risk factors among older (1, 2) but their association has not been investigated. Therefore, we tested our hypothesis that body composition is related to reactive stepping performance in older people.

Methods: This experimental study involved 79 community-dwelling older people (65+ years) without neurological conditions. Bioelectrical impedance analysis (ImpediMed Imp SFB7) was used to estimate fat mass (FM), lean mass, appendicular lean mass (ALM) and ALM-FM ratio. Other measures including fall history, physical (muscle strength, proprioception, postural sway, reaction time, gait speed) and psychological (anxiety, global cognition) profiles were also assessed. Reactive stepping was assessed by exposing harnessed participants to an unpredictable trip and slip while walking at their usual pace. Harness loading relative to the body weight (%) was used as a measure of reactive stepping performance.

Results: FM, lean mass, ALM, ALM-FM ratio and fall history were correlated to slip harness loading (P <0.05). Gait speed was the only variable associated with trip harness loading (r = .350, P <0.01). However, when controlling for gait speed, trip harness loading was associated with lower limb proprioception (r = .238, P <0.05) and postural sway (r = .252, P <0.05).

Conclusions: Body composition profiles such as greater fat mass and lower appendicular lean mass may contribute to impaired reactive stepping following unexpected slips in older people. Poor lower limb proprioception and postural balance may impair reactive stepping following unexpected trips in daily life.

References

1. Okubo Y et al. (2021) Ageing Research Reviews 66, 1-10.
2. Neri SG et al. (2020) J Gerontol A Biol Sci Med Sci 75, 952-960.

P05 Physiological validity of treadmill belt accelerations in simulating a walkway trip in older people

Phu S [1, 2], Sturnieks DL [1, 3], Song PYH [1, 2], Lord SR [1, 2] and Okubo Y [1, 2]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. Faculty of Medicine and Health, University of New South Wales, Sydney, Australia

Background: Perturbations delivered on a treadmill are commonly used as a substitute for real-life trips on a walkway but its physiological validity is unknown. This study tested the hypotheses that perturbations delivered on a treadmill and trips on a walkway induce distinct muscle activation patterns.

Methods: This study recruited 38 healthy older people (65+ years) who wore a full-body safety harness and were exposed to both a treadmill belt acceleration and a trip on a walkway. Muscular responses were measured using 8-channel surface electromyography (1000Hz), bilaterally on the rectus femoris (RF), tibialis anterior (TA), semitendinosus (ST) and gastrocnemius medial head (GM). Pre-trip muscle activity, and post-trip onset latency, peak magnitude, time to peak and co-contraction index (CCI) were measured.

Results: Compared to the treadmill belt acceleration, the walkway trip displayed faster onset latencies for all muscles, greater peak magnitude in the left RF, TA and GM, and faster time to peak in the right RF and GM ($P<0.05$). Lower CCI in both the knee and ankle were also observed during the walkway trip compared to the treadmill belt acceleration ($P<0.05$).

Conclusions: Distinct muscle activation patterns were evident including faster and larger muscular responses during a walkway trip. Treadmill belt accelerations may not provide sufficient physiological challenge to improve reactive balance in older people.

P06 Voluntary activation of the respiratory muscles determined by spinal root magnetic stimulation during graded respiratory efforts

Prajnadewie C [1, 2], Luu BL [1], Mathew AJ [1, 2], Finn HT [1, 2], Gandevia SC [1, 3], Hudson AL [1, 2, 4] and Butler JE [1, 2]

1. Spinal Cord Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. Faculty of Medicine and Health, School of Biomedical Sciences, University of New South Wales, Sydney, Australia
3. Faculty of Medicine and Health, Prince of Wales Clinical School, University of New South Wales, Sydney, Australia
4. Flinders Health and Medical Research Institute, Flinders University, Adelaide, Australia

Introduction: Magnetic stimulation activates the diaphragm via stimulation of the phrenic nerve roots (1) and can be used to assess voluntary activation (VA) during inspiratory efforts via twitch interpolation (2), however its reliability is unknown. Furthermore, no known studies have measured VA of the expiratory muscles. We evaluated spinal root magnetic stimulation as a method to assess VA of the respiratory muscles in humans.

Methods: In 11 healthy participants (4 female, age 18-40 years), magnetic stimulation was delivered over the cervical (C3-C5) and lower thoracic (T10-T11) spine to activate diaphragm (n=9) and abdominal (n=11) muscles, respectively. A nasogastric catheter recorded trans-diaphragmatic and gastric pressures. During voluntary inspiratory and expiratory efforts at 100%, 75%, 50% and 25% maximal efforts, stimuli were delivered (100% stimulator output) to produce a superimposed twitch and, ~5 seconds later, a resting twitch, from which VA was calculated.

Results: Supramaximal stimulation was achieved in 5/20 participant conditions. During inspiratory efforts, the average VA was 92(9)%, 82(18)%, 62(27)% and 33(29)% mean(SD) for 100%, 75%, 50% and 25% maximal inspiratory efforts, respectively. During expiratory efforts, for methodological reasons, an estimated resting twitch was calculated. Expiratory VA was about half of the expected value, with averages of 53(21)%, 34(20)%, 25(18)% and 8(13)% for 100%, 75%, 50% and 25% maximal expiratory efforts, respectively.

Conclusions: Spinal root magnetic stimulation can measure respiratory muscle activation non-invasively. However, there are limitations that must be considered including its inability to evoke maximal resting twitches and the need to estimate resting twitches to calculate expiratory VA.

References

1. Man W, Moxham J, Polkey M (2004). Respir J 24, 846–60.
2. Bellemare F, Bigland-Ritchie B (1984). Respir Physiol 58, 263–77.

P07 Can transcutaneous spinal cord stimulation “boost” contractions produced by functional electrical stimulation?

Collins DF [1], McConnell JC [1], Leverett JA and Wolsey MW [1]

1. Faculty of Kinesiology, Sport, and Recreation, University of Alberta, Edmonton, Canada.

This work was designed to determine whether transcutaneous spinal cord stimulation (tSCS) and functional electrical stimulation (FES) delivered together produces larger contractions than FES alone. tSCS over the spinal cord augments voluntary contractions for people with spinal cord injury by modulating neural circuits. FES produces contractions by depolarising motor axons, however, reflex pathways can also contribute. We hypothesised that tSCS would increase the amplitude of H-reflexes during FES and, in this way, increase or “boost” the amplitude of electrically-evoked contractions. Eight individuals with no history of neuromuscular injury or disease were seated in a Biodex dynamometer to record plantarflexion torque. FES was delivered at 20Hz over the tibial nerve to produce sets of 5 contractions (7s “on” 10s “off”) while M-waves and H-reflexes were recorded from the triceps surae and tibialis anterior. FES was delivered alone and during 3 intensities of tSCS which were set relative to dorsal root reflex threshold found using 1 ms biphasic pulses. During FES, tSCS was delivered at either 0.7x, 1.0x or 1.3x this threshold using pulses with a 9.8 kHz carrier frequency. tSCS had no significant effect on H-reflexes or contraction amplitude at any intensity. These data suggest that delivering tSCS may not effectively boost contractions produced by FES. Alternatively, the high carrier frequency tSCS pulses may not have adequately recruited the target axons in the dorsal roots. Next steps are to try higher intensity tSCS and deliver tSCS using pulses with no carrier frequency.

P08 Transcutaneous spinal cord stimulation of the cervical spine: Waveform frequency, muscle recruitment, anode location and tolerability

Trinh T [1, 2], Héroux ME [1, 2], Palermo AE [1, 2], Gandevia SC [1], Butler JE [1] and Finn HT [1, 2]

1. Neuroscience Research Australia, Sydney, Australia
2. School of Medicine and Health, University of New South Wales, Sydney, Australia

Introduction: Cervical spinal cord stimulation has been used to improve motor (1) and autonomic function in people with cervical spinal cord injury (SCI). Various electrode configurations have been used to target upper-limb muscles(2), without consideration on the effect it may have on evoked responses. This study measured spinally-evoked muscle reflexes (sEMR) in the upper-limb using transcutaneous spinal cord stimulation, to assess differences in reflex responses and tolerance across two stimulus- waveform frequencies and two anode positions.

Methods: A cathode was placed longitudinally over the cervical spine, and bilateral anodes were placed over acromion processes or iliac crests in 16 participants without SCI (36.1±7.8 years). Single biphasic square pulses (either conventional (400-µs pulse width) or with a high-frequency burst (10 kHz)) were delivered until sEMRs were evoked in proximal and distal upper-limb muscles. Stimulation tolerance for each pulse type was assessed during continuous trains of stimulation (30 Hz) while participants rated discomfort on a visual analogue scale.

Results: Conditions with the anode over the acromion, upper-limb sEMR were present at 25±8 mA with conventional stimulation and 115±25 mA with high-frequency stimulation. Stimulation intensities required to evoke sEMR were higher in iliac crest anode conditions (31±8 mA (conventional, $p<0.05$), 132±26 mA (high frequency, $p<0.05$). Tolerance was higher for acromion-anode than iliac spine conditions at 1.96±0.55 vs 1.64±0.47, respectively, (conventional, $p<0.05$) and 1.55±0.36 vs 1.34±0.28, respectively, (high frequency, $p<0.05$) times the sEMR stimulation intensity.

Conclusion: Anode placement over the acromion and conventional stimulation produced sEMR with lower stimulating intensities and greater stimulation tolerance.

References

1. Inanici F, Brighton LN, Samejima S, Hofstetter CP and Moritz CT. Transcutaneous Spinal Cord Stimulation Restores Hand and Arm Function After Spinal Cord Injury. IEEE Trans Neural Syst Rehabil Eng. 2021;29:310–9.
2. de Freitas RM, Sasaki A, Sayenko DG, Masugi Y, Nomura T, Nakazawa K, et al. Selectivity and excitability of upper-limb muscle activation during cervical transcutaneous spinal cord stimulation in humans. Journal of Applied Physiology. 2021 Aug 1;131(2):746–59.

P09 Perspectives on barriers to use and benefits of functional electrical stimulation from Australians and New Zealanders with SCI and clinicians and researchers in the field

Palermo AE [1, 2], Gorgon E [1, 3], Vecchio A [4], McCaughey E [1, 5], Tedesco-Triccas L [6, 7] and Donovan-Hall M [8]

1. Neuroscience Research Australia, Sydney, Australia
2. University of New South Wales, Sydney, Australia
3. Department of Physical Therapy, University of the Philippines Manila, Philippines
4. Spinal Research Institute, Australia
5. Queen Elizabeth National Spinal Injuries Unit, Scotland
6. Department for Clinical and Movement Neurosciences, UCL Queen Square Institute of Neurology, 33 Queen Square, London, WC1N 3BG, United Kingdom
7. REVAL Rehabilitation Research Center, Faculty of Rehabilitation Sciences, Hasselt University, Diepenbeek, Belgium
8. School of Health Sciences, Faculty of Environmental and Life Sciences, University of Southampton, UK.

Functional Electrical Stimulation (FES) is an intervention used in the rehabilitation of people with lived experience of spinal cord injury (SCI) (1). The goal of this study was to document perceptions of FES from people with SCI, carers, clinicians, and researchers (CCR). Online questionnaires were completed from 1/12/2021 to 31/8/2022. Subgroups included people with SCI who have used FES, people with SCI who have not used FES, CCRs who have used FES, and CCRs who have not used FES. Frequencies and percentages of subgroup data were calculated for all questions. Open-ended responses were analyzed with inductive content analysis.

Ninety-nine responses (70:people with SCI, 29:CCR) were analyzed. Seventy-four respondents used FES (47:people with SCI, 27:CCR) while 25 had not (23:people with SCI, 2:CCR). Muscle strength was the most frequently reported benefit by people with SCI and CCR. Lack of training was the most frequently reported barrier to FES use by people with SCI (85%) and CCRs (94%) who had used FES. People with SCI who had not used FES reported access as a barrier (95%). The priorities for future research include: improved ease of use for people with SCI (60%:people with SCI) and clinical guidelines (48%: CCR). Qualitative findings supported the quantitative findings. Results of the survey identified access as a barrier to FES and echoed benefits (strength) and barriers (training) reported in a survey conducted in the United Kingdom. Ameliorating the barriers and investigating the areas of future research identified in this study will ultimately improve FES uptake in SCI rehabilitation.

References

1. Luo S, Xu H, Zuo Y, Liu X, All AH. A Review of Functional Electrical Stimulation Treatment in Spinal Cord Injury. Neuromolecular Med. 2020;22(4):447-63.
2. Tedesco Triccas L, Donovan-Hall M, Dibb B, and Burridge JH. A nation-wide survey exploring the views of current and future use of functional electrical stimulation in spinal cord injury. Disabil Rehabil Assist Technol. 2021:1-11.

P10 Longitudinal changes in motor neurone maximal firing frequencies with Amyotrophic Lateral Sclerosis (ALS) disease progression

Orssatto LBR [1], Henderson RD [2], McCombe PA [2], Rivlin W [2] and Trajano GS [3]

1. Institute for Physical Activity and Nutrition (IPAN), School of Exercise and Nutrition Sciences, Faculty of Health, Deakin University, Geelong, Australia
2. Department of Neurology, Royal Brisbane & Women's Hospital, Brisbane, Australia
3. School of Exercise and Nutrition Sciences, Faculty of Health, Queensland University of Technology (QUT), Brisbane, Australia

Longitudinal reductions in maximal firing frequencies have been shown in mouse ALS models (1); however, it is unclear whether this behaviour is also observed in humans. Technological advancements have allowed non-invasive assessment of motor neurone firing frequencies in humans during voluntary contractions using surface high-density electromyography recordings. We investigated if high-density electromyogram decomposition could be used to identify longitudinal changes in motor neurone maximal firing frequencies of symptomatic and non-symptomatic limbs of 43 ALS individuals. Participants were assessed twice ~17 weeks apart. Tibialis anterior maximal force and high-density electromyograms were recorded, using a hand-held dynamometer and a 64-channel electrode matrix, respectively. Participants were asked to perform two 5-s maximal dorsiflexion contractions. Thereafter, muscle strength test was assessed using Medical Research Council's scale (MRC scale) to classify the tested limb as symptomatic (score<5 in at least one visit) and pre-symptomatic (score=5 in both visit). Symptomatic limb was weaker than pre-symptomatic limb [-62.9 (95%CI 38.0, 87.7) N; p<0.001], but no significant changes were observed over time (p=0.695). Maximal firing frequencies reduced from 31.0 to 29.3 pps on the symptomatic limb [-1.66 (95%CI -2.65, -0.67) pps; p=0.001] and remained unchanged from 29.1 to 29.6 pps on the pre-symptomatic limbs [0.56 (95%CI -1.26, 2.38) pps; p=0.545]. This study confirms the maximal firing frequency of motor neurones are reduced in the symptomatic limb of humans with ALS, as observed in mouse model [1]. Motor neurone maximal firing frequencies could be explored as a potential biomarker of disease progression in ALS.

Reference

1. Hadzipasic M, Ni W, Nagy M, et al. Reduced high-frequency motor neuron firing, EMG fractionation, and gait variability in awake walking ALS mice. *Proc Natl Acad Sci U S A.* 2016;113(47):E7600-E7609. doi:10.1073/pnas.1616832113.

P11 Motor unit tracking using blind source separation filters and waveform cross- correlations: Reliability under physiological and pharmacological conditions

Goodlich BI [1], Del Vecchio A [2] and Kavanagh J [1]

1. Menzies Health Institute Queensland, Griffith University, Gold Coast, Australia
2. Department Artificial Intelligence in Biomedical Engineering, Friedrich-Alexander University (FAU), Erlangen-Nuremberg, Erlangen, Germany

Recent developments in the analysis of high-density surface electromyograms (HDsEMG) have unlocked the potential to reveal the recruitment and discharge characteristics of large populations of motor units (MUs). However, the reliability of MU tracking across similar muscle contractions is unknown. This study aimed to evaluate the reliability of MU tracking using two common methods: blind source separation filters within session, and two-dimensional waveform cross- correlation between sessions. HDsEMG signals were recorded from tibialis anterior during isometric dorsiflexions to 10%, 30%, 50% and 70% of maximal voluntary contraction (MVC). MUs were matched within a 2 hr testing session and between sessions spaced 7 days apart. Both tracking methods demonstrated similar reliability during physiological conditions (e.g., MU discharge: filter ICC 10% of MVC = 0.76 and 70% of MVC = 0.86; waveform ICC: 10% of MVC = 0.78 and 70% of MVC = 0.91). To further explore the robustness of each method, we repeated the experiment using a drug intervention that is known to modify discharge rate of MUs (8 mg cyproheptadine). Although reliability slightly reduced for the pharmacology condition, there were no discernible differences in tracking performance (e.g., MU discharge: filter ICC: 10% of MVC = 0.73 and 70% of MVC = 0.75; waveform ICC: 10% of MVC = 0.84 and 70% of MVC = 0.85). This study confirms that the selection of tracking method may not impact the interpretation of MU data under conditions when MU activity might be expected to change with an intervention.

P12 Paraspinal muscle volume and intramuscular fat asymmetry in Adolescent idiopathic Scoliosis

Duncombe P [1], Dick TJM [1], Ng PTT [1,2], Izatt MT [3,4,6], Pivonka P [5], Labrom RD [3,4,6] and Tucker K [1]

1. School of Biomedical Sciences, The University of Queensland, Australia.
2. KK Women's and Children's Hospital, Singapore
3. Biomechanics and Spine Research Group, QUT at Centre for Children's Health Research
4. Queensland Children's Hospital, Australia
5. ARC Training Centre for Joint Biomechanics, Queensland University of Technology (QUT), Australia
6. School of Mechanical, Medical and Process Engineering, Queensland University of Technology, Australia

Adolescent idiopathic scoliosis (AIS) is characterized by an atypical 3D spinal curvature that develops/progresses between 10-18 years of age. Asymmetry in paraspinal muscle size and quality influences force-generation capacity and may contribute to asymmetrical vertebral growth (1). We aimed to quantify paraspinal muscle volume and intramuscular fat asymmetry in female adolescents with AIS and age-matched controls.

Methods: T1-weighted and mDixon MRI scans were performed on 19 female adolescents with *primary-right-convex* thoracic scoliosis [Cobb angle: 38±16°; age: 13.7±1.5 years]; and 13 controls [age: 13.6±1.9 years]. Partial muscle volumes (multifidus, spinalis, longissimus and iliocostalis) were determined at the apical vertebral level/controls matched vertebral level. To determine intramuscular fat proportions, fat-fraction maps from mDixon scans were co-registered with muscle volumes. Muscle volume and intramuscular fat asymmetry indices [ln(concave/convex)] were determined (2).

Results/Conclusion: The multifidus volume at the curve apex was 24±17% greater on the concave than the convex-side in the AIS group ($p<0.05$) which was significantly larger ($p<0.05$) than the asymmetry observed in the control group (-1±13%). Multifidus and longissimus intramuscular fat were greater on the concave-side than the convex-side in AIS, 37±19% and 45±39%, respectively, and were significantly larger ($p<0.01$) than that observed in the control group (-5±18% and -14±21%, respectively). When taken together, there was no between group difference in fat-free muscle volume asymmetry for any muscle (all $p>0.05$). Multifidus volume, and multifidus and longissimus intramuscular fat asymmetry were greater in those with AIS than adolescents with symmetrical spines, however, how these asymmetries influence paraspinal muscle force-generating capacity requires further interrogation.

References

1. Stokes IAF. et al. (1996) Spine 21, 1161-1167.
2. Cole, T. J. et al. (2017) Statistics in Medicine 19**,** 3109- 3125.

P13 The interaction between metaplastic neuromodulation and neuromuscular fatigue

Boda MR [1], Otieno LA [2], Goldsworthy MR [1, 3, 4], Smith AE [5] and Sidhu SK [1]

1. School of Biomedicine, University of Adelaide, South Australia, Australia
2. Health Policy Centre, South Australian Health and Medical Research Institute (SAHMRI), Adelaide, Australia
3. Behaviour-Brain-Body Research Centre, Justice and Society, University of South Australia, Adelaide, Australia
4. Hopwood Centre for Neurobiology, Lifelong Health Theme, South Australian Health and Medical Research Institute (SAHMRI), Adelaide, Australia
5. Alliance for Research in Exercise, Nutrition and Activity (ARENA), University of South Australia, Adelaide, Australia

Neuromuscular fatigue causes decrements in quality of life and disability. Priming the corticospinal system for induction of long-term potentiation-like plasticity before a fatiguing task may reduce fatigue. This study aimed to examine whether cathodal transcranial direct current stimulation (ctDCS) prior to exercise combined with anodal transcranial direct current stimulation (atDCS) could reduce fatigue and enhance corticospinal excitability (CSE). 15 young healthy adults (9 females; 26 ± 3.5 years) participated in four pseudo-randomised neuromodulation sessions: sham stimulation prior and during exercise (stDCS-stDCS), stDCS prior and atDCS during exercise (stDCS-atDCS), ctDCS prior and atDCS during exercise (ctDCS-atDCS), ctDCS prior and stDCS during exercise (ctDCS-stDCS). The exercise involved a 10-minute intermittent maximum voluntary contraction (MVC) of the first dorsal interosseous muscle. MVC force provided assessment of fatigue while motor evoked potential (MEP) amplitude allowed for measure of CSE. The study revealed that over time, MVC force declined in all neuromodulation conditions ($P < 0.01$). Conversely, MEP amplitude increased during the fatiguing contractions ($P < 0.01$). However, there were no differences in MVC force or MEP amplitude between the neuromodulation conditions ($P > 0.38$). An increase in MEP amplitude indicates an increase in CSE during fatiguing exercise. As ctDCS-atDCS had no significant effect in enhancing CSE or reducing fatigue during exercise, the prospect of harnessing metaplasticity to ameliorate neuromuscular fatigue in young healthy individuals remains unclear. Nevertheless, the present study provides some direction on whether transcranial direct current stimulation has the potential for enhancing performance and reducing fatigue in both health and disease.

P14 Impact of muscle weakness and joint contracture in lower limb on walking impairments in people with Multiple Sclerosis

Hoang P [1, 4], Menant JM [1, 2], Khatiravan T [1], Lord SR [1, 2] and Sturnieks DL [1, 3]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. School of Population Health, Faculty of Medicine and Health, University of New South Wales, Sydney, Australia.
3. School of Biomedical Sciences, Faculty of Medicine and Health, University of New South Wales, Sydney, Australia.
4. MS Plus

Background and aim: There are limited data linking weakness in specific lower limb muscle groups and walking impairment in people with multiple sclerosis (MS). Our study aims to establish the impact of lower limb muscle weakness on gait characteristics in people with MS, to ultimately inform the design of interventions to improve mobility.

Methods: Our sample so far comprises 49 people with MS (27 women, mean (SD) age: 49.7 (10.5) years) and 33 healthy controls (17 women, mean (SD) age: 38.1 (11) years). Strength is measured in the hip and knee flexors and extensors, hip abductors and adductors and ankle plantar- and dorsi-flexors. Lower limb kinematics during walking at self-selected speed are recorded with a motion capture system.

Results: Preliminary findings show that compared with healthy controls and after controlling for age, participants with MS display weakness in all lower limb muscle groups, except for knee flexors and extensors. People with MS have slower speed, display reduced range of motion at the hip, knee and ankle joints during walking, as well as a decrease in hip extension during stance and decrease knee flexion during swing. A multiple linear regression model show that knee joint range of motion, presence of an ankle joint contracture and hip extensor strength are significant and independent predictors of usual walking speed in our sample of people with MS.

Conclusions: Our findings will contribute to inform best practice guidance on training programs to improve walking and mobility in people with MS.

Reference

1. Coca-Tapia M, Cuesta-Gomez A, Molina-Rueda F and Carratala-Tejada, M (2021) Diagnostics 11, 584.

P15 Tools to provide useful assessment of upper limb function are useful both in studies of healthy individuals and those with different motor impairments

Butler AA [1, 2], Ingram L [1, 3], Lord SR [1, 2] and Gandevia SC [1, 2]

1. Neuroscience Research Australia, Sydney, Australia
2. University of New South Wales, Sydney, Australia
3. University of South Australia, Adelaide, Australia

Motor impairments are a large cause of disability and become more common with aging – affecting 37% of those over 55 (1). From a suite of tests applied to 367 healthy adults across the life span (2) we propose a subset of 6 tests for a core upper limb physiological profile assessment (upper limb PPA). Data were also obtained from people with stroke, Parkinson's disease and multiple sclerosis. We settled on 6 core upper limb tests: hand grip strength, finger press reaction time, nine hole peg test, hand tactile sensitivity, bi-manual pole test, and shirt wearing test. They cover a number of functionally important physiological domains. All selected tests are simple, quick and feasible to use in patients. Testing can be completed in ~20 minutes and requires minimal training. All tests give continuous, precise and reproducible outcomes. All data are available in this review (3). Individual Z-scores are used to identify specific physiological deficits and provide a profile that should assist in rehabilitation and treatment decisions related to sensory and motor impairments.

References

1. Herbert RD, Taylor JL, Lord SR, Gandevia SC (2020) BMC Public Health, 20: 1353.
2. Ingram L, Butler AA, Walsh LD, Brodie MA, Lord SR, Gandevia SC (2019) PlosOne.
3. Ingram L, Butler AA, Lord SR, Gandevia SC (2023) Journal of Physiology, 601:2251-2262.

P16 Glial activation in sensory and motor regions of the cortex is related to sensorimotor function in individuals with low back pain maintained by nociplastic mechanisms

Hodges PW [1], Shraim MA [1], Massé-Alarie H [1, 2], Farrell MJ [3], Cavaleri R [4] and Loggia ML [5]

1. School Health & Rehabilitation Sciences, University of Queensland, Brisbane, Australia
2. Centre interdisciplinaire de recherche en réadaptation et integration sociale (CIRRIS), Uni. Laval, Québec, Canada
3. Monash Biomedical Imaging, Monash University, Melbourne, Australia
4. Brain Stimulation & Rehabilitation Lab, Western Sydney University, Sydney, Australia
5. MGH/MIT/HMS Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Harvard Medical School, Charlestown, USA

Chronic pain involves communication between neural and immune systems. Recent data suggest glial activation in sensorimotor brain regions (S1/M1) in chronic low back pain (LBP) (1). As glia perform diverse functions that impact neural function, activation might contribute to sensorimotor changes, particularly in LBP maintained by increased nervous system sensitivity (nociplastic pain). We aimed to: (i) compare glial activation in S1/M1 between individuals with and without LBP (nociceptive and nociplastic LBP), and (ii) evaluate relationships between glial activation and sensorimotor function. Simultaneous PET-fMRI measured glial activation in functionally defined S1/M1 in pain-free individuals and individuals with chronic LBP (nociceptive, nociplastic). Somatotopic regions of M1 and S1 related to the low back, leg and arm were identified using fMRI during motor tasks and thermal stimuli. Sensorimotor measures included single/paired-pulse transcranial magnetic stimulation (TMS) and quantitative sensory testing (QST). Sleep, depression, disability, and pain questionnaires were administered. Glial activation was greater in the lower back cortical representation of S1/M1 for individuals with nociplastic LBP than both nociceptive LBP and painfree groups. S1/M1 glial activation was negatively correlated with intra-cortical facilitation (r=-0.41), positively correlated with sensitivity to hot (r=0.52) and cold (r=0.55) pain, and positively correlated with poor sleep, depression, functional disability, and BMI. This study provides evidence for neuroinflammation in S1/M1 that is greater in nociplastic pain. Although causality cannot be confirmed, data provide foundation to speculate on possible involvement of neuroinflammation in back regions of S1/M1 in sensory and motor features of individuals with nociplastic LBP.

Reference

1. Loggia ML,et al. Brain 2015;138(Pt 3):604-615.