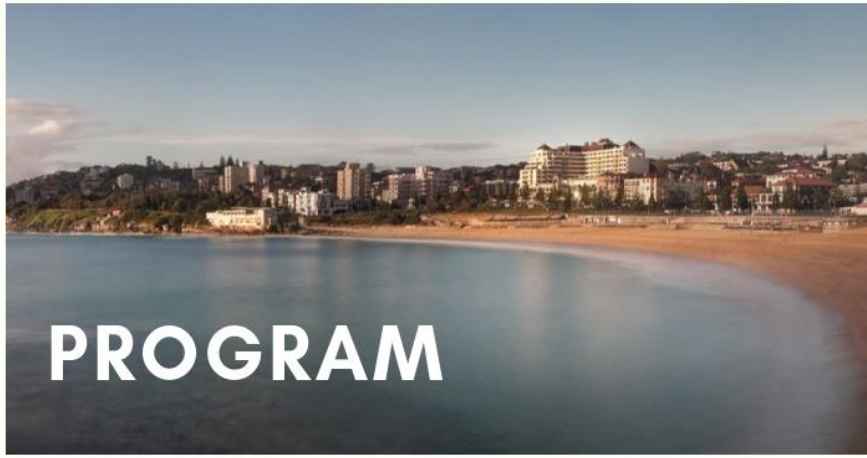
26-28 NOVEMBER 2018
COOGEE, SYDNEY AUSTRALIA

FIRST INTERNATIONAL MOTOR IMPAIRMENT CONFERENCE



PROGRAM

IN BRIEF:

Monday 26 Nov
- 8.00am registration opens
- 8:45am-10.45am - Session 1
- 11.15am-12.45pm - Session 2
- 1.30pm-3.00pm - Session 3 Posters
- 3.30pm-5.00pm - Session 4
- 5.00pm-7.00pm - Welcome drinks

Tuesday 27 Nov
- 9.00am-10.45am - Session 1
- 11.15am - 12.45pm - Session 2
- 12.45pm - 6.30pm - Free time
- 6.30pm Conference Dinner

Wednesday 28 Nov
- 9.00am - 10.30am - Session 1
- 11.00am - 12.30pm - Session 2
- 1.30pm - 2:42pm - Session 3
- 3.15pm - 5pm - Session 4

With thanks to our **Gold** Sponsors:

NeuRA

Discover. Conquer. Cure

Many thanks to our **Silver** Sponsor:

Dear Delegates,

Welcome to the **First International Motor Impairment Conference - Sydney 2018**.

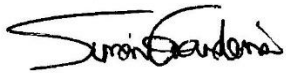
The meeting is designed to highlight the various facets of motor impairment. Motor impairment has many elements: weakness and fatigue, sensory impairments, problems with falls and balance, muscle contractures and many more. It is characterised by major deficits in the activity of daily life and it is a progressive accompaniment to aging. The stimulus to study, develop, and promote the topic of motor impairment came from an NHMRC Program grant awarded to Stephen Lord, Rob Herbert, Janet Taylor and me.

Over the three days we will have 9 sessions of oral presentations, including one devoted to presentations by Young Investigators. There are more than 30 posters which will be up throughout the meeting and available at multiple times for discussion. A wide range of topics associated with aspects of motor impairment will be covered, all the way from a fundamental to an effective clinical translation.

To host the meeting we have been helped by underwriting by NeuRA (Neuroscience Research Australia) as well as the NSW Government, KHINN (Knowledge Health Innovation), CED (Cambridge Electronic Design Limited), Symbiotic Devices and the Journal of Physiology. We are grateful to all sponsors for their financial and other contributions. The most recent help from the Journal of Physiology is especially welcome.

We hope you enjoy your stay at Coogee in Sydney and enjoy the local environment (try a walk along the ocean front either north or south). Hopefully, dinner at the Museum of Contemporary Art overlooking the harbour will be a social highlight.

Sincerely,



Simon Gandevia
(on behalf of the organising group Stephen Lord, Janet Taylor, Rob Herbert)

We are grateful for local help from the following:
Andrew Cartright and assistance from Annie Butler, Bronwyn Chapman, Joanna Diong, Martin Héroux, Anna Hudson, Euan McCaughy, Jasmine Menant and Daina Sturnieks.

Many thanks also to our Scientific Committee: Jane Butler, Simon Gandevia, Rob Herbert, Stephen Lord and Janet Taylor.

DAY 1: MONDAY 26 NOVEMBER 2018

0800	REGISTRATION & COFFEE		
	SESSION 1 – MUSCLE 8:45am – 10:45am Chairs: Simon Gandevia & John Rothwell		**SESSION 2 - RESPIRATION** 11:15am – 12:45pm Chairs: Jane Butler & Claire Boswell-Ruys
08:45	***SIMON GANDEVIA*** Opening remarks	11:15	***BILL SHEEL*** The respiratory musculature: impairments and limitations in health and disease
09:00	***ANTHONY BLAZEVICH*** Training-induced changes in muscles and their mechanics	11:45	***ANNA HUDSON*** Age-related adaptions in the neural control of the human diaphragm muscle
09:30	***JAMES WAKELING*** Prediction of performance from muscle models	12:00	***DAVID NGUYEN*** Neural drive to the diaphragm in cervical spinal cord injury
10:00	***BART BOLSTERLEE*** Regional hypertrophy in the human quadriceps following progressive resistance training	12:15	***HANNA HENSEN*** Sleep apnoea in people with multiple sclerosis
10:15	***TREVOR ALLEN*** What can isometric contractions tell us about muscle injury and rehabilitation?	12:30	***JESSICA BEAMISH*** Transient, broad field, visual input strongly modulates reactive saccade latency
10:30	***JOANNA DIONG*** Involuntary muscle activity reduces passive range of motion at known torque		
	MORNING TEA – 10:45am – 11:15am		**LUNCH** - 12:45pm – 1:30pm

DAY 1: MONDAY 26 NOVEMBER 2018

	SESSION 3 **POSTERS** 1:30pm – 3:00pm **See Separate Poster List**		**SESSION 4 - BALANCE** 3:30pm – 5:00pm Chairs: Stephen Lord & Daina Sturnieks
		3:30	***BRIAN DAY*** Am I the right way up? Disturbances of spatial orientation in variants of Alzheimer's disease
	Poster presenters are to remain beside their poster for the duration of the formal poster session.	4:00	***ELEFTHERIA GIANNOULI*** A novel group-based stepping exercise program to improve fall risk factors in older adults: first results of a pilot study
		4:15	***MIRJAM PIJNAPPELS*** Adaptive, reactive and daily life gait in older populations
		4:45	***MORAG TAYLOR*** The relationship between white matter hyperintensity clusters (size and location) and prospective falls in older adults across the cognitive spectrum
	AFTERNOON TEA – 3:00pm – 3:30pm		**END OF DAY 1** 5:00pm

Welcome Drinks Reception

Monday 26 November

5:00pm – 7:00pm

Crowne Plaza, Ocean View Terrace

DAY 2: TUESDAY 27 NOVEMBER 2018

0800	REGISTRATION & COFFEE	MORNING TEA 10:45-11:15am	
	SESSION 1 – CONTRACTURE AND MORE 9:00am-10:45am Chairs: Robert Herbert & Glen Lichtwark		**SESSION 2 – BRAIN STIMULATION & STROKE** 11:15am – 12:45pm Chairs: Janet Taylor & Irene di Giulio
09:00	***RICK LIEBER*** Mechanisms of contracture	11:15	***JOHN ROTHWELL*** Brain stimulation and treatment of motor impairments
09:30	***AMY ADKINS*** Early Evidence for a decrease in biceps optimal fascicle length based on in vivo muscle architecture in Chronic Hemiparetic stroke	11:45	***ANN-MAREE VALLENCE*** Characterizing age-related changes in supplementary motor area-primary motor cortex connectivity.
09:45	***ZEV RYMER*** Changes in muscle architecture after hemispheric stroke can adversely affect efficiency of muscle contraction in pennate muscles	12:00	***IRENE DI GIULIO*** Effect of STN-DBS frequency on postural performance in Parkinson's disease
10:00	***TAYLOR DICK*** A speed-adaptive myoelectric ankle exoskeleton to improve post-stroke walking performance	12:15	***CJ HECKMAN*** Distortions in the synaptic organization of motor commands to proximal and distal muscles following hemiparetic stroke
10:15	***PETER MALLIARAS*** People with Achilles tendinopathy display greater force fluctuations than controls at low force levels	12:30	***JULIUS DEWALD*** Increased dependence on contralesional cortico-reticulospinal pathways a form of maladaptive plasticity post hemiparetic stroke?
10:30	***MORGAN EVELEIGH*** A finite element method for integrated design and testing of 3D printed ankle and foot orthoses for children with cerebral palsy and motor impairment	12:45	***Sightseeing and enjoying Sydney followed by CONFERENCE DINNER at the Museum of Contemporary Art (6:30pm)***

DAY 3: WEDNESDAY 28 NOVEMBER 2018

0800	**REGISTRATION & COFFEE**		
	SESSION 1 – MOTOR CONTROL 9:00am – 10:30am Chairs: Martin Héroux & Graham Kerr		**SESSION 2 – STANDING & FALLS** 11:00am – 12:30pm Chairs: Kim Delbaere & Mirjam Pijnappels
9:00	***RANDY FLANAGAN*** Coming to grips with sensorimotor control	11:00	***IAN HARRIS*** Evidence-based surgery
9:30	***LEAH BENT*** Stochastic Resonance can enhance cutaneous reflex responses in the lower limb	11:30	***JOANNE KUA*** The effects of a specialized treadmill system on gait speed and gait parameters for older adults with high falls risk
9:45	***JAYNE GARLAND*** Do reactions to balance perturbations improve with Fast muscle Activation and Stepping Training (FAST) in sub-acute stroke?	11:45	***KIM VAN SCHOOTEN*** The effect of central processing and muscle torque development speed on balance recovery during standing
10:00	***SEAN DUKELOW*** Using robots and other techniques to guide stroke rehabilitation	12:00	***KATE CARROLL*** Footsteps, falls and functional ambulation in children with neuromuscular disease
		12:15	***GRAHAM KERR*** Objective assessment of upper limb tremor distinguishes Parkinson's fallers and non-fallers and is predictive of future falls
	MORNING TEA – 10:30am – 11:00am		**LUNCH** - 12:30pm – 1:30pm

DAY 3: WEDNESDAY 28 NOVEMBER 2018

	SESSION 3 –YOUNG INVESTIGATORS 1:30pm – 2:42pm Chairs: Karen Søgaard & Jayne Garland		**SESSION 4 – PAIN & FATIGUE** 3:15pm – 5:00pm Chairs: Andrew Cresswell & Siobhan Schabrun
1.30	***KEVIN GILMORE*** The effects of demyelination in Chronic Inflammatory Demyelinating Polyneuropathy on neuromuscular properties, muscle quantity & quality	3:15	***KAREN SØGAARD*** Muscle pain, fatigue and performance in motor impairments
1:42	***HARRISON FINN*** Firing of fatigue-sensitive small-diameter afferents of the calf muscles impairs maximal contractions of the knee extensor muscles	3:45	***JANET TAYLOR*** Impairment of motor output by fatigue-related firing of small-diameter muscle afferents
1:54	***SHARI O'BRIEN*** Visuomotor ankle force training in individuals with spastic cerebral palsy compared to their typically developed peers.	4:00	***CHRIS MCNEIL*** Peripheral fatigue in young and old females and males
2:06	***ZOE DJAJADIKARTA*** Ankle proprioception in people with Multiple Sclerosis	4:15	***SIOBHAN SCHABRUN*** Motor function and motor cortical reorganization in the transition to sustained pain
2:18	***LYNDON SMITH*** Impaired sensorimotor control of the hand in congenital absence of functional muscle spindles	4:30	***PAUL HODGES*** Physical activity reduces dysregulation of the inflammatory mediators in the multifidus muscle after spontaneous intervertebral disc degeneration in SPARC-null mice
2:30	***PAULO PELICIONI*** Cognitive contributions to the control of balance during stepping in young & older adults - a fNIRS study.	4:45	***STEPHEN LORD*** End of conference remarks
	AFTERNOON TEA – 2:42-3:15PM		**CONFERENCE CONCLUDES** 5:00PM

DAY 1: MONDAY 26 NOVEMBER 2018

SESSION 1: MUSCLE 8:45-10:45am

(Chairs Simon Gandevia & John Rothwell)

Training-induced changes in muscles and their mechanics

Blazevich A
Edith Cowan University, Australia

Muscles show remarkable plasticity in response to both use and disuse. Whilst changes at both micro and macro levels can occur, the overall aim of this presentation is to examine key macro-level changes that may critically affect muscle function. Changes in muscle size and architecture are thought to play an important role in muscle force (and power) generation, so changes in them should affect muscle performance. Nonetheless, relationships between changes in size and architecture and changes in muscle function are not consistently observed, and numerous methodological issues and misinterpretations of both human and animal data have potentially led to incorrect conclusions in this research area. The first specific aim of this presentation, therefore, is to review our current knowledge of the role of muscle size and architecture, and point out currently unresolved issues and misinterpretations of data. Additionally, changes in both collagenous and non-collagenous connective tissues also change with muscle use and disuse, and increasing evidence indicates that these may play a key role in muscle function. In particular, intra- and inter-fibre force transmission may be affected, and the ratio of muscle to fascicle (fibre) length changes during dynamic contractions may also be altered. An ongoing research effort is required to further understand whether changes in connective tissue structures can be specifically targeted with exercise training interventions, and whether these impact muscle function. A second specific aim of this presentation, therefore, is to review current evidence in this regard with the purpose of stimulating ongoing work.

Prediction of performance from muscle models

Wakeling J
Simon Fraser University, Canada

Muscles function by changing length and developing force when they contract. Whilst there is a range of methods for measuring muscle length changes, there are currently no methods for directly measuring the force from individual muscles in man. Thus, muscle models are required to predict the contractile force for us to understand muscle function during healthy movements, and the dysfunction that comes with injury and disease. Most biomechanics studies use Hill-type muscle models to estimate muscle forces. Very few studies have been able to validate measured to modeled forces using this approach, and those that have report that there is still a substantial portion of force that is not predicted by these models. Over the last decade there have been a range of additional force generating mechanisms that have been tested for improving the predictive ability of muscle models: these include the representation of titin, fibre-type and recruitment, muscle tissue mass, 3D properties and material properties of the muscle tissue. This presentation will consider some of these recent developments in muscle modelling.

Regional hypertrophy in the human quadriceps following progressive resistance training

Bolsterlee B, Eguchi J, Thom JM and Herbert RD
NeuRA, Sydney, New South Wales, Australia
University of New South Wales, Sydney, New South Wales, Australia

Background
Muscles have complex three-dimensional (3D) shapes, and may remodel in complex 3D patterns when their structure adapts in response to progressive resistance training (PRT) [1]. We used magnetic resonance imaging (MRI) to study regional changes in muscle cross-sectional area (CSA) following PRT.

Methods
mDixon MRI scans of the upper legs were obtained from 11 healthy young adults (9 female) before and after 8 weeks of PRT of the knee extensors. 3D models of the vastus lateralis (VL), vastus intermedius (VI), vastus medialis (VM) and rectus femoris (RF) were created. CSAs were measured before and after training at 1% intervals of femur length. Changes in absolute and relative CSA were grouped by region in distal, middle and proximal thirds of the leg.

Results
CSA increased in all muscles and all regions by, on average, 13%. In all muscles, the relative increase in CSA was largest in the distal third, ranging from 13% in the VI to 24% in RF. In the VL and VI, the absolute increase was larger in the middle third than in the distal third by a factor of 1.8 and 1.6 times, respectively. Conversely, in the VM, the distal third grew 1.9 times more than the middle third.

Discussion
All regions and muscles increased in CSA after PRT, but patterns of hypertrophy differed strongly between muscles and regions. Further analyses showed that mid-thigh CSAs, as measured with ultrasound in this group, reflected the overall shape change of the muscles poorly.

1. Narici MV et al. (1996) Human quadriceps cross-sectional area, torque and neural activation during 6 months strength training. Acta Phys Scan 157(2), 175-186.

What can isometric contractions tell us about muscle injury and rehabilitation?

Allen TJ[1,2], Jones T[2], Tsay A[2], Morgan DL[2] and Proske U[2]

1. Accident Research Centre, Monash University, Australia
2. Department of Physiology, Monash University, Australia

Most of the literature on muscle injury and weakness induced by exercise has focussed on eccentric or lengthening contractions, due to their strong association with muscle damage (1-3). While there have been reports that isometric contractions can also be accompanied by damage, much less attention has been given to these contractions. Given the advantages of isometric exercise for rehabilitation, it would be helpful to establish the conditions under which damage is minimised. Isometric contractions also offer an opportunity to improve our understanding of muscle injury mechanisms during volitional exercise, since both neural and mechanical factors are much simpler. The purpose of this study was therefore to investigate which parameters of isometric contractions were associated with muscle damage. Bouts of 30 maximum voluntary contractions (MVCs) of elbow flexors were carried out in 38 subjects over 5 separate experiments. MVC force and soreness were measured pre-exercise and at 0h, 2h, and 24h post-exercise. When one arm was held near optimum angle (90°), MVC force was ~28% greater than the other arm held at longer length (155°). However, the muscle held at longer length exhibited more damage than the muscle exercised at 90°, supporting a greater length than force dependence of the damage process. In four additional experiments results suggested that the damage occurred during the plateau of the contractions and not the activation or relaxation phases. We conclude that muscle damage from isometric exercise is minimised if carried out at lengths below the optimum, using contractions of half maximum capacity or less.

1. Byrnes WC, Clarkson PM, White JS, Hsieh SS, Frykman PN, Maughan RJ. (1985). J Appl Physiol (1985) 59, 710-715.
2. Lieber RL, Fridén J. (1999) J Sci Med Sport 2, 253-265.
3. Proske U, Morgan DL. (2001) J Physiol. 537, 333-345.

Involuntary muscle activity reduces passive range of motion at known torque: a stimulation study

Diong J[1], Héroux ME[2], Nguyen D[2], Foo Y[3], Kastre C[4], Andersson K[4], Gandevia SC[2], Butler JE[2]

1. Sydney Medical School, The University of Sydney, Australia.
2. Neuroscience Research Australia (NeuRA), Sydney, Australia
3. Faculty of Health Sciences, The University of Sydney, Australia.
4. Faculty of Medicine, Linköping University

Assessments of passive joint range of motion either assume that muscles around a joint are relaxed or concomitant involuntary muscle activity of up to 5% of maximal voluntary contraction is small enough to ignore [1,2], but these assumptions have not been tested. We aimed to determine the extent to which small amounts of involuntary muscle activity limit passive range of motion, by measuring passive range of motion in the presence of simulated involuntary muscle activity in antagonist muscles. Thirty able-bodied adults participated in this study. Subjects were first seated with the tested knee flexed at 90 deg and ankle neutral, and predicted maximal plantarflexion torque was determined using twitch interpolation. With the knee flexed at 90 deg and fully extended, soleus was continuously stimulated to generate 0, 1, 2.5, 5, 7.5 and 10% of predicted maximal torque, in random order, while the ankle was passively dorsiflexed by an investigator blinded to the amount of stimulation. Ankle dorsiflexion torque-angle curves at each percent of predicted maximal torque were obtained. On average, for every 1% increase in plantarflexion torque, ankle range of motion at 9 Nm decreases by 2.4 deg (95% CI 2.0 to 2.7 deg; knee flexed 90 deg) and by 2.3 deg (95% CI 2.0 to 2.5 deg; knee fully extended). For a 5% increase in plantarflexion torque, the amount usually considered small enough to ignore, ankle range of motion decreases by ~12 deg. That is, small amounts of involuntary muscle activity substantially limit passive joint range of motion.

1. Lannin NA, Horsley SA, Herbert R, McCluskey A, Cusick A (2003) Arch Phys Med Rehabil 84:297-302.
2. Whatman C, Knappstein A, Hume P (2006) Phys Ther Sport 7:195 200.

SESSION 2: RESPIRATION 11:15am-12:45pm
(Chairs Jane Butler & Claire Boswell-Ruys)

The respiratory musculature: impairments and limitations in health and disease

Sheel AW
School of Kinesiology, The University of British Columbia, Vancouver, BC, Canada

In healthy humans, breathing in most physiological states (*i.e.* wakefulness, sleep, and exercise) is remarkably well-controlled. Although the partial pressure of oxygen and carbon dioxide within the alveoli are regulated precisely within a few millimetres of mercury, we are able to speak, cough, chew, swallow, and breathe with minimal effort, all of which occurs through the same series of airways and using many of the same skeletal muscles. The system that allows us to simultaneously accomplish this wide range of tasks with such precision and efficiency consists of three highly integrative, overlapping levels of control including: (1) the central controller (or driver) of respiratory rhythm and pattern, (2) distribution and synchronization of respiratory motor output to the appropriate respiratory muscles and, (3) sensory inputs to the central pattern generator. With this framework in mind, the presentation will first focus on the respiratory muscles and their mechanisms of action. This will be followed by a presentation of two specific clinical examples of respiratory muscle impairment: Duchenne muscular dystrophy and spinal cord injury. Emphasis will be placed on therapeutic interventions designed to improve respiratory health. Finally, the presentation will conclude with an examination of the respiratory musculature in health, under conditions of strenuous whole-body exercise. The high levels of ventilation that accompany exercise requires increases in force output by the diaphragm and many obligatory and accessory inspiratory muscles that can reach approximately 60-90% of their dynamic capacity for force generation. Emphasis will be placed on the effects of a high work of breathing and diaphragmatic fatigue on neurovascular control.

Age-related adaptions in the neural control of the human diaphragm muscle

Hudson AL[1, 2], Nguyen DAT[1, 2], Lewis RHC[1, 2, 3], Gandevia SC[1, 2, 3] and Butler JE[1, 2]

1. NeuRA, Sydney, Australia
2. University of New South Wales, Sydney, Australia
3. Prince of Wales Hospital, Sydney, Australia

There are changes in the skeletal, pulmonary and respiratory neuromuscular systems with healthy ageing. A study using a gastro-oesophageal catheter to record EMG reported higher diaphragm EMG during eupnoea in healthy subjects > 50 years, but these measures may be affected by the normalisation process used (1). The definitive method to assess neural drive is the single motor unit technique. Here, to assess age-related changes in neural drive to the diaphragm during eupnoea, EMG was recorded from the costal diaphragm using a monopolar needle electrode in participants from three age groups (n ≥ 7 each): older (65-80 years); middle-aged (43-55 years) and young (23-26 years). In each group, 154, 174, and 110 single motor units, respectively, were discriminated. A mixed effects linear model showed no significant differences between age groups for onset (group range 9.5-10.2 Hz) or peak (14.1-15.0 Hz) discharge frequencies during eupnoea. However, there was delayed onset (by ~10% of inspiratory time; p=0.02) and earlier offset (by ~20% of inspiratory time; p=0.04) of single motor unit activity in the older group. The respiratory parameters during the recordings were similar across groups. The area of motor unit potentials was ~40% larger in the middle-aged and older groups ($p < 0.02$). Therefore, although we found no age-related difference in firing frequencies during eupnoea, there were differences in the timing of motor unit activity in the older group. Changes in motor unit morphology indicate axonal sprouting and re-innervation of diaphragm muscle fibres is associated with ageing, even in middle-aged participants.

1. Jolley CJ, Luo Y-M, Steier J, Reilly C, Seymour J, Lunt A, Ward K, Rafferty GF, Polkey MI & Moxham J. (2009). Neural respiratory drive in healthy subjects and in COPD. European Respiratory Journal 33, 289-297.

Neural drive to the diaphragm in cervical spinal cord injury

Nguyen DAT[1,2], Lewis RHC[1,2,3], Boswell-Ruys CL[1,2,3], Hudson AL[1,2], Gandevia SC[1,2,3] and Butler JE[1,2]

1. NeuRA, Sydney, Australia
2. University of New South Wales, Sydney, Australia
3. Prince of Wales Hospital, Sydney, Australia

In people with cervical spinal cord injury (cSCI), inspiratory muscle strength decreases by ~60% compared to able-bodied individuals. Paralysed or weak respiratory muscles in cSCI compromises lung function, increases the incidence of respiratory infections and can cause dyspnoea (1). Reduced muscle strength in cSCI may result in altered neural drive to the inspiratory muscles to maintain ventilation. This study assessed the neural drive to the diaphragm by recording the discharge properties of single motor units from the diaphragm in participants with chronic cSCI (6 males, 48-78 years, C3-C6 injury, AIS A-C) and able-bodied control participants (6 males matched for age and BMI). In each group, 98 and 166 single motor units, respectively, were discriminated from recordings in the costal diaphragm using a monopolar electrode. A linear mixed-effects model analysis showed higher peak discharge frequencies of motor units during quiet breathing in cSCI (17.2 ± 5.0 Hz; mean ± SD) compared to controls (12.4 ± 2.2 Hz) ($P < 0.001$). There were no significant differences in tidal volume (0.63-0.76 l), inspiratory time (1.62-1.81 s) or mean air flow (0.39-0.42 l/s). Motor unit potentials in cSCI, compared to controls, were larger in amplitude (1.0 ± 0.7 mV and 0.5 ± 0.3 mV, respectively, $P = 0.025$) and area (1.79 ± 1.56 μV/s and 0.69 ± 0.53 μV/s, respectively, $P = 0.016$). This study definitively shows an increase in the neural drive to the diaphragm during quiet breathing and indicates that neurogenic changes occur in diaphragm motor units after cSCI.

1. Raab AM, Krebs J, Perret C, Michel F, Hopman MT & Mueller G (2016) Respir Care 61, 1636-1643

Sleep apnoea in people with multiple sclerosis

Hensen HA[1,2], Krishnan AV[3], Hoang PD[1], Menant JC[1], Lord SR[1], Gandevia SC[1], Eckert DJ[1]

1. Neuroscience Research Australia (NeuRA), Sydney , NSW, Australia
2. School of Medical Sciences, University of New South Wales, Sydney, NSW, Australia
3. Prince of Wales Clinical School, University of New South Wales, Sydney, NSW, Australia

Background: Sleep apnoea (SA) is common in multiple sclerosis (MS). These disorders share several consequences including fatigue, daytime sleepiness and depression(1). Thus, it is important to understand potential links between SA and MS as their coexistence may increase morbidity. This study aims 1/ to define the prevalence of SA and key symptoms in an unselected MS cohort and 2/ to conduct detailed upper airway physiology studies to determine the pathophysiological causes of SA in MS.

Methods: Adults with confirmed MS and an expanded disability scale score (EDSS) between 2-6 were recruited for this sub-study as part of a larger RCT (ACTRN12616001053415). Several sleep and health-related questionnaires plus a home-based overnight sleep study were performed. Physiology studies involved upper airway reflex testing and overnight assessments of pharyngeal muscle activity.

Results: Thus far, data have been analysed in 88 (F=64) people for aim 1. 27% of females and 42% of males had SA (apnoea-hypopnoea index >5events/h). Participants with SA were significantly older (49±11vs 58±10years, $p<0.01$) and had higher BMI (25.6±6vs 26.9±6kg/m^2, $p=0.035$). EDSS, self-reported fatigue, daytime sleepiness and quality of life were not different in people with or without SA. Data for aim 2 are being collected (n=3).

Conclusions: Despite the female predominance, SA was common (30%) in this unselected MS cohort. Similar risk factors as in the general population (age, gender and BMI) seem to play a key role in the MS population. However, the MS population tends not to be obese suggesting that the causes of SA likely differ.

1. Hensen HA, Krishnan AV, Eckert DJ. Sleep-Disordered Breathing in People with Multiple Sclerosis: Prevalence, Pathophysiological Mechanisms, and Disease Consequences. Frontiers in neurology. 2017;8:740.

Transient, broad field, visual input strongly modulates reactive saccade latency

Beamish J[1], Loeb G[2], Corneil B[3], Marinovic W[4], Wallis G[1], Carroll T[1]

1. Centre for Sensorimotor Performance, School of Human Movement and Nutrition Sciences, The University of Queensland, Brisbane, Australia.
2. Department of Biomedical Engineering, University of Southern California, Los Angeles, USA.
3. Brain and Mind Institute, University of Western Ontario, London, Canada.
4. School of Psychology and Speech Pathology, Curtin University, Perth, Australia.

In humans, the superior colliculus is a key midbrain node for the control of saccadic gaze shifts (and possibly some limb movements [1]). Its role is illustrated by “express saccades”, which occur when the first arrival of sensory information from the retina and/or primary visual cortex triggers very short latency gaze shifts (<110ms). Here we sought a method to experimentally manipulate the state of the superior colliculus, and thereby modulate the latency of saccadic initiation to visual targets. We presented black and white checkerboard stimuli over a large proportion of the visual field (~57 x 32 degrees of visual angle) for 8ms, at seven different timings with respect to the appearance of left or right saccade targets (-83ms to 58ms). We characterised the effect of checkerboard presentation timing on saccade properties (reaction time, directional error and amplitude) in ten people, to test the hypothesis that the stimulus would influence the latency but not the metrics of saccades. Checkerboard stimuli presented 83ms prior to the target reduced reaction time in all participants (from 113.5 [26.0] to 98.0 [7.8] ms; median [IQR]), whereas reaction times dramatically increased for checkerboard stimuli presented immediately before (162.3 [11.8] ms) or after the target (138.8 [27.8] ms). The checkerboard stimuli did not compromise movement accuracy at any timing; there were no effects on directional error or amplitude. The data suggest that broad field visual input can dramatically modulate saccade onset latency. The general approach might be beneficial in treatment for people with disorders of movement initiation.

Pruszynski JA, King GL, Boisse L, Scott SH, Flanagan JR, Munoz DP. (2010). European Journal of Neuroscience 32 (6), 1049-1057.

SESSION 3: POSTERS 1.30-3:00pm

See separate poster section.
Posters will remain up for the duration of the conference.
Presenters must remain beside their posters for the duration of the poster session.

****

SESSION 4: BALANCE 3:30-5:00pm
(Chairs Stephen Lord & Daina Sturnieks)

Am I the right way up? Disturbances of spatial orientation in variants of Alzheimer's disease

Day BL[1], Peters A[1], Ocal D[2], Gonzalez AS[2], Yong KX[2], Crutch SJ[2]
1. Department of Clinical and Movement Neurosciences, UCL Queen Square Institute of Neurology
2. Dementia Research Centre, UCL Queen Square Institute of Neurology

People with typical Alzheimer's disease (tAD) tend to present with memory problems, but there are variants of the disease where this is not the case. Posterior cortical atrophy (PCA) is such a variant that initially can primarily affect parietal, occipital and occipitotemporal cortices leading to profound disturbances of higher-level visual processing. Additionally, anecdotal reports from people with PCA and their carers often describe problems that would seem to impinge on brain functions more concerned with spatial orientation, posture and balance. Some experiences can be transient and bizarre, such as perception of the environment being upside down for a brief period, perhaps suggesting a disturbance of visual-vestibular integration[1,2]. The disordered mechanisms underlying the various perceptual and motor disturbances that have been reported and their prevalence in PCA have hardly been investigated and so remain poorly understood. We have therefore undertaken an extensive series of studies investigating a range of perceptual and motor mechanisms in people with PCA (n=24), tAD (n=22), and healthy age-matched controls (n=21). The tests were designed to be suitable for most people in these cohorts and were aimed to tease out specific processes related to multi-sensory integration and spatial orientation. Our aims were to identify precise disturbances of known mechanisms and to build up a picture of how such deficits may coexist within an individual, how the pattern of deficits varies within and between cohorts, and ultimately to associate those patterns with neuroanatomical findings. Parts of these data will be presented.

1. Crutch SJ, Lehmann M, Gorgoraptis N, Kaski D, Ryan N, Husain M, Warrington E K (2011) Neurocase 17, 160-177.
2. Crutch SJ, Lehmann M, Schott JM, Rabinovici GD, Rossor MN, Fox NC (2012) Lancet Neurol 11, 170-178.

Monday 26 November 2018

WELCOME DRINKS

5pm-7pm

Ocean View Terrace

CROWNE PLAZA HOTEL
242 Ardern Street, Coogee

Meet your fellow conference registrants. Enjoy the sea breeze and ocean view.

Your conference registration includes two drink vouchers (inside your name tag) which can be redeemed on selected beverages from the Oceans Bar during the welcome drinks event from 5pm-7pm on Monday 26 November.

A novel group-based stepping exercise program to improve fall risk factors in older adults: first results of a pilot study

Giannouli E, Morat T and Zijlstra W
Institute of Movement and Sport Gerontology, German Sport University Cologne, Germany

Stepping training is one type of exercise-based interventions that is effective in reducing fall risk (1). However, it is offered mostly in form of exergames which require costly equipment and lack the benefits of the social aspect of group training. Furthermore, additional studies are needed to gain insight in dose-response relationships of stepping interventions and to develop tailored exercise programs for older adults that can easily be implemented in clinical practice.

We propose a concept for group-based stepping training that systematically addresses motor as well as cognitive aspects, that does not require costly equipment, and that as a group-based activity has social context as an additional benefit. Participants are presented with stepping patterns, which they have to memorize and implement themselves on a mat. Based on four principles, difficulty level systematically and gradually increases session by session: execution speed, pattern complexity, pattern length and execution in dual-/multi-tasking conditions. A pilot-study with 40 community-dwelling older adults (n=20 intervention group and n=20 control group) was executed to investigate its feasibility and the effects on physical, cognitive as well as psychological fall-risk factors.

First results show high levels of adherence, enjoyment, perceived effectiveness and intention to recommend as well as improvement of dual-task ability and executive functioning.

The proposed stepping training program is easy-to-administer and effective in improving some fall risk factors after 9 weeks of training. A larger randomized controlled trial over longer duration is necessary to validate the improvements reported in the current study.

1. Okubo, Y., Schoene, D., & Lord, S. R. (2016). Step training improves reaction time, gait and balance and reduces falls in older people: a systematic review and meta-analysis. Br J Sports Med, bjsports-2015.

Adaptive, reactive and daily life gait in older populations

Pijnappels M
Vrije Universiteit Amsterdam, Netherlands

In our previous work at the department of Human Movement Sciences, we studied motor impairments by measuring adaptive and reactive responses of older adults to gait perturbations in experimental settings (e.g. tripping over obstacles), and showed that these discriminate fallers from non-fallers[1]1. In addition, we investigated older adults' gait behaviour in daily settings by ambulant measurements with accelerometry and found that daily gait quality characteristics (e.g. stability and variability measures) contribute to predicting future falls[2,3]. Despite the fact that motor and balance impairments increase the risk of falling; we noticed that older individuals do not always match their motor behaviour with their actual motor abilities. Such misjudgement might lead to inappropriate behaviour and therefore possibly falls or inactivity. In this presentation, I will extend on our previous work by giving some examples of studies in which we compared adaptive, reactive and daily life gait, in order to show matches between what people can do, think they can do and actually do. I will give an example of a expected and unexpected stepping down paradigm[4], and on standardized versus distribution of daily life gait speed[5]. Future studies are needed to see whether such mismatches between actual and perceived motor abilities will lead to falls in daily life situations.

1. Pijnappels M, Reeves ND, Maganaris CN, van Dieën JH. Tripping without falling; lower limb strength, a limitation for balance recovery and a target for training in the elderly. J Electromyogr Kinesiol, 2008; 18(2), 188-196.
2. van Schooten KS, Pijnappels M, Rispens SM, Elders PM, Lips P, Daffertshofer A, Beek PJ van Dieën JH. Daily-life gait quality as predictor of falls in older people: a 1-year prospective cohort study. PlosONE 2016; 11(7).
3. van Schooten KS, Pijnappels M, Rispens SM, Elders PM, Lips P, van Dieën JH. Ambulatory fall-risk assessment: Amount and quality of daily life gait predict falls in older adults. J Gerontol A Biol Sci Med Sci 2015; 70(5):608-15.
4. Kluft N, Bruijn SM, van Dieën JH, Pijnappels M. Do older adults select appropriate motor strategies in a stepping down paradigm? Front. Physiol. 2018; 9:1419.
5. van Ancum J, van Schooten KS, Jonkman NH, Huijben B, van Lummel RC, Meskers CGC, Maier AB, Pijnappels M. Gait speed assessed by a 4-meter walk test is not representative of daily-life gait speed in community-dwelling adults. Under revision.

The relationship between white matter hyperintensity clusters (size and location) and prospective falls in older adults across the cognitive spectrum

Taylor ME[1, 2, 3], Delbaere K[1, 4], Lord SR[1, 4], Sachdev PS[5, 6, 7], Wen W[5, 6], Jiang J[5, 6], Brodaty H[6, 7], Kurrle SE[2], Sturnieks D[1,8], Trollor J[6, 9] and Close JCT[1, 3]

1. Falls, Balance and Injury Research Centre, NeuRA, UNSW Sydney, Sydney, Australia.
2. Cognitive Decline Partnership Centre, Faculty of Medicine and Health, The University of Sydney, Sydney, Australia.
3. Prince of Wales Clinical School, Medicine, UNSW Sydney, Sydney, Australia.
4. School of Public Health and Community Medicine, Medicine, UNSW Sydney, Sydney, Australia.
5. Neuropsychiatric Institute, Prince of Wales Hospital, Randwick, Australia.
6. Centre for Healthy Brain Ageing, School of Psychiatry, Medicine, UNSW Sydney, Sydney, Australia.
7. Dementia Centre for Research Collaboration, School of Psychiatry, Medicine, UNSW Sydney, Sydney, Australia.
8. School of Medical Sciences, Medicine, UNSW Sydney, Sydney, Australia.
9. Department of Developmental Disability Neuropsychiatry, School of Psychiatry, UNSW Sydney, Sydney, Australia.

Objectives: The relationship between white matter hyperintensity (WMH) clusters and, physical performance and falls remains unexamined. Investigating WMH clusters (size/location) may identify differential effects in relation to WMH aetiology and, physical performance and fall risk. We hypothesized an association between the number of WMH clusters (NoCs) and sensorimotor function and falls, and that this relationship would be strongest in the frontal brain region.

Measurements: At baseline, 168 community-dwelling older people underwent Magnetic Resonance Imaging and sensorimotor and neuropsychological assessment. WMH NoCs were quantified using fully-automated methods. Falls were ascertained prospectively for 12-months.

Results: The sample included participants who were cognitively intact (n=79), had MCI (n=61) and dementia (n=28), their mean age was 79±5 years and 53% were female. In minimally-adjusted analyses (age, sex, education, Mini-Mental State Examination, vascular risk, scanner), total, focal, medium and confluent whole-brain NoCs and frontal, temporal and parietal NoCs were associated with faller status. In fully-adjusted analyses, further adjusting for total WMH volume, mood, executive and sensorimotor function, total, focal, temporal and parietal NoCs remained significantly associated with falls. Sensorimotor function showed significant relationships with focal, frontal and parietal NoCs.

Conclusions: Total, focal, parietal and temporal NoCs were independently associated with falls. The strength of the association between frontal NoCs and falls was affected by mood, sensorimotor and executive function, which may be secondary to the known relationships between fronto-executive circuits and sensorimotor function and/or apathy. WMH clusters present as a novel fall risk factor in this study. However, these findings need validating in future studies.
****

DAY 2: TUESDAY 27 NOVEMBER 2018

SESSION 1: CONTRACTURE & MORE 9:00-10:45am

(Chairs Robert Herbert & Glen Lichtwark)

Biological and Biomechanical Studies of Skeletal Muscle Contractures in Cerebral Palsy

Lieber RL
Shirley Ryan AbilityLab and Departments of Physical Medicine and Rehabilitation and Biomedical Engineering, Northwestern University, Chicago

Skeletal muscle is a highly plastic tissue, responding both to level of use and amount of neural input. After cerebral palsy (CP) altered neural input can result in muscle contractures. We have studied the mechanics and biology of muscle from children with wrist flexion contractures secondary to CP. Dramatic architectural changes are observed in these children whereby sarcomere lengths are dramatically altered relative to patients without upper motor neuron lesions. This suggests dramatic alterations in the regulation of muscle growth in these children. Biomechanical studies of isolated single muscle cells reveal an increased passive modulus and decreased resting sarcomere length suggesting alterations in the cellular cytoskeleton. Gene expression profiling reveals a number of “conflicting” biological pathways in spastic muscle. Specifically, this muscle adapts by altering processes related to extracellular matrix production, fiber type determination, fiber hypertrophy and myogenesis. These transcriptional adaptations are not characteristic of muscle adaptations observed in Duchenne muscular dystrophy or limb immobilization. Superimposed upon the dramatic biological and structural adaptations is a loss in the number of satellite cells that are located throughout the muscle. Even the remaining satellite cells have epigenetic changes that can dramatically influence our ability to rehabilitate these muscles. Recently, we have shown that several anti-cancer drugs are able to reverse these epigenetic changes, thus “rescuing” the satellite cells and promoting myogenesis. Taken together, these results support the notion that, while contracture formation is multifactorial and neural in origin, significant structural alterations in muscle also occur. An understanding of the specific changes that occur in the muscle and extracellular matrix may facilitate the development of new conservative or surgical therapies for this devastating problem..

Early Evidence for a Decrease in Biceps Optimal Fascicle Length Based on In Vivo Muscle Architecture Measures in Individuals with Chronic Hemiparetic Stroke

Adkins AN[1, 4, 5], Garmirian L[1, 2, 4], Nelson CM[1, 2], Dewald JPA[1, 2, 3], and Murray WM[1, 2, 3, 4, 5]

1. Department of Biomedical Engineering, Northwestern University, Evanston, Illinois, USA
2. Department of Physical Therapy and Human Movement Science, Northwestern University, Chicago, Illinois, USA
3. Department of Physical Medicine and Rehabilitation, Northwestern University, Chicago, Illinois, USA
4. Shirley Ryan AbilityLab, Chicago, Illinois, USA
5. Edward Hines, Jr. VA Hospital, Hines, Illinois, USA

There are currently no comprehensive in vivo muscle architecture studies that allow for the calculation of optimal fascicle length (OFL) in any impaired population or any upper limb muscle. Here we combined novel imaging methods to determine OFL and physiological cross-sectional area (PCSA) in the biceps brachii. We compared inter-limb differences in 5 participants with moderate to severe chronic hemiparetic stroke (2F/3M, 48-72yrs, Fugl-Meyer 12-33) and one able-bodied participant (M, 61yrs). Sarcomere length, fascicle length, and muscle volume of the biceps were measured in vivo in both arms under passive conditions. PCSA and OFL were calculated from these data using 2.7μm as optimal sarcomere length. To image sarcomeres in vivo, second-harmonic generation (SHG) microendoscopy (Zebra Medical Technology) was implemented on the long head of the biceps. The SHG signal was used to directly measure sarcomere length as a distance between A-bands(1). Separately, extended field-of-view ultrasound images were obtained(2); 3 images were obtained per arm, 4 fascicles were measured per image. In both studies, participants were seated, secured to a chair, with their arms supported in a controlled posture. In a third study, the Dixon method, a fat suppression MRI sequence, was used to acquire volume of biceps contractile material(3). For the able-bodied participant, absolute differences between limbs were <5% for all parameters. Inter-limb differences in fascicle and sarcomere length resulted in an OFL that was substantially shorter in the paretic limb of all stroke participants (30±10%). Inter-limb differences in volume and PCSA were less consistent across participants.

1. Sanchez G (2015) Neuron 88, 1109-1120
2. Nelson CM (2016) Journal of Biomechanics 49, 1948-1952
3. Garmirian L (2017) Proceedings of ASB, Boulder, CO, 2017

Changes in muscle architecture after hemispheric stroke can adversely affect efficiency of muscle contraction in pennate muscles: an analysis of muscle gear ratios

Rymer WZ[1] & Son J[1]
1. Arms and Hands Lab, Shirley Ryan AbilityLab, Chicago, Illinois, USA

After hemispheric stroke, there is routinely weakness for voluntary movement in contralesional limbs. While much of this weakness is attributable to a loss of descending excitatory neural commands from cerebral cortex and brainstem, there are also progressive changes in muscle architecture, associated with changes in muscle material properties. Our objective here is to evaluate the relative impact of these muscular and architectural changes on the generation of voluntary force in stroke-impaired muscles.

Our specific hypothesis is that changes in the muscle matrix of pennate muscles following stroke may limit rotation of fascicles in pennate muscles, forcing fascicles to stay aligned with the shortening direction of the muscle, a suboptimal mechanical state. In particular, we plan to evaluate changes in fascicle "gear ratio", in which we estimate the ratio between muscle shortening velocity and fascicle shortening velocity (1) using B mode ultrasound imaging.

We report here on differences in gear ratio between impaired and contralateral medial gastrocnemius (MG) muscles of four hemispheric stroke survivors. Subjects were required to perform isometric contractions of the MG muscle at predetermined activation levels, over a range of ankle joint angles. Fascicle length and fascicle rotation were assessed using advanced ultrasound techniques.

Our findings were that there was a systematic reduction in fascicle rotation in impaired MG muscles as voluntary force increased. Comparisons of fascicle rotation between the two sides showed a consistent 6 to 12° difference, which would contribute to a significant change in force generating capacity of the plantar flexor muscles.

1. Azizi E, Brainerd EL, Roberts TJ, "Variable gearing in pennate muscles," Proc Natl Acad Sci, 105(5):1745-50, 2008.

A speed-adaptive myoelectric ankle exoskeleton to improve post-stroke walking performance

Taylor JMD[1], McCain E M[2], Giest TN[2], and Sawicki GS[3]
1. University of Queensland, St Lucia, QLD, Australia
2. North Carolina State University, Raleigh, NC, USA
3. Georgia Institute of Technology, Atlanta, Georgia, USA

Limited ankle `push-off' power is a hallmark of post-stroke gait, leading to high inter-limb asymmetry, reduced walking speeds, and elevated metabolic demands [1]. Powered exoskeletons offer a promising approach to restore mechanical deficits by applying torque at the paretic ankle during push-off. Previous devices [2] have been effective at improving paretic ankle plantarflexion moment, but were unable to increase ankle power output or reduce the metabolic costs of paretic gait. This devices' performance was limited because it was unable to respond to reductions in plantarflexor muscle activity that occur with added assistance. Here, we developed and tested a powered ankle exoskeleton - driven with the user's soleus electromyographic (EMG) signal and ground reaction force profile - that modulates propulsive assistance with speed and ensures assistance levels do not decline with reduced muscle activity. We tested the device during a speed-endurance test in 6 stroke survivors walking on an instrumented treadmill with and without an ankle exoskeleton on their paretic limb. We collected kinematics, kinetics, EMG, and metabolic cost. The exoskeleton increased assistive torque as walking speed increased and muscle activity decreased, verifying its efficacy. At all speeds, net paretic ankle power was significantly higher with the exoskeleton compared to normal walking. Despite this improvement in ankle function, only 2 of the 6 subjects experienced a reduction in metabolic cost while wearing the device. This study suggests that assistive devices have potential to restore paretic ankle function in post-stoke individuals, however future work into understanding proximal joint-level effects of added assistance is necessary.

1. Peterson CL, Kautz SA, Neptune RR. J Biomech. 2010; 43:2348-55
2. Takahashi KZ, Lewek MD, Sawicki GS. J NeuroEng Rehab. 2015;12:23

People with achilles tendinopathy display greater force fluctuations than controls at low force levels

Malliaras P[1], Tomassoni D[1], Hasani F[1], Allan T[2], Kidgell D[1]

1. Department of Physiotherapy, School of Primary and Allied Health Care, Monash University
2. Department of Physiology, School of Biomedical Sciences, Monash University

Background: People with Achilles tendinopathy (AT) display reduced maximal planterflexor torque [1], but whether muscle force control tasks are affected is unknown. We aimed to compare planterflexor muscle force control in AT and control groups, and whether torque and muscle force control change following a loading task.

Methods: 11 men with AT and 11 matched controls were recruited. Ankle planterflexor torque during maximal voluntary contraction (MVC) and a 15-second isometric planterflexor force matching task (a measure of muscle force control) at 10% and 50% of MVC (randomised order) were assessed pre-post an isometric task (5 x 45 sec at 70% MVC). Force fluctuations during force matching were quantified using coefficient of variation (CV). MVC torque and force matching were investigated between groups and pre-post the isometric task (ANCOVA with age as the covariate).

Results: The AT group displayed significantly lower MVC torque ($F(1) = 6.82$, $p = 0.017$) and greater CV at 10% MVC ($F(1) = 7.32$, $p = 0.014$) compared with controls. CV did not change significantly pre-post the isometric task. There was a between group interaction for MVC ($F(1,1) = 5.17$ $p = 0.035$), with the AT group displaying a significant increase after the isometric task. Among the AT group, there was a moderate correlation between baseline pain and function and force fluctuations at 10% ($r=-0.57$, $p=0.07$).

Conclusion: People with AT display decrement in muscle force control at low force levels that is associated with symptom severity and remained despite increased MVC post a loading task.

1. Mahieu NN, Witvrouw E, Stevens V, Van Tiggelen D, Roget P. Intrinsic Risk Factors for the Development of Achilles Tendon Pain. Am J Sports Med. 2006: 34(2):226-35

A finite element method for integrated design and testing of 3D printed ankle and foot orthoses for children with cerebral palsy and motor impairment

Eveleigh M[1], Howlin P[2], Stebbins J[3], Kilic K[4], Reid R[4] and Brodie M[1,5]

1. Graduate School of Biomedical Engineering, University of NSW, Sydney, Australia
2. School of Mechanical and Manufacturing Engineering, University of NSW, Sydney, Australia
3. Oxford Gait Laboratory, Nuffield Orthopaedic Centre, Oxford, United Kingdom
4. AbilityMate, Sydney, Australia
5. NeuRA, Sydney, Australia

Cerebral palsy (CP) affects approximately two in every thousand babies born in developed countries and causes debilitating gait impairments, [1-4] which may be remedied with ankle and foot orthoses (AFOs). Current methods of manufacturing AFOs are expensive and time-consuming; 3d-printing may provide an efficient and cost-effective alternative. A systematic review [5] was conducted and revealed that computer simulations of AFOs are under-utilised for design optimisation and pre-manufacture testing.

The hypothesis tested was that a novel integrated design and testing approach, incorporating finite element (FE) modelling could be used to predict the strength, stiffness and buckling of paediatric AFOs. Topology optimisation was used to produce three new designs with reduced (85%, 66% and 38%) mass. The three models were 3d-printed and the predicted AFO performance validated against results from a mechanical testing rig.

The FE model predicted the buckling of the new designs and also changes in stiffness and strength with normalised errors ranging from 0.7% to 16%. Both predicted and actual AFO strength decreased significantly ($p<0.05$) with reduced mass (24.8 Nm for 100% to 2.14 Nm for 38%). Strength loss could be minimised through more complex designs.

This novel method may be used to predict and optimise orthoses properties during the design stage. With further research it may be possible to precisely match the mass and design of a 3d-printed AFO to a child's mass and gait pattern. The use of simulation-based methods to efficiently produce optimised designs may assist children with CP and motor impairment to walk better.

1. Bertens, L.C., et al., Development and validation of a model to predict the risk of exacerbations in chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis, 2013. 8: p. 493-9.

SESSION 2: BRAIN STIMULATION & STROKE 11:15-12:45pm
(Chairs Janet Taylor & Irene di Giulio)

Brain stimulation and treatment of motor impairments

Rothwell J
UCL Queen Square Institute of Neurology, London UK

There is good evidence in animal models that following stroke there is a general up-regulation of synaptic plasticity in the surviving tissue that occurs at the same time as a rapid improvement in behavioural outcome. Genes important for growth, repair and plasticity are activated rapidly following infarct as well as expression of growth stimulating genes in the first week following ischaemic infarct which is then followed by up-regulation of growth inhibiting genes. Circulating levels of molecules that support developmental critical period neuroplasticity are also up-regulated following focal infarcts in animal models. Together these findings suggest a period of increased capacity for reorganisation following stroke and that there may be a window of enhanced neuroplastic potential in the weeks after injury.

I will describe an investigation in which we used theta burst TMS to probe the amount of plasticity in a group of 30 patients from 2 weeks to 6 months after a unihemispheric stroke affecting upper limb function. We opted to investigate the plasticity in the non-stroke hemisphere for the practical reason that following stroke it is sometimes not possible to evoke any muscle twitches with TMS of the affected hemisphere. By using the non-stroke hemisphere we could ensure that we would be able to study all patients. In addition, the animal data show that the post-stroke changes in plasticity are not confined to the damaged areas of brain, but are seen widely even in the non-stroke hemisphere. We found that there was an enhanced response to the plasticity protocol early after stroke which then receded by 6 months. Although we have no measures of an individual's pre-stroke plasticity, the data would be consistent with the notion that in human patients, as in animals, there is a short "window" of increased synaptic plasticity in the motor system that might contribute to functional recovery. If correct this may be the time when therapy will have the greatest impact.

Characterizing age-related changes in supplementary motor area-primary motor cortex connectivity.

Vallence AM[1], Rurak BK[1] and Drummond PD[1]

1. School of Psychology and Exercise Science, Murdoch University, Perth, Australia

Cortico-cortical connectivity between motor areas is important for motor control. The supplementary motor area (SMA) is densely connected with the primary motor cortex (M1) (1); these two regions are important for bilateral motor control (2). Connectivity within the cortical motor network declines with advancing age (3), therefore, age-related changes in SMA-M1 connectivity might underlie age-related decline in bilateral motor control. First, we examined the reliability of facilitatory interactions between SMA-M1 measured using transcranial magnetic stimulation (TMS): we hypothesized good test re-test reliability for SMA-M1 facilitation. Second, we measured SMA-M1 facilitation in younger and older adults, and investigated associations between SMA-M1 facilitation and bilateral motor control: we hypothesized less SMA-M1 facilitation in older than younger adults, and positive associations between SMA-M1 facilitation and bilateral motor control.

Dual-coil TMS was used to measure SMA-M1 facilitation (and preSMA-M1 as a control): a conditioning TMS pulse to SMA preceded a test TMS pulse to M1 by 7 ms. The Purdue Pegboard and four square step test were used to measure bilateral motor control of upper and lower limbs, respectively. An intra-class correlation coefficient of 0.74 showed good test re-test reliability of SMA-M1 facilitation. SMA-M1 facilitation was reduced in older compared to younger adults, and SMA-M1 facilitation was positively associated with task performance.

Findings suggest that SMA-M1 facilitation can be reliably measured with TMS, and that reduced SMA-M1 facilitation with age might play a role in age-related decline in bilateral movement control.

1. Dum, RP & Strick, PL (2002) Physiol Behav 77, 677-682
2. Nachev, P et al. (2008) Nat Rev Neurosci 9, 856-869
3. Seidler, RD et al. (2010) Neurosci Biobehav Rev 34, 721-733

Effect of STN-DBS frequency on postural performance in Parkinson's disease

Di Giulio I[1,2], Kalliolia E[1,3], Georgiev D[1,4], Peters AL[1], Voyce DC[1], Akram H[1], Foltynie T[1], Limousin P[1], Day BL[1]

1. Sobell Department of Motor Neuroscience and Movement Disorders, Institute of Neurology, University College London, London, UK.
2. School of Basic and Medical Biosciences, King's College London, London, UK.
3. St. Luke's Hospital Thessaloniki, Greece.
4. Ljubljana University Medical Centre, Ljubljana, Slovenia.

Postural instability is a debilitating motor symptom in Parkinson's disease (PD). Deep-brain stimulation (STN-DBS) may help initially, but its efficacy decreases in the years following surgery (1-3). We hypothesise that bespoke tuning of STN-DBS frequency will improve postural performance in chronically stimulated patients.

Methods: The effect of stimulation frequency (40 to 140Hz, 20Hz-steps) on postural performance was assessed in 24 PD patients treated with STN-DBS for more than 4 years. Forward and backward shoulder pulls were delivered using two force-feedback-controlled motors (4). Outcome measures were antero-posterior ground force (FAP) to gentle pulls, step length to strong pulls, and back length during pre-pull standing as an indicator of stoop. These measures were analysed statistically to establish optimal frequency(ies) for each patient's postural performance.

Results: Most patients showed best FAP with STN-DBS set to 100 and 120Hz (21 patients), while the first step was longer at 80Hz (20 patients). The back was less stooped at 100Hz (10 patients). When an optimal frequency was sought that improved one measure without deteriorating the others, 10 patients optimised at 100Hz, 5 patients at 80Hz and 5 patients at120Hz.

Conclusions: Postural performance in PD is dependent on STN-DBS frequency, although not all aspects of performance necessarily improve at the same frequency. Lowering the stimulation frequency from the common post-surgery setting of 130Hz to 100Hz may help to reduce postural problems associated with chronic stimulation and disease progression.

1. Rodriguez-Oroz MC, Obeso JA, Lang AE, Houeto J-L, Pollak P, Rehncrona S, Kulisevsky J, Albanese A, Volkmann J, Hariz MI, Quinn NP, Speelman JD, Guridi J, Zamarbide I, Gironelli A, Molet J, Pascual-Sedano B, Pidoux B, Bonnet AM, Agid Y, Xie J, Benabid A-L, Lozano AM, Saint-Cyr J, Romito L, Contarino MF, Scerrati M, Fraix V, Van Blercom N (2005) Brain 128, 2240-9.
2. St George RJ, Nutt JG, Burchiel KJ, Horak FB (2010) Neurology 75(14), 1292-9.
3. Mahlknecht P, Limousin P, Foltynie T (2015) J Neurol 262, 2583-95.
4. Di Giulio I, St George RJ, Kalliolia E, Peters AL, Limousin P, Day BL (2016) J Neurophysiol 116, 493-502.

Distortions in the synaptic organization of motor commands to proximal and distal muscles following hemiparetic stroke

Heckman CJ
Physiology, Physical Medicine and Rehabilitation, Physical Therapy and Human Movement Sciences, Northwestern University, Chicago USA

Motor unit firing patterns are highly sensitive indicators of the motor commands that produce them. Recent advances in electrode technology allow recording of up to 30 motor units simultaneously from a flexible electrode array place on the surface of human muscles(1). Our systematic studies using these arrays to assess motor unit firing patterns in both proximal and distal muscles of the arm in normal subjects have revealed that motor commands to proximal muscles have much stronger input from the reticulospinal system than do distal muscles. This difference is especially striking for the component of the reticulospinal system that utilizes serotonin as a neurotransmitter and constitutes the primary controller of the intrinsic excitability of motoneurons releases serotonin onto spinal motoneurons. Our studies in subjects with hemiparetic stroke however suggest that excessive reliance on the reticulospinal system to generate motor commands results in distorted motor unit firing patterns that lack rate modulation. We interpret these data as revealing inappropriate coupling of excitation and inhibition that lacks the normal reciprocal pattern. We will discuss the possibilities for pharmacological interventions to ameliorate these deficits.

1. Johnson MD, Thompson CK, Tysseling VM, Powers RK, Heckman CJ. The potential for understanding the synaptic organization of human motor commands via the firing patterns of motoneurons. J Neurophysiol. 2017;118(1):520-31.

Increased dependence on contralesional corticoreticulospinal pathways a form of maladaptive plasticity post hemiparetic stroke?

Dewald JPA[1, 2, 3]

1. Department of Biomedical Engineering, Northwestern University, Evanston, Illinois, USA
2. Department of Physical Therapy and Human Movement Science, Northwestern University, Chicago, Illinois, USA
3. Department of Physical Medicine and Rehabilitation, Northwestern University, Chicago, Illinois, USA

Paretic arm and hand function is a major cause of chronic disability among stroke survivors. In addition to weakness or paralysis, the arm/hand is also affected by the flexion synergy -involuntary elbow, wrist, and finger flexion when an individual with stroke attempts to lift the paretic arm (1). The flexion synergy compromises the ability to reach and open the hand and reduces the control of grasp strength during functional tasks, thus compounding the stroke survivor's functional deficits. The fine motor control required for normal arm/hand function is largely driven by the contralateral corticospinal tract. Evidence will be provided, using high-density electroencephalographic recordings, that suggests that following a loss of corticospinal and corticobulbar (i.e., corticofugal) pathways post stroke, there is increased activation of contralesional motor cortices with increasing levels of paretic limb weight support by stroke participants (2), indicating the use of indirect corticobulbospinal pathways based on primate research. Evidence will also be provided that in the most impaired stroke participants a greater reliance on contralesional motor cortices over time is resulting in an increase in structural tract integrity in contralesional reticulospinal tract integrity (3). Finally, evidence will be provided showing the reemergence of a developmental brainstem reflex, the asymmetrical tonic neck reflex, to show that anatomically diffuse reticulospinal motor pathways are active during flexion synergy expression (2). We interpret this progressive recruitment of contralesional cortico-reticulospinal pathways as an adaptive strategy that increases shoulder abduction strength at the cost of functional movement control in the paretic upper limb.

1. Lan Y, Yao J, Dewald JPA. The Impact of Shoulder Abduction Loading on Volitional Hand Opening and Grasping in Chronic Hemiparetic Stroke. Neurorehabil Neural Repair. 2017;31(6):521-9. doi: 10.1177/1545968317697033. PMCID: PMC5505320.
2. McPherson JG, Chen A, Ellis MD, Yao J, Heckman CJ, Dewald JPA. Progressive recruitment of contralesional cortico-reticulospinal pathways drives motor impairment post stroke. J Physiol. 2018. Epub 2018/02/20. doi: 10.1113/JP274968. PubMed PMID: 29457651
3. Owen M, Ingo C Dewald JP. Upper extremity motor impairments and microstructural changes in bulbospinal pathways in chronic hemiparetic stroke. Frontiers in Neurology, 2017. 8:257. PMCID: PMC5468392.

Conference Dinner

The Harbourside Room
MUSEUM OF CONTEMPORARY ART

Tuesday 27 November 2018
6:30pm-10:30pm

Dress: Smart Casual

Enjoy a delicious meal with your fellow registrants overlooking Sydney's iconic harbour.

Make your way to the Museum of Contemporary Art after exploring the sights of Sydney during the afternoon.

Buses have been booked to return to the Crowne Plaza, Coogee at 10.15pm and 10.30pm.

Out of town guests will have priority use of the buses.

Address: 140 George Street, The Rocks, Sydney

DAY 3: WEDNESDAY 28 NOVEMBER 2018

SESSION 1: MOTOR CONTROL 9:00-10:30am

(Chairs Martin Héroux & Graham Kerr)

Coming to grips with motor control

Flanagan R
Queens University, Canada

Skilled motor behaviour relies on our ability to both estimate the motor commands required to achieve desired outcomes and predict the sensory consequences of motor commands. In tasks involving object manipulation, including most of the action tasks we perform on a daily basis, this ability requires storing and recalling memories related to the dynamics of objects (e.g., weight), that specify the mapping between applied force and motion. In this talk I will describe behavioural and neuroimaging studies examining how object weight is represented at both the conceptual and neural levels. I will show that predictons about object weight, which are critical for dexterous manipulation, rely on multiple memory systems. I will also provide evidence showing that regions of the brain generally believed to not be engaged in action—including the ventral visual pathway and the medial temporal lobes—play an important role in representing object weight.

Stochastic Resonance can enhance cutaneous reflex responses in the lower limb

Bent LR[1], Sharma T[1], Peters RM[2]

1. Department of Human Health and Nutritional Sciences, University of Guelph, Guelph, Ontario, Canada
2. Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada

Location specific stimulation of plantar foot skin has been shown to reflexively modulate lower limb muscles to effect balance and gait strategies1,2. Decreased cutaneous reflex generation has been proposed to contribute to increased fall risk in aging and pathological populations3. One solution is to augment the skin signal with stochastic resonance (SR), a phenomenon whereby the addition of noise to an undetectable stimulus, can make the stimulus detectable4. SR mediated enhancements have been shown in tactile detection but have not been explored in cutaneous reflexes. Here we ask whether enhancing natural skin input through SR could improve cutaneous reflex responses in the lower limb. Eleven young, healthy subjects (mean age 20.9 years) were recruited. To evoke cutaneous reflex responses, we used a mechanical vibrotactile input over the heel at 10 times perceptual threshold (PT). SR noise was elicited with an electrotactile stimulus applied at various intensities between 0 and 100% of noise PT. Electromyography was recorded from soleus (SOL), tibialis anterior (TA) and medial (MG) and lateral gastrocnemius (LG). Cutaneous reflexes were quantified with peak to peak amplitude (PTP) of the cumulant density plot at each noise intensity. Subjects were separated based on their directional response to noise-mediated enhancements of SOL reflex (responders: n=6, non-responders: n=5). SR effects were observed at 20% of noise threshold in responders. We conclude that SR can be elicited in reflex responses in a subset of the population. This information may help inform the design of biomedical aids to improve balance in clinical populations.

1. Nakajima T, Sakamoto M, Tazoe T, Endoh T, Komiyama T (2006) Location specificity of plantar cutaneous reflexes involving lower limb muscles in humans. Exp Brain Res 175:514-525.
2. Zehr EP, Nakajima T, Barss T, Klarner T, Miklosovic S, Mezzarane RA, Komiyama T (2014). Cutaneous stimulation of discrete regions of the sole during locomotion produces “sensory steering” of the foot. BMC Sports Science, Medicine and Rehabilitation, 6(1), 33.
3. Peters RM, McKeown MD, Carpenter MG, Inglis JT (2016) Losing touch: age-related changes in plantar skin sensitivity, lower limb cutaneous reflex strength, and postural stability in older adults. J Neurophys 116:1848-1858.
4. Wiesenfeld K, Jaramillo F (1998) Minireview of stochastic resonance. Chaos 8:539-548.

Do reactions to balance perturbations improve with Fast muscle Activation and Stepping Training (FAST) in sub-acute stroke?

Garland SJ[1,2,] Ivanova TD[1], Siedlecki P[3], Peters S[4], Hunt M[4]. Pollock C[4]. and Miller K[5].

1. Faculty of Health Sciences, Western University
2. Department of Physiology and Pharmacology, Western University
3. School of Kinesiology, Western University
4. Department of Physical Therapy, University of British Columbia
5. Childrens Hospital of British Columbia

Postural reactions to balance perturbations are known to be impaired following stroke (1). A Fast muscle Activation and Stepping Training (FAST) protocol was designed to improve the speed of postural reactions and tested using a randomized controlled trial (2). Sixty-five participants received 12 sessions of outpatient physical therapy following discharge from in-patient rehabilitation and were randomly assigned to either FAST or usual care. Clinical measures of balance (Community Balance and Mobility Scale, Berg Balance Scale) and strength, as well as physiological balance measures (EMG, kinetic and kinematic data during internal arm-raise perturbations and external perturbations) were collected before, immediately after, and after 4 weeks retention. We hypothesized that while FAST and usual care would both produce improvements in clinical measures of balance, FAST would produce more effective postural reactions to balance perturbations than usual care. We also explored whether there was a relationship between clinical characteristics and responders/non-responders to the FAST treatment. Preliminary data analysis suggests that EMG measures may be too variable to be used as a primary outcome but biomechanical variables, which may be easier for clinicians to collect and interpret show more promise.

1. Garland et al. Motor Control 13: 387-411, 2009
2. Miller et al. BMC Neurology 14: 187, 2014

Using robots and other techniques to guide stroke rehabilitation

Dukelow S
University of Calgary, Canada

Stroke can lead to a number of different sensory and motor impairments. Clinically these are typically quantified using relatively simple observer-based ordinal scales which suffer from several challenges. However, these clinical assessments form the foundation for much of what occurs in stroke rehabilitation and monitoring of clinical trials. Robotic technology offers an alternative approach to measuring sensory and motor function after stroke. This presentation will focus on the use of robotic technology for measuring impairments in movement and proprioception in the upper extremity after stroke. Studies documenting the time course of stroke recovery will be presented and links between robotic assessments and neuroimaging (lesion symptom mapping, tractography) will be reviewed.

****

SESSION 2: STANDING AND FALLS 11:00-12:30pm

(Chairs Kim Delbaere & Mirjam Pijnappels)

Evidence-based surgery

Harris I
University of New South Wales, Australia

Surgery has long flown under the radar regarding effectiveness research, with new procedures introduced based largely on biological plausibility and observational evidence. Recent improvements in the methodology of surgical effectiveness research has shown surgery to be lacking, with many procedures that were once standard practice now no longer used. The evidence base for surgery is poor and newer, higher quality methods (and regulations) are required to raise the level of evidence to what should be required for such expensive and potentially harmful interventions.

The effects of a specialized treadmill system on gait speed and gait parameters for older adults with high falls risk

Kua J[1], Wong WC[1], Ramason R[1], Selvaganapathi N[1], Yu CS[2], Ng D[1], Yap J[3], Yeo A[4], Tan CN[4], Win KK[1] and Ismail NH[3]

1. Department of Geriatric Medicine, Tan Tock Seng Hospital, Institute of Geriatrics and Active Aging, Singapore
2. Department of Engineering, Ngee Ann Polytechnic, Singapore
3. Department of Continuing and Community Care, Tan Tock Seng Hospital, Singapore
4. Institute of Geriatrics and Active Aging, Tan Tock Seng Hospital, Singapore

Treadmill exercises can improve gait parameters in patients with strokes and parkinson's disease. There is limited research on treadmill exercise in falls prevention for older adults. Our study evaluates the impact of exercising on a specialized treadmill machine on gait speed and gait parameters in older adults at risk of falls. A single blinded randomized controlled study was conducted. Interventions consisted of either 60 minutes of usual care exercises; 30 minutes of usual care exercises plus 30 minutes of normal treadmill belt walking exercises or 30 minutes of usual care exercises plus 30 minutes of uneven treadmill belt walking exercises. Exercises were done twice per week. Follow up was 6 weeks. Gait and balance parameters were assessed at baseline, week 3 and at week 6. 46 participants (usual care n= 15; normal belt treadmill n=16; uneven belt treadmill n= 15) were randomized (mean age 74.95 ± 6.34 years (61- 85) and 56.5% (n=26) females). The 3 groups are similar in baseline characteristics. 4 participants dropped out leaving 42 participants for per protocol analysis. Gait speed ($t(13)= -3.36$, $p= 0.005$, $d= 0.50$) and 10m walk time ($t(13)= 2.73$, $p= 0.017$, $d= 0.45$) improved in the uneven belt treadmill group but not in the other two groups. Cadence ($t(12)=-1.06$, $p= 0.037$, $d= 0.47$) improved in the normal belt treadmill group but not in the other two groups. Exercising on the modified treadmill system can improve gait speed and gait parameters in older adults who are at high risk of falls.

1. Cheng SP, Yang CY, Tang FL & Chen IJ (2013) Training effects of a 12-week walking program on Parkinson disease patients and community-dwelling older adults. NeuroRehabilitation 32 (4): 967- 76
2. Patterson SL, Rodgers MM, Macko RF, Forrester LW (2008) Effect of treadmill exercise training on spatial and temporal gait parameters in subjects with chronic stroke: A preliminary report. J Rehabil Res Dev 45(2): 221-228

The effect of central processing and muscle torque development speed on balance recovery during standing

Van Schooten KS[1, 2], Sturnieks DL[1, 2], Menant J[1, 2], Brodie MA[1, 3], Lord SR[1, 2] and Delbaere K[1, 2]

1. Falls, Balance and Injury Research Centre, NeuRA, Sydney, Australia
2. School of Public Health and Community Medicine, University of New South Wales, Sydney Australia
3. Graduate School of Biomedical Engineering, University of New South Wales, Sydney Australia

Stepping thresholds, the maximum perturbation one can withstand without taking a step, predict falls in older people (1). This ability may require fast central processing of sensory information followed by rapid execution of adequate motor responses; both processes are impaired with age. This study tests the hypothesis that stepping thresholds are affected by central processing and muscle torque development speed.

Two-hundred forty-two people (80±4yrs;110 ♀) underwent a series of waist-pulls of increasing forces to assess stepping thresholds in anterior, posterior and mediolateral directions. We also assessed simple reaction time and neuropsychological trail making test performance, peak and rate of torque development of knee and hip flexors and extensors and hip abductors in the dominant leg. Data analysis included principal component analysis followed by a multivariate model with participant as random intercept.

We identified four factors represented muscle strength, muscle torque development speed, executive function and processing speed. Weaker (b=-2.9±0.9) and slower (b=-2.1±0.9) muscles, impaired executive functions (b=-2.7±0.9 only for mediolateral direction), and slower processing speed (b=-2.5±0.6) were associated with lower stepping thresholds. Analysis in quartiles revealed that only people in the lowest quartile of muscle strength had significantly lower stepping thresholds ($p<=0.014$). Stepping thresholds were lowest in the posterior direction (45.5±0.9N), followed by anterior (50.2±0.9N) and mediolateral directions (71.6±1.4N).

Overall, muscle strength showed a threshold effect and executive functions seem particularly important for mediolateral balance recovery. Moreover, central processing and muscle torque development speed affect stepping thresholds and may be important age-related motor impairment targets for preventing falls in older people.

1. Sturnieks DL, Menant J, Delbaere K, Vanrenterghem J, Rogers MW, Fitzpatrick RC & Lord SR (2013) PloS one 8(8), e70981

Footsteps, falls and functional ambulation in children with neuromuscular disease

Carroll KM[1,2], de Valle KL[1,2], Ryan MM[1,2,3], Kennedy RA[1,2]

1. Department of Neurology, The Royal Children's Hospital, Parkville, Australia
2. Murdoch Children's Research Institute, Parkville, Australia
3. The University of Melbourne, Parkville, Australia

One hundred and seven independently ambulant children attending the outpatient Neuromuscular Clinic at The Royal Children's Hospital were enrolled in this study. The children were aged 4-18 years (mean 9.4, SD 3.2); their diagnoses included Duchenne muscular dystrophy (n=37), Becker muscular dystrophy (n=7), Charcot-Marie-Tooth disease (n=16), congenital myopathies (n=16), collagen VI myopathies (n=11), spinal muscular atrophy (n=7), facioscapulohumeral muscular dystrophy (n=5) and `other' diagnoses (myotonic dystrophy, chronic inflammatory demyelinating polyneuropathy, congenital fibre-type disproportion, undiagnosed; n=8). Gait was assessed using an electronic walkway to measure spatio-temporal gait parameters. Mean self-selected gait speed across the group was slower than reported normative values at 111.2 cm/sec (SD 22.8). Seventy-one children reported falling at least once in the previous month, with 16 children falling every day. Tripping was the most common fall mechanism (reported by 55 children), followed by legs giving way (29), overbalancing (14), slipping (6) and rolling ankles (2). Forty-two children reported injuries from falling - mainly bruises and grazes but also instances of sprains, concussion and fractures. The number of monthly falls was moderately correlated with the 10 metre run time ($r = 0.48$, $p < 0.001$) and step time step-to-step gait variability ($r = 0.44$, $p < 0.001$). From the Functional Mobility Scale, 17 children were part-time wheelchair users and 77 children reported some limitation in their typical walking over any distance from 5 to 500 metres. Children with neuromuscular diseases face significant challenges to maintain efficient and safe ambulation sufficient to meet their everyday mobility needs.

Objective assessment of upper limb tremor distinguishes Parkinson's fallers and non-fallers and is predictive of future falls

Kerr G[1,2], White N[1], Morrison S[3]

1. Movement Neuroscience, Institute of Health & Biomedical Innovation, Queensland University of Technology, Brisbane, Australia.
2. School of Exercise & Nutrition Sciences, Queensland University of Technology, Brisbane, Australia.
3. Department of Physical Therapy, Old Dominion University, Norfolk, Virginian, U.S.A.

Postural instability leading to falls and injury is a disabling feature of Parkinson's disease (PD). Increased rigidity of the legs and trunk contributes to postural instability. However, the contribution of tremor to postural instability is less certain, even though both resting and postural tremor forms are a common motor problem. Bilateral upper limb postural and resting tremor responses of PD (51) and age-matched controls (39) were assessed while they stood on a force plate. All data were recorded at 100 Hz for 30 s. Clinical falls-risk tests and neurological assessments were also performed. Falls were recorded prospectively over 12 months. Falls occurred in 69% of PD and 46% of older people over 12 months. PD fallers had longer disease duration, greater dopamine agonist use, increased freezing of gait, decreased activities of daily living compared to PD non-fallers. Both postural and resting tremors were greater for PD fallers compared to PD non-fallers, Control fallers and Control non-fallers. There were no differences between Control Faller and Non-Faller groups. Anterior-Posterior postural sway was greater for PD Fallers compared to Control Fallers and Non-Fallers for both postural and resting tremor conditions. Linear discriminant function analysis by forward variable selection revealed that a combination of postural upper limb tremor RMS, dopamine agonist use and Tinetti total score predicted falls outcome in the Parkinson's group with a sensitivity of 89%, specificity of 69& and accuracy of 82%. Objective assessment of upper limb tremor distinguishes between Parkinson's fallers and non-fallers and is an important predictor of future

SESSION 3: YOUNG INVESTIGATORS 1:30-2:42pm
(Chairs Karen Søgaard & Jayne Garland)

The effects of demyelination in chronic inflammatory demyelinating polyneuropathy (cidp) on neuromuscular properties, muscle quantity and quality

Gilmore KJ[1], Kimpinski K[1,2], Doherty TJ[1,2,4], Rice CL[1,3]
1. School of Kinesiology, The University of Western Ontario, London, ON, Canada
2. Department of Clinical Neurological Sciences, The University of Western Ontario, London, ON, Canada
3. Department of Anatomy & Cell Biology, The University of Western Ontario, London, ON, Canada
4. Department of Physical Medicine and Rehabilitation, The University of Western Ontario, London, ON, Canada

Introduction: CIDP is an acquired neuropathy of immunological origin. It is characterized by symmetrical weakness in proximal and distal muscles that progresses for greater than 2 months [1,2]. Little is known about the pathophysiology of this disease as it relates to motor impairment. We hypothesize that CIDP patients will have significantly less overall muscle mass with increased fat infiltration, and have reduced motor unit (MU) firing rates compared to healthy controls.

Methods: In 10 patients and 10 age and sex-matched controls, magnetic resonance imaging (MRI) was used to calculate tibialis anterior (TA) muscle volume. Quantitative anatomical measures were acquired using a T1 sequence and muscle quality was assessed by T2 relaxation times using a spin-echo sequence. In addition, MU firing rates were obtained in the TA at 25, 50, 75 and 100% maximal voluntary contraction (MVC) during non-fatiguing isometric contractions.
Results: As a relative percentage of total muscle volume, CIDP patients had significantly less contractile tissue (-28%) and more non-contractile tissue (+60%) than controls. Furthermore, T2 relaxation times were ~39% longer in duration in CIDP. MU firing rates at 25 and 50% MVC were higher in CIDP by ~25%, but rates at 75 and 100% MVC were lower by ~30 and 50% compared to controls.

Conclusion: These results support that disruptions to MU firing properties have negative consequences on muscle. Thus, the utilization of MRI for muscle analysis may provide a better understanding of the impact of neuronal changes in CIDP on muscular characteristics, and motor impairment.
Supported by NSERC

1. Latov N. Diagnosis and treatment of chronic acquired demyelinating polyneuropathies. Nat Rev Neurol (2014) 10:435-46.
2. Dalakas MC. Advances in the diagnosis, pathogenesis and treatment of CIDP. Nat Rev Neurol(2011) 7:507-17.

Firing of fatigue-sensitive small-diameter afferents of the calf muscles impairs maximal contractions of the knee extensor muscles

Finn H[1, 2], Kennedy D[2, 3], Green S[4], Taylor J[1, 5]

1. NeuRA, Sydney, Australia
2. University of New South Wales, Sydney, Australia
3. University of Technology Sydney, Australia
4. Western Sydney University, Campbelltown, Australia
5. Edith Cowan University, Perth, Australia

In the arm, maintained firing of fatigue-sensitive group III/IV afferents of hand muscles reduce voluntary activation of the elbow flexors (1). Analogous effects in the leg have not been investigated. Here we test whether maintained group III/IV afferent feedback from the plantarflexor muscles reduces voluntary activation of the knee extensors.

On two days, voluntary activation (VA) of the knee extensors was assessed during brief maximal voluntary contractions (MVCs) before and after a 3-min fatiguing task of the plantarflexors (n=12). On one day immediately post-exercise, a cuff inflated around the calf occluded blood flow for two minutes. Supramaximal stimulation of the femoral nerve during and 2-3 s after MVCs of the knee extensors elicited superimposed and resting twitches. VA was calculated as (1- (superimposed/resting twitch)) x100. Muscle pain was reported on a 0-10 point scale.

In the 2 min after the fatiguing plantarflexor task, VA was 5.4% (SD 6.9) lower with blood flow occlusion than without (P=0.045). MVC force was also reduced by 12% (SD 15) (P=0.022) with the cuff inflated, and pain rated 4.9 points higher (P=0.001).

Maintained firing of group III/IV afferents from the fatigued plantarflexor muscles reduced voluntary activation and maximal force of the unfatigued knee extensors. This suggests that fatigue-related sensory feedback from the calf acts centrally to inhibit neural drive to the knee extensor muscles. When perfusion of working muscles is low, as in peripheral artery disease, this mechanism could contribute to poor performance of the knee extensors.

1. Kennedy DS, McNeil CJ, Gandevia SC, Taylor JL. (2014). Fatigue-related firing of distal muscle nociceptors reduces voluntary activation of proximal muscles of the same limb. J Appl Physiol 116(4), 385-94.

Visuomotor ankle force training in individuals with spastic cerebral palsy compared to their typically developed peers.

O'Brien S[1,2], Carroll T[1,2], Barber L[3,4] and Lichtwark G[1,2].

1. School of Human Movement and Nutrition Sciences, The University of Queensland, Brisbane, Australia.
2. Centre for Sensorimotor Performance, The University of Queensland, Brisbane, Australia.
3. School of Health, Medical and Applied Sciences, Central Queensland University, Bundaberg, Australia.
4. Child Health Research Centre, Faculty of Medicine, The University of Queensland, Brisbane, Australia.

Lower limb motor impairment produces inefficient gait in individuals with Cerebral Palsy (CP) due to their reduced ability to activate muscles in an appropriate pattern. The trainability of lower limb muscle control in CP is unknown. We tested whether 6 weeks of training involving visuomotor force tracking can improve ankle control, voluntary activation capacity and strength in individuals with CP. Four spastic type CP ([mean+SD] 20.87+1.13yrs, 2 males, hemiplegia=3, diplegia=1, GMFCS I=3, III=1) and nine typically developed (TD) (22.76+2.07yrs, 2 males) individuals completed 18 training sessions for the affected (CP) or dominant (TD) ankle. Isometric maximum voluntary plantarflexion strength, voluntary activation (using supramaximal tibial nerve stimulation), and tracking accuracy were assessed. Data were analysed as the absolute pre-post mean difference (95%CI). Voluntary activation and plantarflexion strength were 35.3% and 61.0% lower in CP than in TD, and did not improve in either group following training (TD:2.2%(-4.9:9.2%), CP:5.7%(-7.2:18.6%); TD:-4.6Nm(-18.0:8.7Nm), CP:5.6Nm(-3.3:14.6Nm)). Tracking accuracy was lower for CP than TD at baseline. Following training maximum cross-correlation co-efficient improved across all difficulties in TD only (TD: low=0.04(0.02:0.06), moderate=0.11(0.09:0.13), high=0.12(0.09:0.16) vs CP: low=0.19(-0.04:0.43), moderate=0.17(-0.003:0.35), high=0.29(-0.004:0.60)). Mean error improved across all difficulties in both groups (TD: low=-0.43Nm(-0.82:-0.05Nm), moderate=-0.94Nm(-1.39:-0.49Nm), high=-0.89Nm(-1.36:-0.44Nm); CP: low=-0.81Nm(-1.39:-0.23Nm), moderate=-0.69Nm(-1.02:-0.35Nm), high=-0.77Nm(-1.45:-0.09Nm)). The training stimulus was not sufficient to illicit improvements in maximal muscle output but indicates potential for learning to improve appropriate muscle patterning in response to a specific task in CP. Additional participants are required to understand the impact and utility of visuomotor ankle training for improving control in CP.

Ankle proprioception in people with Multiple Sclerosis

Djajadikarta ZJ[1], Gandevia SC[2] and Taylor JL[3]
1. Neuroscience Research Australia, Sydney, NSW, Australia
2. Neuroscience Research Australia, Sydney, NSW, Australia
3. Edith Cowan University, Jundaloop, Perth, WA, Australia

Multiple sclerosis (MS) is a progressive, neurological disease resulting in demyelination throughout the central nervous system. People with MS often mobilise with difficulty and over 50% fall regularly(1,2). Impaired proprioception at the ankle can contribute to an increased risk of falling(3). This study compared ankle proprioception in people with MS to healthy people.

People with MS (n = 30; 34-78 years; 22 female) and age- and gender-matched healthy controls (n = 30) were recruited. Participants sat with the knee extended and ankle in mid-range. The following outcomes were measured: (1) threshold displacement for detection of passive ankle movement, (2) plantar flexion reaction time to ankle movement, and (3) joint position sense at the ankle.

Participants with MS had impaired mobility (median EDSS = 4.0, IQR = 2). The threshold of movement detection (MS mean = 0.19^{o}, SD = 0.21^{o} and control mean = 0.14^{o}, SD = 0.12^{o}) and joint position sense at the ankle (MS mean error = 13.3^{o}, SD = 7.29^{o} and control mean error = 15.1^{o} and SD = 8.73^{o}) were not different between groups. Participants with MS had a slower reaction time than control participants (MS mean = 0.37 s, SD = 0.16 s and control mean = 0.26 s, SD = 0.06 s. Mean between-group difference [95% CI]: 0.11 s [0.05 s to 0.17 s]).

Slow reaction time to a perturbation under the foot may increase the risk of falling in people with MS, even if other aspects of ankle proprioception are intact.

1. Freeman JA. Improving mobility and functional independence in persons with Multiple Sclerosis. Journal of Neurology 2001; 248(4):
2. Nilsagard Y, Gunn H, Freeman J, Hoang P, Lord S, Mazumder R, Cameron M. Falls in people with MS - an individual data meta-analysis from studies from Australia, Sweden, United Kingdom and the United States. Multiple Sclerosis Journal 2015; 21(1)
3. Sohn J and Kim S. Falls Study: Proprioception, postural stability and slips. Bio-Medical Materials and Engineering 26 2015; 26(1)

Impaired sensorimotor control of the hand in congenital absence of functional muscle spindles

Smith LJ[1], Palma J-A[2], Norcliffe-Kaufmann L[2] , Kaufmann H[1, 2] and Macefield VG[1,3,4]

1. School of Medicine, Western Sydney University, Sydney, Australia
2. Dysautonomia Center, Department of Neurology, New York University School of Medicine, New York, USA
3. Baker Heart & Diabetes Institute, Melbourne, Australia
4. NeuRA (Neuroscience Research Australia), Sydney, Australia

Patients with Hereditary Sensory & Autonomic Neuropathy type III (HSAN III) exhibit marked gait disturbances. The cause of the gait ataxia is not known, but we recently showed that functional muscle spindle afferents in the leg, recorded via intraneural microelectrodes inserted into the peroneal nerve, are absent in HSAN III, although large-diameter cutaneous afferents are intact (1). Moreover, there is a tight correlation between loss of proprioceptive acuity at the knee and the severity of gait impairment (2). Here we tested the hypothesis that manual motor performance is also compromised in HSAN III, attributed to the predicted absence of muscle spindles in the intrinsic muscles of the hand. Manual performance in the Purdue pegboard task was assessed in 12 individuals with HSAN III and 12 age-matched healthy controls. The mean (+/-SD) pegboard score (number of pins inserted in 30 s) was 8.1+/-1.9 and 8.6+/-1.8 for the left and right hand respectively, significantly lower than the scores for the controls (14.3+/-2.9 and 15.5+/-2.0; $p<0.0001$). In five patients we inserted a tungsten microelectrode into the ulnar nerve at the wrist. No spontaneous or stretch-evoked muscle afferent activity could be identified in any of the 11 fascicles supplying intrinsic muscles of the hand, whereas rich tactile afferent activity could be recorded from 4 cutaneous fascicles. We conclude that functional muscle spindles are absent in the hand, and likely absent in the long finger flexors and extensors, and that this largely accounts for the poor manual motor performance in HSAN III.

1. Macefield VG, Norcliffe-Kaufmann L, Gutiérrez J, Axelrod, F & Kaufmann H. (2011) Brain 134: 3198-3208
2. Macefield VG, Norcliffe-Kaufmann LJ, Axelrod F & Kaufmann H (2013) Movement Disorders 28: 823-827

Cognitive contributions to the control of balance during stepping in young and older adults - a fNIRS study.

Pelicioni PHS[1, 2], Lord SR[1, 2], Seng N[3], Halmy B[1], Sturnieks DL[1, 4] and Menant JC[1, 2]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. School of Public Health and Community Medicine, University of New South Wales, Sydney, Australia
3. School of Medicine, University of New South Wales, Sydney, Australia
4. School of Medical Sciences, University of New South Wales, Sydney, Australia

Standing balance tasks requires cortical input, but whether this relates to balance control per se or simply the undertaking of a motor task (i.e. stepping) has not been investigated. We investigated prefrontal and motor function cortical activation during stepping tasks using fNIRS (functional near-infrared spectroscopy) in 20 young and 48 older people. The conditions comprised: supported standing using arm rests and unsupported free standing. Cortical activation in pre-frontal and motor brain areas was determined as relative changes in haemoglobin concentrations during a Stroop complex stepping task relative to that during a simpler choice-stepping reaction time (CSRT) task. We hypothesised unsupported stepping would require greater cortical activation, and this would be more so for older people. We found the older group was slower than the young group in both stepping conditions ($p<0.01$). Both young and old groups had slower Stroop and CSRT test times in unsupported versus supported standing ($p<0.01$), and in both groups this was accompanied by increased pre-frontal activation ($p<0.05$). The older group showed increased activation in motor areas compared with the young group in both the supported and unsupported conditions ($p<0.05$). No group by stepping condition effects were observed for either brain regions. These findings suggest unsupported stepping tasks take more time and involve higher pre-frontal activation regardless of age. However, the finding that motor areas are more highly activated in older people across conditions may provide insight into the slower stepping performances observed in this group.

SESSION 4: PAIN & FATIGUE 3:25-5:00pm
(Chairs Andrew Cresswell & Siobhan Schabrun)

Muscle pain, fatigue and performance in motor impairments.

Søgaard K
Dep of Sports Science and Clinical Biomechanics, Faculty of Health, University of Southern Denmark, Odense, Denmark.

Muscle fatigue and pain both have an impairing effect on motor performance and force generating capacity. It is evident that pain is associated with decreased maximal voluntary force in the affected muscle group both regarding work related pain and specific conditions like myalgia, impingement, and chronic neck pain. Fatigue as a precursor of pain causes some of the same effects with a decreased force response to maximal stimulation and a longlasting depression of force output evoked during low frequency stimulation[1].

Specifically, for myalgic muscles case-control studies have shown mechanical insufficiencies such as lower static, dynamic, and repetitive contraction force as well as lower rate of force development. In contrast, both voluntary activation and muscle thickness seem to be maintained at the same level as in healthy controls[2].

The underlying cause for lower force generation may be found in motor control as well as in metabolic and algesic responses to sustained low force contractions. Motor control on a single motor unit level shows activation patterns including doublets that may impair muscle Ca metabolism during repetitive contractions[3]. Disturbed intracellular Ca regulation has recently been confirmed in an animal model on work related pain. Human micro dialysis studies show that repetitive low force contraction does involve anaerobic metabolism with an increase in nociceptive substances such as lactate and glutamate in healthy and more so in myalgic muscles.
In contrast, most recently, intervention studies among patient groups have shown that specific exercise training can be tailored to effectively reverse pain conditions and motor impairment[4].

1. Søgaard K, Gandevia SC, Todd G, Petersen NT and Taylor JL. (2006). The effect of sustained low-intensity contractions on supraspinal fatigue in human elbow flexor muscles. J Physiol: 511-523
2. Beck KT, Larsen CM, Sjøgaard G, Holtermann A, Taylor JL, Søgaard K. (2017) Voluntary activation of the trapezius muscle in cases with neck/shoulder pain compared to healthy control. 2017 J Electromyogr Kinesiol. 2017 Oct;36:56-64.
3. Søgaard K, Olsen HB, Blangsted AK and Sjogaard G (2014). Single motor unit firing behaviour in the right trapezius muscle during rapid movement of right or left index finger. Frontiers in Human Neuroscience. 8:881.
4. Søgaard K and Sjøgaard G. (2017) Physical activity as cause and cure of muscular pain: evidence of underlying mechanisms. Exerc Sport Sci Rev. 2017 Jul;45(3):136-145.

Impairment of motor output by fatigue-related firing of small-diameter muscle afferents

Taylor JL
School of Medical and Health Sciences, Edith Cowan University & Neuroscience Research Australia

During fatiguing exercise, firing of small-diameter muscle afferents, which are sensitive to the accumulation of metabolites, leads to sensations of burning and fatigue from the exercising muscles. As well as eliciting reflex cardiorespiratory responses, these afferents impair voluntary motor performance. Occlusion of blood flow to the muscle after fatiguing exercise can trap metabolites and prolong firing of these afferents to allow investigation of their actions. Such studies have shown that voluntary activation of both upper and lower limb muscles is reduced by firing of afferents that innervate the tested muscle, as well as by firing of afferents from antagonist muscles, and also from more distal muscles in the same limb (1,2). For example, voluntary activation of the elbow flexor muscles is reduced by feedback from the elbow flexors, the elbow extensors or the hand. By contrast, afferents from the contralateral limb do not reduce voluntary activation (3). Reductions in motoneurone excitability may contribute to reduced voluntary activation for some muscle groups but some motoneurone pools are facilitated by fatigue-related sensory feedback (4). Therefore, supraspinal actions of the afferents are likely to feature in impairment of voluntary activation. However, no robust effects on responses to motor cortical stimulation have been reported. Thus, the supraspinal site of action and the mechanism by which fatigue-sensitive small-diameter muscle afferents impair motor output remain uncertain.

1. Kennedy DS, McNeil CJ, Gandevia SC, Taylor JL. (2013) Firing of antagonist small-diameter muscle afferents reduces voluntary activation and torque of elbow flexors. J Physiol 591, 3591-3604.
2. Kennedy DS, McNeil CJ, Gandevia SC, Taylor JL. (2014) Fatigue-related firing of distal muscle nociceptors reduces voluntary activation of proximal muscles of the same limb. J Appl Physiol 116, 385-394.
3. Kennedy DS, Fitzpatrick SC, Gandevia SC, Taylor JL. (2015) Fatigue-related firing of muscle nociceptors reduces voluntary activation of ipsilateral but not contralateral lower limb muscles. J Appl Physiol 118, 408-418.
4. Martin PG, Smith JL, Butler JE, Gandevia SC, Taylor JL. (2006) Fatigue-sensitive afferents inhibit extensor but not flexor motoneurons in humans. J Neurosci 26, 4796-4802.

Peripheral fatigue in young and old females and males

Yacyshyn AF, Gelinas JC, Brunton N, Eves ND and McNeil CJ
School of Health and Exercise Sciences and Centre for Heart, Lung and Vascular Health, University of British Columbia - Okanagan Campus, Kelowna, BC, Canada

Physical activity-induced muscle fatigue is a common experience that can limit daily tasks in many populations. This fatigue is task-dependent and evidence suggests both sex and age play critical roles. However, data are scant on sex differences for non-volitional contractions, which assess intrinsic fatigability of muscle while limiting spinal and supraspinal adaptations to mitigate fatigue. The purpose of this study was to assess the effects of sex and age on fatigability during isometric contractions induced by electrical stimulation at a physiological frequency. It was hypothesized that young females would fatigue less than males, but old adults would fatigue similarly. To date, data have been collected from 8 young females, 8 young males, 6 old females and 8 old males (24±3, 24±3, 64±3 and 67±3 years, respectively). The quadriceps of the dominant leg were fatigued by 3min of intermittent transcutaneous muscle belly stimulation (10 pulses at 15Hz; 1.25s between train onsets) at the intensity which initially evoked 25% of maximal voluntary force. Preliminary data support the hypothesis that young females fatigue less than young males (end-task force = 57±11 vs. 50±10% baseline, respectively). Interestingly, in contrast to the hypothesis, old females may fatigue more than old males (end-task force = 46±12 vs. 54±15% baseline, respectively). This suggests an interactive effect of sex and aging, wherein old females undergo intrinsic contractile changes that increase susceptibility to fatigue compared to old males. If true, old females may be more successful at using central nervous system adaptations to mitigate muscle fatigue during voluntary tasks.

Motor function and motor cortical reorganization in the transition to sustained pain

Schabrun SM[1], Seminowicz DA[2]

1. School of Science and Health, Western Sydney University, Sydney, Australia
2. Department of Neural and Pain Sciences, University of Maryland School of Dentistry, Baltimore, USA

Altered motor function and aberrant corticomotor plasticity have been identified in chronic musculoskeletal pain conditions (e.g. 1-5). However, it is unknown where in the transition to chronic pain these changes develop. A further question is whether adaptation to pain is consistent within and between individuals. Here we used a human pain model (repeated injection of nerve growth factor into the elbow extensor musculature) to investigate motor function and motor cortical organization (transcranial magnetic stimulation mapping of the representation of the elbow extensor muscles) in individuals as they developed progressively worsening muscle pain lasting up to 14 days. We hypothesized that altered motor function would develop in parallel with the pain trajectory and would be associated with aberrant motor cortical plasticity, but that the direction of change would differ between individuals. In 21 otherwise healthy individuals, we observed two discrete patterns of corticomotor plasticity in response to pain (depression or facilitation of corticomotor excitability) that were consistent within an individual and were associated with altered motor function. The pattern of corticomotor excitability adopted by an individual was related to their pain severity and self-reported disability. These data provide preliminary evidence of individual differences in motor adaptation in response to the development of sustained pain that could be related to an individual's pain susceptibility.

1. Moseley GL & Hodges PW (2006). Behav neurosci 120, 474
2. Madeleine P et al (2008). Exp Brain Res 185, 689
3. Heales LJ et al (2016). Clin biomech 35, 124
4. Schabrun et al. (2015). Med Sport Ex Sci 47, 681
5. Schabrun SM et al (2017). Spine 42, 1172.

Physical activity reduces dysregulation of the inflammatory mediators in the multifidus muscle after spontaneous intervertebral disc degeneration in SPARC-null mice

Hodges, PW[1], James, G[1], Millecamp, M[2], Stone, L[2].

1. School of Health and Rehabilitation Sciences, The University of Queensland, Brisbane, QLD, Australia;
2. Faculty of Dentistry, McGill University, Montreal, Quebec, Canada

A pro-inflammatory response is present in the multifidus muscle after an intervertebral disc lesion and is proposed to drive structural alterations in back muscles in low back pain(1). These changes are purported to contribute to persistence and worsening of the condition. Exercise and physical activity produce a strong anti-inflammatory response but the effectiveness in ameliorating inflammation in the multifidus muscle is unknown. We assessed the inflammatory profile of multifidus using SPARC-null mice that develop spontaneous intervertebral disc degeneration (IDD) and whether physical activity could prevent changes. Wild-type and SPARC null mice were sedentary or housed with a running wheel. Multifidus muscle segments were harvested from L2-L6 from the mice at 9 months after an MRI scan to determine levels with IDD. Multifidus inflammatory profile was examined using real time PCR assays. Inflammatory cytokine expression was considered with respect to proximity to levels with IDD and compared between wild-type and SPARC-null mice and those with and without exposure to physical activity. Spontaneous IDD in the SPARC-null mice caused dysregulation of interleukin-1beta (IL-1β), interleukin 6 (IL6), Transforming growth factor beta1 (TGFβ1) and adiponectin expression. The proximity and degree of IDD was related to levels of IL-β1 expression. Physical activity reduced the pro-inflammatory response to IDD in multifidus. IL-1β, tumor necrosis factor, interleukin-10, adiponectin, and leptin levels were lower in the physically active group. These results reveal that spontaneous IDD dysregulates the inflammatory pathways active in the multifidus muscle. Alterations were related to the severity of IDD and were prevented by physical activity.

1. Hodges PW, James G, Blomster L, Hall L, Schmid A, Shu C, Little C, Melrose J (2014) Spine, 39(13), 1010-7.

Brainsight®
cTMS

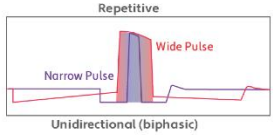
Based on a completely different architecture than traditional TMS, cTMS offers a whole new level of control for TMS.

Features of the cTMS

- Variable pulse shapes
- Integrated EMG
- Integrated output recording
- Multiple general purpose triggers (4 IN 4 OUT)
- External control via network

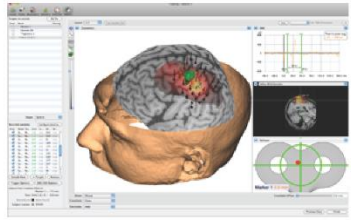
Flexible Pulse
Programming

The cTMS allows for variable and controllable pulse shapes, which include unidirectional and biphasic rTMS, including theta burst and quadripulse.



Brainsight®
TMS Neuronavigation

BrainSight TMS stereotaxic neuronavigation system offers online visual feedback of the TMS coil position in respect to the individuals MRI image or MRI generated 3D curvilinear reconstruction of the brain through a subject-image coregistration.



- Intuitive and flexible project workflow
- Universal TMS compatibility
- Flexible target selection
- Record data with every TMS pulse:
  - Coil location and orientation
  - Stimulator information*
  - MEP/EMG*, EEG* and fNIRS response*

SYMBIOTIC DEVICES
p au 1300 934 947 nz 09 886 4877
w www.symbioticdevices.com.au
e team@symbioticdevices.com.au

POSTERS (on display throughout meeting)

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

Monday 26 November 1:30-3:00pm

P01 Cold-water immersion of a single limb increases motor cortex excitability for the opposite limb

Delahunty ET and Kavanagh JJ
Menzies Health Institute Queensland, Griffith University, Gold Coast, Queensland, Australia

A body of evidence indicates that strong voluntary contractions can elicit unintended motor activity in the opposite limb. However, it is unknown if acute changes of sensory input for one limb can alter motor activity on the opposite side of the body. The current study examined if immersing a single upper limb in very cold water (4 degrees Celsius) affected motor cortex circuitry for the opposite non-immersed limb. We hypothesised that intense pain evoked by cold stimuli would increase excitability in ipsilateral primary motor cortex.

Eight healthy subjects (22.1 ± 2.7 yr) participated in the experiment. Standard paired-pulse TMS protocols were used to assess motor cortex circuitry associated with the non-immersed limb. Resting motor threshold, short interval intracortical inhibition (SICI), long interval intracortical inhibition (LICI), and intracortical facilitation (ICF) were assessed for the extensor carpi radialis brevis muscle in the non-immersed limb.

Visual analogue scales confirmed that significant changes in pain and temperature occurred due to the intervention. Although resting motor threshold and LICI was unaltered, SICI was significantly reduced ($p = 0.02$), ICF was significantly increased ($p < 0.01$), and background EMG was significantly increased ($p = 0.04$) for the non-immersed limb during the intervention. The presence of a localised painful stimulus on one side of the body affected cortical circuits responsible for activating muscles on the opposite side of the body. While separate mechanisms may regulate SICI and ICF, the overall effect of intense pain was an increase in motor cortex excitability of the ipsilateral hemisphere.

P02 Group III/IV muscle afferent feedback does not modulate intracortical excitability and inhibition following fatiguing exercise.

Latella C[1], Taylor JL[1, 2]

1. Centre for Exercise and Sports Science Research (CESSR), School of Medical and Health Sciences, Edith Cowan University, Perth, Australia
2. Neuroscience Research Australia, Randwick, Australia

Objective: Feedback from group III/IV muscle afferents is known to cause a reduction in motor drive and voluntary activation of the muscle during intense exercise (1,2). However, the effect of group III/IV muscle afferent feedback on intracortical excitatory and inhibitory networks is not well understood. Methods: On two separate days, 16 participants (11M,5F) completed a sustained maximal isometric index finger abduction until force decreased by 40%. On one day, post-exercise blood flow occlusion of the hand maintained group III/IV afferent firing whereas recovery was allowed on the other day (control). Pain was assessed using a 0-10 scale. Single- and paired-pulse transcranial magnetic stimulation (TMS) assessed motor evoked potentials (MEP), intracortical facilitation (ICF), and inhibition at 2 and 3 ms (SICI2, SICI3, respectively) in the first dorsal interosseous muscle. Maximal M waves (MMAX) were also elicited pre- and post-exercise. Results: Pain was significantly greater for the occlusion condition ($p<0.001$). MMAX (-8.7% and -5.4%, $P<0.001$) and the MEP/MMAX ratio (-46.5% and -49.8%, $P=0.007$) were reduced post-exercise for occlusion and control, respectively, but were not different between conditions (MMAX: $P=0.559$, MEP/MMAX: $P=0.415$). No differences were observed for SICI2 ($P=0.084$), SICI3 ($P=0.342$) or ICF ($P=0.087$) between conditions and across time. Conclusion: Consistent with previous findings (3), the reduction of MEPs after exercise is not influenced by the maintained firing of fatigue-sensitive muscle afferents. Additionally, intracortical networks do not appear to be modulated. This suggests that the failure of voluntary activation with group III/IV muscle afferent firing occurs via mechanisms outside of the primary motor cortex.

1. Kennedy DS, Fitzpatrick SC, Gandevia SC & Taylor JL (2015) J Appl Physiol 118: 408-418
2. Kennedy DS, McNeil CJ, Gandevia SC & Taylor JL (2013) J Physiol 591(14): 3591-3604
3. Taylor JL, Petersen N, Butler JE, Gandevia SC (2000) J Physiol 525(3): 793-801

P03 Paired corticospinal-motoneuronal stimulation does not improve maximal voluntary elbow flexion in people with incomplete cervical spinal cord injury

Dongés SC[1], Boswell-Ruys CL[1], Butler JE[1,2] and Taylor JL[1,2,3]
1. NeuRA, Sydney, Australia
2. University of New South Wales, Sydney, Australia
3. Edith Cowan University, Perth, Australia

Corticospinal transmission to motoneurones can be modified using repeated pairs of stimuli to presynaptic corticospinal neurones and postsynaptic motoneurones. This technique, termed paired corticospinal-motoneuronal stimulation (PCMS), can modify evoked muscle potentials and voluntary motor performance in people with and without spinal cord injury (1-4). Maximal voluntary performance after PCMS has only been assessed for thumb adduction in people without spinal cord injury (3). Here, we hypothesised that PCMS would enhance maximal voluntary elbow flexion in people with incomplete cervical spinal cord injury. PCMS comprised 100 stimulus pairs (transcranial magnetic and electrical peripheral nerve stimulation) at 0.1 Hz, timed so corticospinal potentials arrived at corticospinal-motoneuronal synapses 1.5 ms before antidromic motoneuronal potentials. On two days (5-22 days apart), sets of 5 maximal elbow flexions were performed by 11 individuals with spinal cord injury (C4/C5 level) before and after PCMS or control (100 peripheral nerve stimuli) conditioning. To measure maximal voluntary activation, supramaximal biceps brachii stimulation elicited superimposed twitches during contractions, which were normalised to resting twitches. Torque and electromyographic activity during contractions were also assessed. Baseline median (interquartile range) maximal torque was 11 Nm (10 to 25 Nm) and voluntary activation was 92% (83 to 96%). There were no significant differences in outcome measures between PCMS and control protocols after conditioning. Thus, PCMS did not improve maximal motor output for this group. Possible explanations for the lack of effect include a potential ceiling effect for voluntary activation, or that PCMS may be less effective for elbow flexors than more distal muscles.

1. Taylor JL & Martin PG (2009) J Neurosci 29, 11708-11716
2. Bunday KL & Perez MA (2012) Curr Biol 22, 2355-2361
3. D'Amico JM, Dongés SC & Taylor JL (2018) J Neurophysiol 119, 369-376
4. Dongés SC, D'Amico JM, Butler JE & Taylor JL (2018) J Neurophysiol 119, 652-661

P04 Investigating the effects of muscle contraction and conditioning stimulus-intensity on short-interval intracortical inhibition

Hendy AM[1], Ekblom MM[2], Latella C[3], Teo WP[1]

1. Institute for Physical Activity and Nutrition (IPAN), School of Exercise and Nutrition Sciences, Deakin University, Burwood, Australia.
2. The Swedish School of Sport and Health Sciences, GIH, Stockholm, Sweden.
3. School of Medical and Health Sciences, Edith Cowan University, Joondalup, Australia.

Short-interval intracortical inhibition (SICI) is typically assessed using paired transcranial magnetic stimulation (TMS) over the primary motor cortex (M1)(1). A reduction in SICI has been shown to precede long-term potentiation after motor practice(2), and occur with enhanced muscle strength after resistance training(3). This study assessed the effect of muscle contraction intensity and conditioning stimulus parameters on modulations in SICI.

Single and paired-pulsed TMS was applied to the M1 and motor-evoked potential (MEP) amplitude was recorded from the biceps brachii in 16 adults. Stimuli were delivered while participants performed 10, 20, 40 and 75% of maximal voluntary isometric contraction (MVIC). At each contraction level, the test stimulus was assessed at 120% of active motor threshold (AMT), while the conditioning stimulus was set to three different conditions: 60, 70 and 80% of AMT.

The single pulse MEP increased with force output, with the highest values occurring at 75% MVIC. In contrast to previous literature(4), the current study did not identify a reduction in SICI from 10 to 40 % MVIC, but rather from 40 to 75 % MVIC ($p < 0.01$). There was no significant interaction between conditioning stimulus intensity and force level ($p = 0.558$), or main effect for conditioning stimulus intensity ($p = 0.752$).

Even during high force outputs (75% MVIC), SICI was still present, possibly allowing for even greater withdrawal of inhibition at higher contraction intensities. Future studies might consider assessing SICI not only at rest or during low contraction intensities, but also at high or maximal intensity.

1. Kujirai T, Caramia MD, Rothwell JC, Day BL, Thompson, PD, Ferbert A, & Marsden CD (1993) J Physiol 471, 501-519
2. Coxon JP, Peat NM, & Byblow WD (2014) J Neurophysiol 112, 156-164
3. Weier AT, Pearce AJ, & Kidgell DJ (2012) Acta Physiol 206, 109-119
4. Ortu E, Deriu F, Suppa A, Tolu E & Rothwell JC (2008) J Physiol 586, 5147-5159

P05 Effects of postural challenge on responses to cortical stimulation: a potential probe of extrapyramidal tract function?

Russell CL[1, 2]*, Difford NB[1, 2]*, Stamenkovic A[1,2], Arpel C[1,2], Stapley PJ[1,2], Walsh JA[1,2], McAndrew DJ[1,2] and Shemmell J[1,2]
*Equal author contributions
1. School of Medicine, University of Wollongong, Wollongong, Australia
2. Illawarra Health and Medical Research Institute, Wollongong, Australia

The reticulospinal tract is known to play a key role in postural control yet is difficult to directly assess in humans due to its subcortical origins (1). However, cortico-reticulospinal contributions to responses generated by transcranial magnetic stimulation (TMS) over the motor cortex are shown to occur ~10 ms later than those driven by corticospinal input in monkeys (2). We hypothesised that the area of late responses (10-20 ms after response onset) in the lower limb would be greater than early responses (0-10 ms after response onset) when posture was challenged.
Two experimental protocols targeted 1) the triceps brachii or 2) medial gastrocnemius with single-pulse TMS. Bilateral muscle activity was recorded during isometric contractions (5% MVC upper limb; 20% MVC lower limb). Motor evoked potentials were produced and response area quantified across four levels of postural challenge: seated, bilateral and uni-lateral limb support (right or left limb). During the upper limb tasks, balance also involved using both or one arm.
Preliminary analysis (n = 5) shows that late responses were significantly larger than early responses across conditions ($p = 0.045$). A small (but ns) increase in the area of the late response was observed when the contralateral arm was supporting posture. In the lower limb, a greater late response (vs. early) was observed in the postural support limb.

These results suggest that postural challenge modulates TMS-induced muscle responses in the upper and lower limbs, with the modulation being primarily restricted to late portions of the response.

1. Petersen BW (1979) Reticulospinal projections to spinal motor nuclei. Ann Rev Physiol 41, 127-140
2. Fisher KM, Zaaimi B, Baker SN (2012) Reticular formation responses to magnetic brain stimulation of the primary motor cortex. J Physiol 590(16), 4045-4060

P06 The relationship between motor cortex organisation and motor variability in the transition to sustained muscle pain

Summers SJ[1], Chipchase LS[1, 2], Hirata R[3], Graven-Nielsen T[4], Cavaleri R[1], Schabrun SM[1]

1. Western Sydney University, School of Science and Health, Penrith, NSW, Australia.
2. Faculty of Health, University of Canberra, ACT, Australia
3. Laboratory for Musculoskeletal Pain and Motor Control, SMI, Department of Health Science and Technology, Faculty of Medicine, Aalborg University, Aalborg, Denmark.
4. Center for Neuroplasticity and Pain (CNAP), SMI, Department of Health Science and Technology, Faculty of Medicine, Aalborg University, Aalborg, Denmark.

Evidence to support a relationship between the reorganisation of the primary motor cortex(M1) and altered motor control in response to pain is limited.Here, we examined the relationship between M1 reorganisation and motor variability in response to sustained muscle pain. We hypothesized that sustained muscle pain would stimulate M1 reorganisation, and that changes in M1 would correlate with the magnitude of motor variability.Twenty-eight healthy individuals were injected with nerve growth factor(NGF) into right extensor carpi radialis brevis(ECRB) muscle on Days 0 and 2. Assessment of M1 organisation using transcranial magnetic stimulation and motor variability were performed on Days 0,2,4, and 14.Motor variability was assessed during a radial-ulna movement and quantified as variability of wrist flexion-extension and forearm pronation-supination (kinematic variability),and electromyography(EMG) activity of ECRB(EMG variability).Pain intensity, disability,and muscle soreness were assessed on each day.Pain intensity, disability,and muscle soreness increased at Day 2 and 4(P0.15).Discrete peaks and centre of gravity (CoG) were unchanged(P>0.55).Map volume reduced at Day 2 and 4(P0.13),nor between map outcomes and kinematic variability(P>0.15).These data indicate a decrease in map excitability in response to sustained muscle pain.Reduced map excitability was associated with reduced EMG variability during a wrist radial/ulna movement.These findings suggest a relationship between M1 reorganisation and motor variability in response to pain.

1. Schabrun S, Christensen SW, Mrachacz-Kersting N, Graven-Nielsen T. Motor cortex reorganization and impaired function in the transition to sustained muscle pain. Cerebral Cortex. 2015

P07 Timed Up and Go task after applying anodal-transcranial Direct Current Stimulation (tDCS)in people with Parkinson's disease? Preliminary results

Alizad V[1,2], Meinzer M[3], Frossard L[4], Polman R[5], Smith SS[6], Kerr G[1]

1. Institute of Health & Biomedical Innovation, Queensland University of Technology, Brisbane, QLD.
2. Iranian Research Centre on Ageing, The University of Social Welfare and rehabilitation Sciences, Tehran, Iran.
3. Centre for Clinical Research, The University of Queensland, Brisbane, QLD.
4. Institute of Health & Biomedical Innovation Queensland University of Technology, Brisbane, QLD.
5. School of Exercise and Nutrition Sciences, Queensland University of Technology, Brisbane, QLD.
6. Institute for Social Science Research (ISSR), The University of Queensland, Brisbane, QLD.

Locomotion difficulties are disabling to people with Parkinson's disease (PD). Current treatment approaches, such as pharmacological treatments and physical rehabilitation have only limited effectiveness in improving ambulation. Deep brain stimulation may be effective in treating the locomotion difficulties, but its highly invasive nature and potential side effects have prompted the search for alternative strategies. TDCS is a non-invasive alternative that might improve locomotor performance in PD (1). The objective of this study was to investigate the effects of anodal-tDCS with two different montages on locomotion in PD. Eight patients (aged 40-80 years; 3 women, 5 men; MDS-UPDRS score: 39.03±10.50) participated in a three-way, cross-over, sham-tDCS controlled study and received bilateral anodal-tDCS (1 mA, 20 minutes, 10×4cm2) of the pre- and primary-motor cortices with either a small active cathode (4×4 cm2), or a large functionally inert cathode (10×10 cm2) over the cerebellum, or sham-tDCS presented randomly while walking on a treadmill over three sessions one week apart. Locomotor performance was measured using the Timed Up and Go (TUG) test before and after each tDCS session (2). Only anodal-tDCS over the pre-and primary-motor cortices with a functionally inert cathode combined with treadmill walking significantly decreased time taken to perform the TUG (pre- vs. post diff: 0.76 ± 0.54 sec, 95% CI: 0.34 to 1.18). Sham-tDCS and the biphasic montage (active M1/Cerebellum) did not improve TUG. These results provide preliminary evidence M1 tDCS may be effective to improve walking ability in PD, which needs to be verified in larger samples and in combination

1. Ferrucci R, Mameli F, Ruggiero F, Priori A. Basal Ganglia. 2016;6(1):53-61.
2. da Silva BA, Faria C, Santos MP, Swarowsky A. Journal of rehabilitation medicine. 2017;49(9):723-31.

P08 Guidelines for the design of stepping interventions for falls prevention

Giannouli E, Morat T and Zijlstra W
Institute of Movement and Sport Gerontology, German Sport University Cologne, Germany

To maximize effectiveness, falls-prevention exercise programs need to implement research evidence into practice. The ability to execute steps that vary in amplitude, speed, accuracy (1) in single and multi-task conditions (2) is critical for preventing accidental falls. For that reason, stepping training has been found to be particularly effective in reducing falls (3). However, to achieve optimal effects, training plans need to be specific and well dosed. Based on an analysis of age-related changes in stepping patterns, relevant ingredients for step training as well as their gradual progression are defined and a structured approach to stepping training which allows systematic manipulation of spatiotemporal aspects (e.g. stepping speed, amplitude, direction), sensory aspects (e.g. stepping on wobbly surfaces) and task complexity (single-/, dual-tasking) is presented. The proposed framework can be used for the optimal design of dose-response based exercise programs in individual or group-based training of voluntary stepping, with or without assistive technology. An exemplary stepping training program which includes the suggested components and complies with the design principles is described in detail. Further studies developing stepping interventions using these guidelines are encouraged.

1. Schoene, D., Delbaere, K., & Lord, S. R. (2017). Impaired Response Selection During Stepping Predicts Falls in Older People - A Cohort Study. Journal of the American Medical Directors Association, 18(8), 719-725.
2. Melzer, I., Kurz, I., Shahar, D., & Oddsson, L. I. (2010). Do voluntary step reactions in dual task conditions have an added value over single task for fall prediction? A prospective study. Aging clinical and experimental research, 22(5-6), 360-366.
3. Okubo, Y., Schoene, D., & Lord, S. R. (2016). Step training improves reaction time, gait and balance and reduces falls in older people: a systematic review and meta-analysis. Br J Sports Med, bjsports-2015.

P09 Motor learning processes in responding to increasingly unpredictable trips and slips in older adults

Okubo Y[1, 2], Sturnieks DL[1, 2], Brodie MA[1, 2], Duran L[1, 3] and Lord SR[1, 2]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, New South Wales, Australia
2. UNSW Sydney, New South Wales, Australia
3. Department of Human Movement Sciences, Vrije Universiteit Amsterdam, The Netherlands

Background: Previous studies have reported that older adults can learn to recover from predictable laboratory-induced postural perturbations (often of fixed location and/or type) within a few repetitions. In real-life, however, many postural perturbations are not predictable. We hypothesized older adults could be trained to recover from unpredictable trips and slips, which could form the basis of an effective fall prevention program.

Methods: Nineteen community-dwelling older adults (65+yr) underwent three 40-min training sessions comprising (1) 20 trips, (2) 20 slips and (3) 10 trips and 10 slips in mixed order, over two days (ACTRN12617000564358). Perturbation unpredictability (e.g. hazard location and/or type) was increased within and between sessions. Participants were in a full-body safety harness and peak loading on the harness (normalized to body weight [%BW]) was recorded (reduced loading indicating better recovery). Student paired t-tests were used to compare harness loading between the first and last perturbation of each session.
Results: There was no significant change in harness loading during session 1 (trips only). During session 2, harness loading significantly reduced for slips (16.8±2.5%BW versus 8.2±1.1%BW, p=0.006). During session 3, harness loading significantly reduced for slips (14.6±7.3%BW versus 10.6±8.5%BW, p=0.025) but not trips. During sessions 3, average harness loading during trips was significantly higher than during slips (17.5±11.8%BW versus 12.3±5.1%BW, p=0.018).

Conclusion: Older adults could learn to respond better to unpredictable slips. Effective training for trips with increasing unpredictability may require more sessions or a modified protocol.

1. Bohm S, Mademli L, Mersmann F, Arampatzis A. Predictive and Reactive Locomotor Adaptability in Healthy Elderly: A Systematic Review and Meta-Analysis. Sports medicine (Auckland, NZ). 2015;45:1759-77.

P10 Using smart socks and rhythmic haptic cues to stimulate the foot arch may reduce gait variability during a freezing of gait elicitation task

Brodie M[1], Iberzanov A[1], Lord S[1], Canning C[2], Fung V[3], Henderson E[4], Close J[1], Lovell N[5], Lung T[6], Schreier G[7], Vigano D[8], and Delbaere K[1]

2. NeuRA, Randwick, Australia
3. Faculty of Health Sciences, University of Sydney, Australia
4. Movement Disorders Unit, Westmead Hospital, Westmead, Australia
5. Department of Population Health Sciences, University of Bristol, Bristol. UK
6. Graduate School of Biomedical Engineering, University of NSW, Randwick, Australia
7. The George Institute for Global Health, Sydney, Australia
8. Digital Health Information Systems, AIT Austrian Institute of Technology, Graz, Austria
9. Sensoria Health Inc, Redmond, USA

Falls are a serious complication for people with Parkinson's disease (PD) and are often precipitated by excessive step-time-variability and freezing-of-gait (FOG). [1-2] Our previous work showed an acetylcholinesterase inhibitor can reduce step-time-variability; contributing to a 45% reduction in falls. [1] Rhythmic auditory cues may also reduce step-time-variability, but this could intrude on activities of daily living (ADLs). [3] This study tests the hypothesis that rhythmic haptic cues can reduce gait variability in healthy people during tasks known to evoke FOG in people with PD. [4]. Eleven healthy people (6-male, 5-female, aged 24-61) participated in two pilot studies including: (i) a FOG elicitation task comprising walking and turning in tight spaces; (ii) three-laps of a flight of stairs; (iii) five-laps of a six-meter walkway. Step-time-variability for baseline walks (no cues), training walks (cued) and retention walks (no cues) was assessed. During training, haptic cues were applied to alternate foot arches using vibrotactile buzzers for 250ms at the participants' preferred cadences. Step-time-variability was assessed with an accelerometer attached to the sacrum and pressure sensor within a Sensoria smart-sock.

Study one (n=6): Step-time-variability remained unchanged during three repeated baseline FOG elicitation walks. After three training walks with haptic cues, step-time-variability was significantly reduced by 35% ($p=0.04$). Study two (n=5): Non-significant 45% and 8% reductions in step-time-variability were observed for laps of the walkway and stairs respectively (both $p>0.05$).
Rhythmic haptic cues may reduce step-time-variability during tasks known to elicit FOG. Further research is now required in people with PD.

1. Henderson, E. J., et al. Lancet Neurol 15, 249-258, doi:10.1016/S1474-4422(15)00389-0 (2016)
2. Allen, N. E., Schwarzel, A. K. & Canning, C. G. Parkinson's disease 2013, 906274, doi:10.1155/2013/906274 (2013).
3. Brodie, M. A., et al. Journal of Parkinson's disease 5, 105-116, doi:10.3233/JPD-140430 (2015).
4. Lord, S., et al. Lancet Neurology (Submitted 2018).

P11 Estimates of gait initiation-onset in both stroke and healthy individuals during the sit-to-walk task

Jones GD[1, 2], James DC[3], Thacker M[1, 2, 4], Perry R[2], and Green DA[1, 5, 6]

1. Centre for Human and Applied Physiological Sciences (CHAPS), Faculty of Life Sciences & Medicine, King's College London, London, UK
2. Department of Physiotherapy, Guy's & St Thomas' NHS Foundation Trust, London, UK
3. Sport and Exercise Science Research Centre, London South Bank University, London, UK
4. Allied Health Sciences, London South Bank University, London, UK.
5. European Astronaut Centre, Directorate of Human Spaceflight and Robotic Exploration Programmes (D/HRE), European Space Agency, Cologne, Germany
6. KBRwyle GmbH, Albin Köbis Straße 4, Cologne, 51147, Germany

Gait-initiation (GI) during sit-to-walk (STW) includes an anticipatory-phase where the centre-of-pressure moves towards the swing-limb before an execution-phase begins with heel-off, similar to GI from quiet-standing [1,2]. The mediolateral ground-reaction-force (xGRF) breaching a pre-determined threshold from sit-to-stand (STS) trials normally estimates STW GI-onset [3]. However, it has poor utility following stroke, with alternative estimation methods typically deployed [4]. We aimed to determine the extent of xGRF-threshold failure in stroke, and test the hypothesis that alternatives estimate GI-onset later during anticipatory or execution-phases of GI. Twenty (7F) stroke individuals [median(IQR) age=60(50-64years)], and twenty-one (7F) age-matched healthy volunteers [64(51-75years)] performed 5 standardised STW and STS trials. Force-plates and optical motion determined 4 GI-onset estimations; xGRF threshold (xGRFthresh), maximum xGRF (xGRFmax), maximum swing-limb vertical GRF (vGRFmaxSWING), and heel-off (firstHEELoff). Differences in transition-times (seat-off–GI-onset) across methods were assessed using Kruskal-Wallis tests. In stroke, there was no statistical difference in transition-time across methods with median vGRFmaxSWING the shortest estimate [0.522(0.303-1.435s)]. Healthy individuals' transition-times differed across methods [$\chi^2(3)=29.264$; $p<0.001$]. Median xGRFmax transition-time [0.183(0.083-0.270s)] and vGRFmaxSWING [0.080(0.020-0.180s)] consistently placed GI-onset within the GI anticipation-phase, albeit later than xGRFthresh [0.027(-0.033-0.098s)], with firstHEELoff placing it later in the execution-phase [0.293(0.167-0.365s)]. In 49% of stroke, and 6% of healthy trials, equivalent peak xGRFs during STW and STS meant GI-onset using xGRFthresh was indeterminate because xGRF failed to breach the pre-determined threshold. Estimating GI-onset using xGRFthresh is not appropriate in individuals with stroke. In contrast, maxSUMxGRF or maxSWINGvGRF are practical methods to estimate anticipatory-phase GI-onset regardless of STW performance dynamics.

1. Buckley, T., et al. Journal of Biomechanics, 2009. 42(14): p. 2318-22.
2. Magnan, A., B.J. McFadyen, and G. St-Vincent, Gait & Posture, 1996. 4(3): p. 232-241.
3. Kerr, A., B. Durward, and K.M. Kerr, 2004. 19(4): p. 385-90.
4. Frykberg, G.E., et al. Archives of Physical Medicine and Rehabilitation, 2009. 90(6): p. 1009-17.

P12 Balance in dizzy middle-aged and older people reporting unsteadiness: is it all in the head?

Menant JM[1], Brodie MA[1], Migliaccio A[1], Close J[1,2], Titov N[3], Delbaere K[1], Sturnieks D[1], Turner J[1] and Lord SR[1]

1. Falls Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. Prince of Wales Clinical School, UNSW, Sydney, NSW, 2031, Australia
3. Department of Psychology, Macquarie University, Sydney, NSW, 2109, Australia

Anecdotally, self-reports of long-lasting unsteadiness among people with dizziness are often attributed to psychological causes. Here, we investigated balance during standing and walking in middle-aged and older dizzy people self-reporting unsteadiness lasting for hours to days. We conducted a secondary analysis of baseline data from a randomised controlled trial (1). Three hundred and five community-dwellers aged 50-92 years, reporting significant dizziness in the past year and not undergoing treatment completed questionnaires relating to dizziness history and psychological function and undertook tests of sensori-motor function, balance, stepping and gait. Based on self-reported dizziness history, we identified participants (n=65) who reported experiencing symptoms of constant imbalance, unsteadiness, “legs detached from the body”, “floating sensation” for at least one hour at the time. Compared with the rest of the dizzy sample (n=240), those self-reporting unsteadiness did not differ in age, general cognition, symptoms of anxiety, depression, neuroticism or fear of falling ($p>0.05$). However, participants with self-reported unsteadiness had increased postural sway during standing (eyes open / closed, on /off a compliant surface) compared with the rest of the dizzy sample ($p<0.05$ for all). They also displayed greater medio-lateral instability at the head and pelvis (smaller harmonic ratios recorded with 3D accelerometers) during walking (p0.05). In conclusion, contrary to common beliefs, middle-aged and older people self-reporting long lasting unsteadiness appear to have impaired balance during standing and walking, as indicated in quantitative assessments.

1. Menant JC & al (2018) Plos Med 15(7):e1002620

P13 The validity of inertial measurement units (IMU) in three-dimensional lower-body human gait analysis

Letton M, Thom JM and Ward RE
Department of Exercise Physiology, School of Medical Sciences, Faculty of Medicine, University of New South Wales, Sydney Australia

Inertial measurement units (IMUs) are small, cost effective, wearable sensor technology used to record human motion (1), especially useful when remotely analysing movement, including gait patterns, for a range of clinical conditions. Thus, the application of IMUs is broader than optical motion capture, the current 'gold standard' technique (2). The aim of this study was to validate Vicon IMUs with optical motion capture during gait. We hypothesized that IMUs would accurately measure joint angle kinematics during gait, as compared to optical motion capture. Methods: IMUs and optical motion capture simultaneously assessed human motion during the gait cycle, in 8 healthy adult volunteers (23.25±2.96 years, BMI 21.76±2.44, mean±SD). IMUs were attached to volunteers at the pelvis, thigh, shank and foot segments. Accelerometer, gyroscope and magnetometer data was sent via Bluetooth to the Vicon Nexus program on a PC. MATLAB was then used to calculate the hip, knee and angle joint kinematics. The average error between the measurement methods was 11.8°±1.5° for hip sagittal ROM, 2.1°±4.1° for knee sagittal ROM, and 8.9°±6.0° for ankle sagittal ROM. Current IMU technology was found to be accurate in recording knee joint kinematics. Further analysis is needed to determine whether hip and ankle joint kinematic data can be accurately obtained using IMUs. Whole body joint kinematic data also needs to be analysed to validate IMUs for possible use in motor impairment/falls risk populations in clinical settings.

1. Schall Jr, M. et al. (2015). Accuracy and repeatability of an inertial measurement unit system for field-based occupational studies. Ergonomics. 59(4): 591-602
2. Goodvin, C. et al. (2006). Development of real-time three-dimensional spinal motion measurement system for clinical practice. Med Bio Eng Comput. 44:1061-1075

P14 Can retrospective report of falls provide an accurate snapshot of falling compared to prospective reporting in children and adolescents with Charcot-Marie-Tooth disease?

Kennedy RA[1,2,3], McGinley JL[2,3], Ryan MM[1,2,3], Paterson, KL[3] and Carroll K[1,2]

1. Department of Neurology, The Royal Children's Hospital, Parkville, Australia
2. Murdoch Children's Research Institute, Parkville, Australia
3. The University of Melbourne, Parkville, Australia

A six-month prospective falls study in paediatric Charcot-Marie-Tooth disease (CMT) reported falls incidence 33 times greater than typically developing children with a large number of injurious falls [1]. Whilst prospective studies are the gold standard of reporting falls [2], and provide important details of falls incidence and consequences, they are time- and labour-intensive, and burdensome on participants and families. This study aimed to determine if retrospective reporting of falls in the clinical setting is comparable to prospective reporting. Twenty-five children aged 4-17 years (mean 11.4, SD 3.5) with CMT participated in a six-month prospective falls study [1]. Retrospective report at the commencement of the prospective study included falls frequency, mechanism, location, surface type and injuries. Falls frequency was comparable between the two methods when divided into categories: non-fallers (retrospective 16%; prospective 12%), fallers (1-2 falls; retrospective 36%; prospective 44%) and recurrent fallers (>2 falls; retrospective 48%; prospective 44%). Children who fell infrequently, under-estimated falls recall from 6 months beforehand. Tripping was the most common mechanism reported both retrospectively (56%) and prospectively (76%). Most injuries sustained were cuts and grazes (retrospective 68%; prospective 48%). Interestingly, children under-estimated falls in home and community environments, and on flat surfaces (indoors and outdoors) when recalling falls history, and over-estimated the number of falls in the playground. Retrospective falls reporting is meaningful to ascertain fallers from non-fallers, mechanism of falls and injuries sustained in paediatric CMT. Reporting of falls in the outpatient clinic is valuable in determining the functional consequences of neuromuscular weakness.

1. Kennedy, R.A., et al., Falls in paediatric Charcot-Marie-Tooth disease: a six-month prospective cohort study. Arch Dis Child, 2018 (under review, May 2018).
2. Lamb, S.E., et al., Development of a Common Outcome Data Set for Fall Injury Prevention Trials: The Prevention of Falls Network Europe Consensus. J Am Geriatr Soc, 2005. 53(9): p. 1618-1622.

P15 Quadriceps rate of force development following total knee replacement is associated with gait speed - low-cost clinically feasible methodology

Perraton LG[1], Bower KJ[2], Mentiplay BF[3], Feller J[4], Whitehead T[4], Webster K[3], Clark R[2]

1. Department of Physiotherapy, Monash University, Melbourne, Australia
2. School of Health and Sports Sciences, University of the Sunshine Coast, Sippy Downs, Australia
3. Faculty of Health Sciences, La Trobe University, Melbourne, Australia
4. Orthosport Victoria, Epworth Hospital, Melbourne, Australia

Background: Rate of force development (RFD) is a measure of how rapidly a muscle can produce force. Insufficient quadriceps strength and RFD following total knee replacement (TKR) may be associated with reduced physical function, physical activity and gait speed. We recently developed a valid and reliable RFD testing protocol using a hand-held dynamometer (HHD) and freely-available software [1]. However, the clinical relevance of this protocol is yet to be assessed in people following TKR.

Hypothesis: Greater quadriceps strength/RFD would be associated with better knee function, higher physical activity levels and greater gait speed.

Methods: Fifty-five people (26 women, mean age 69±8, mean 4±1 months post TKR) volunteered to participate. Quadriceps peak torque and RFD were assessed in 90 degrees knee flexion using a Lafayette HHD. RFD was calculated using custom software. Knee pain (VAS), knee function (Oxford scale), physical activity (International Physical Activity Questionnaire) and gait speed (6-metre walk test) were assessed concurrently. Pearson r values were used to determine associations between variables.

Results: The operated limb had significantly lower body-weight-normalized quadriceps strength ($p<0.001$, 31% difference) and RFD ($p<0.001$, 32% difference) than the contralateral side. There were no significant associations between quadriceps strength/RFD and knee pain, knee function or physical activity. There were significant moderate correlations between gait speed and quadriceps RFD on the operated ($r=0.45$) and contralateral side ($r=0.57$) and quadriceps strength on the contralateral side ($r=0.46$).

Conclusion: Quadriceps RFD on either limb may be an important determinant of gait speed following TKR.

1. Mentiplay BF, Perraton LG, Bower KJ, Adair B, Pua Y-H, Williams GP, et al. (2015) Assessment of lower limb muscle strength and power using hand-held and fixed dynamometry: a reliability and validity study. PloS one 10:e0140822

P16 Measurement of intramuscular fat in the medial gastrocnemius of stroke patients.

D'Souza A[1, 2], Bolsterlee B[1, 2] and Herbert R[1, 2]
1. Neuroscience Research Australia, Randwick, NSW, Australia
2. University of New South Wales, Randwick, NSW, Australia

The force producing capacity of a muscle depends on the cross-sectional area of the muscle fibers. Infiltration of intramuscular fat (IMF) reduces the cross-sectional area of muscle fibers per unit cross-sectional area of muscle, compromising the force producing capacity and, potentially changing muscle stiffness. Previous studies have shown that in stroke patients the muscles of the paretic side have increased IMF [1, 2]. We investigated IMF in the medial gastrocnemius of stroke patients.

MRI scans were used to quantify IMF of seven patients who have had a stroke (mean age 63±8 years) and 17 controls (mean age 69±10 years). Both legs were scanned in a 3T MRI scanner (Philips Achieva TX) using an mDixon protocol, from which reliable measurements of fat content were obtained. For stroke patients, IMF measurements were made of the muscle on the paretic and non-paretic sides. For control subjects, the mean IMF of the left and right muscle was used. Linear mixed models compared (1) the paretic and non-paretic legs in stroke patients, and (2) the paretic leg of stroke patients and the control subjects. This is the first report of IMF measurements using mDixon imaging in stroke patients. The mean difference between the paretic and non-paretic side was 2.7% (95%CI -1.5% - 6.9%), which was not significant. The paretic side showed 11% (7.6% - 15%) higher IMF than the control subjects.

These findings may help explain the increased stiffness often seen in the muscles of stroke patients.

1. Ryan, A.S., et al., Hemiparetic muscle atrophy and increased intramuscular fat in stroke patients. Archives of Physical Medicine and Rehabilitation, 2002. 83(12): p. 1703-1707.
2. Ramsay, J.W., et al., Paretic Muscle Atrophy and Non-Contractile Tissue Content in Individual Muscles of the Post-Stroke Lower Extremity. Journal of biomechanics, 2011. 44(16): p. 2741-2746.

P17 The topography of hypertrophy: how muscle architecture changes with strength training.

Eguchi J, Bolsterlee B, Thom JM and Herbert RD
1. NeuRA, Sydney, New South Wales, Australia
2. University of New South Wales, Sydney, New South Wales, Australia

Background. Progressive resistance training (PRT) changes muscle architecture [1]. Training-induced changes in muscle architecture have been measured previously using two-dimensional ultrasound imaging, which is prone to projection errors [2]. We used diffusion tensor imaging (DTI; an MRI technique) to investigate three-dimensional architectural changes in the human quadriceps following PRT.
Methods. Eleven healthy young adults completed eight weeks of PRT (leg press and leg extension). Anatomical MRI and DTI scans were obtained before and after training. Mean fascicle lengths, pennation angles, volume and physiological cross-sectional area (PCSA) were obtained from the rectus femoris (RF), vastus lateralis (VL), vastus intermedius (VI) and vastus medialis (VM) muscles using procedures described elsewhere [3].
Results. Mean isometric strength increased by 11.8 ± 14.2% ($p<0.05$). Volume increased ($p<0.01$) in all muscles, ranging from 11.1% in VI to 14.1% in VL. Fascicle length increased ($p<0.01$) by 13.3% in VM, by 18.6% in VI and by 22.1% in RF, and did not change significantly in VL. Only the VL changed its PCSA (13.1% increase, $p<0.05$). Pennation angles and summed PCSA did not change significantly. Isometric strength change did not correlate with summed PCSA change ($r=0.33$; $p=0.32$).
Discussion. This is the first DTI-based study on PRT-induced changes in muscle architecture. The data corroborate previous findings made with ultrasound that fascicles increase in length following PRT. Surprisingly, PCSA change was not related to isometric strength change. Muscle volume increased by a similar amount to fascicle length.

1. Timmins, R. G., Shield, A. J., Williams, M. D., Lorenzen, C., and Opar, D. A. (2016b) Architectural adaptations of muscle to training and injury: a narrative review outlining the contributions by fascicle length, pennation angle and muscle thickness. Br. J. Sports Med. 50:1467 - 1472
2. Bolsterlee B, Veeger HEJ, van der Helm FCT, Gandevia SC, Herbert RD (2015) Comparison of measurements of medial gastrocnemius architectural parameters from ultrasound and diffusion tensor images. J Biomech 48 (6):1133-1140
3. Bolsterlee B, D'Souza A, Gandevia SC, Herbert RD (2017) How does passive lengthening change the architecture of the human medial gastrocnemius muscle? J Appl Physiol 122(4):727-738

P18 Assessment of individual muscle mechanical properties: a systematic review

Tucker K[1,2], Goo M[1] and Johnston L[2]

1. School of Biomedical Sciences, Faculty of Medicine, University of Queensland, Australia
2. School of Health and Rehabilitation Sciences, Faculty of Health and Behavioral Sciences, University of Queensland, Australia

Aims and Methods: The aim of this study was to examine psychometric evidence, clinical utility, and potential use for children of instrumented tools that measure individual skeletal muscle mechanical properties. Studies that include tools measuring individual muscle stiffness, elasticity, and/or viscoelasticity were identified from four databases. Psychometric evidence of each tool was determined by COnsensus-based Standard for the selection of Measurement Instruments (COSMIN) checklist.

Results and Interpretation: Sixty-three articles were included with 5 devices, including: Aixplorer, ACUSON S3000, MyotonPRO, Myoto-3, and Myotonometer. All devices estimate muscle mechanical properties by measuring tissue displacement following acoustic radiation or compression force. Strong reliability was identified for Aixplorer (intra-rater, inter-rater, and test-retest), MytonPRO and Myoton-3 (test-retest), and Myotonometer (inter-rater). Strong and moderate construct validity were identified for Aixplorer and MyotonPRO, respectively. The Aixplorer and ACUSON S3000 have strong clinical utility given the non-invasive administration for superficial and deep muscle. The MyotonPRO, Myoton-3, and Myotonometer are clinically useful given their small size and lower cost. Psychometric evidence for children was only available for Aixplorer and Myotonometer. The Aixplorer and MyotonPRO were supported by sound psychometric evidence. Of these, Aixplorer has the greatest psychometric data and therefore can be suggested to measure muscle elasticity in adults and children.

P19 Reliability of tests of muscle strength and voluntary activation: a narrative review

Nuzzo JL[1], Taylor JL[1, 2], and Gandevia SC[1]

1. 1. Neuroscience Research Australia, Randwick, NSW, Australia
2. 2. School of Medical and Health Sciences, Edith Cowan University, Perth, WA, Australia

The number of research trials that report measures of muscle strength and voluntary activation continues to increase. In this narrative review of 104 studies, we report on the intra- and inter-rater reliability of common tests of upper- and lower-limb muscle strength and voluntary activation in various samples. Tests of isometric strength (grip strength, mid-thigh pull, knee extension, elbow flexion), isokinetic strength (knee extension and elbow flexion at 60°/sec), and isoinertial strength (bench press, chest press, lat pulldown, biceps curl, squat, leg press, knee extension) exhibit good intra-rater reliability (intraclass correlation coefficients, ICC ≥ 0.90). Their reliability is not influenced by sex, age, motor impairment, resistance training experience, or limb tested. However, some tests of isoinertial strength exhibit systematic bias - an increase in group means (up to 5 - 10%) at retest. The number of studies on inter-rater reliability of strength tests has been limited, but the existing evidence suggests two different raters can obtain similar scores on these tests, particularly for grip strength (ICC ≥ 0.90). Tests of voluntary activation from both peripheral electrical stimulation and transcranial magnetic stimulation exhibit good intra-rater reliability. They are free from systematic bias (≤ 1% change at retest), and ICCs are usually > 0.80. To our knowledge, the inter-rater reliability of tests of voluntary activation has not been examined. In conclusion, tests of muscle strength and voluntary activation of upper- and lower-limb muscles are reliable across test modalities and subject samples.

P20 Antagonism of the D2 dopamine receptor reduces voluntary muscle activation and enhances central fatigue in humans

Thorstensen JT[1], Tucker MG[2] and Kavanagh JJ[1].

1. 1. Menzies Health Institute Queensland, Griffith University, Gold Coast, Queensland, Australia.
2. 2. Mental Health, Drugs and Alcohol Service, Barwon Health, University Hospital Geelong, Geelong, Victoria, Australia.

Dysfunction of the dopaminergic system in the basal ganglia has been implicated in motor impairments such as Parkinson's disease and the neuroleptic-associated tardive dyskinesia. However, an absence of (in vivo) human studies that modulate dopamine receptor activity has clouded the relationship between motor control impairments and dopamine receptor activity. Given that a D2 receptor antagonism suppresses locomotion (1, 2), and the destruction of nigrostriatal dopamine neurons reduces time to exhaustion in animal studies (3, 4), we hypothesised that D2 antagonism would reduce the capacity to voluntarily activate skeletal muscle in humans during fatiguing contractions. Eight healthy individuals (22.5 ± 1.8 years, 2 females) ingested the D2 antagonist haloperidol in a double-blind, placebo-controlled, two-way, cross-over study. Superimposed and resting twitches were obtained from the elbow flexors before, and after, sustained maximal effort contractions. Level of voluntary activation was calculated from twitch data. Ratings of perceived exertion were collected throughout testing.
The ability to voluntarily activate the elbow flexors to produce a maximal torque was compromised following the blockade of the D2 receptor. This reduction in activation occurred for both unfatigued and fatigued muscle contractions, whereby the D2 antagonism also shortened time-to-fatigue when performing sustained muscle contractions. Ratings of perceived exertion measured during the maximal effort contractions were not affected by D2 antagonism.
This is the first study to provide direct evidence that the D2 receptor has a role in central fatigue, where voluntary muscle activation is reduced with augmented activity in the indirect pathway of the basal ganglia.

1. Ahlenius S & Hillegaart V (1986) Pharmacol Biochem Behav 24, 1409-1415
2. Hillegaart V & Ahlenius S (1987) Pharmacol Toxicol 60, 350-354
3. Derevenco P, Stoica N, Sovrea I, & Imreh S (1986) Psychoneuroendocrinology 11, 141-153
4. Heyes MP, Garnett ES & Coates G (1985) Life Sci 36, 671-677

P21 The effect of moderate-duration passive muscle stretching on persistent inward currents estimated through paired motor unit analysis.

Trajano GS[1], Taylor JL[2,3], Blazevich AJ[2]
1. Queensland University of Technology, Brisbane, Australia
2. Edith Cowan University, Perth, Australia
3. NeuRA (Neuroscience Research Australia), Sydney, Australia

Passive muscle stretching can reduce muscle force production and neural drive to the muscle [1]. This reduction could be caused by prolonged inhibition of Ia afferents, which could consequently affect the ability to develop persistent inward currents (PICs) in motoneurons [2]. In humans, PIC amplitude can be estimated using the delta f (ΔF). The ΔF is calculated as the change in firing rates of a lower-threshold control motor unit during the recruitment and derecruitment of a higher-threshold test unit, and is proposed to be proportional to PIC amplitude [3]. Therefore, the aim of this study was to compare ΔFs before and after passive stretching.
Five healthy males performed isometric trapezoidal plantarflexor contractions to 20% of maximal force. Four contractions were performed before (Control 1) and after (Control 2) 3 min of rest (Control) and immediately after three 1-min plantarflexor stretches (Stretch). Surface electromyography (EMG) was recorded from a 32-channel electrode matrix over medial gastrocnemius (MG). EMG signals were decomposed into single motor unit discharges and ΔFs were calculated for pairs of motor units.
After exclusions, 23, 27 and 17 pairs of motor units at Control 1, Control 2 and Stretch, respectively, were analyzed. ΔFs were on average 4.5 (95% CI, 3.8 to 5) during Control 1, 4.7 (95% CI 3.9 to 5.4) during Control 2 and 4.3 (95% CI 3.1 to 5.4) after Stretch condition. There was no difference between conditions ($p=0.78$). In conclusion moderate-duration passive stretch did not affect estimates of PICs measured at MG.

1. Trajano, G. S., Nosaka, K.,& Blazevich, A. J. (2017). Neurophysiological mechanisms underpinning stretch-induced force loss. Sports Med, 47(8), 1531-1541.
2. Trajano, G. S., Seitz, L. B., Nosaka, K., & Blazevich, A. J. (2014). Can passive stretch inhibit motoneuron facilitation in the human plantar flexors?. J Appl Physiol, 117(12), 1486-1492.
3. Johnson, M. D., Thompson, C. K., Tysseling, V. M., Powers, R. K., & Heckman, C. J. (2017). The potential for understanding the synaptic organization of human motor commands via the firing patterns of motoneurons. J Neurophysiol, 118(1), 520-531.

P22 Involuntary hamstring muscle activity reduces passive hip range of motion during the straight leg raise test

Diong J[1], Foo Y[2], Chia L[2] and Héroux ME[3]

1. Discipline of Biomedical Science, Sydney Medical School, The University of Sydney, Australia.
2. Discipline of Physiotherapy, Faculty of Health Sciences, The University of Sydney, Australia.
3. NeuRA (Neuroscience Research Australia), Sydney, Australia

Involuntary hamstring muscle activity is present in some people during the straight leg raise test [1], but it is not known to what extent involuntary muscle activity limits passive joint range of motion. We aimed to determine whether small amounts of involuntary hamstring activity limit passive hip range of motion during the straight leg raise test in healthy people. Thirty healthy subjects were recruited from The University of Sydney. As the hamstring muscles were continuously stimulated to generate 0, 2.5, 5, 7.5 and 10% of knee flexion maximal voluntary contraction force, an investigator blinded to the amount of simulation performed a straight leg raise test by passively raising the tested leg while keeping the knee extended. The stimulation intensities were applied in random order. The test was stopped when the knee started to flex, at which point hip range of motion was recorded. On average, passive hip range of motion decreased by 0.6° for every 1% increase in knee flexion force caused by muscle activation (95% CI 0.3 to 0.9°, p=0.0012). Correspondingly, hip range of motion decreased by 2.9° when 5% of knee flexion force was present. A small amount of involuntary muscle activity (median 2.4% of maximal activation) was present during the trial without stimulation. In conclusion, small amounts of involuntary hamstring muscle activity reduce passive hip range of motion during the straight leg raise test in healthy people. We recommend muscle activity be recorded when passive joint range is used to inform diagnoses or assess interventions.

1. Göeken LN & Hof AL (1993) Arch Phys Med Rehabil 74:194-203

P23 Poor statistical reporting, inadequate data presentation and spin persist despite editorial advice

Héroux ME[1, 2], Butler AA[1, 2], Gandevia SC[1, 2], Diong J[1, 3]
1. NeuRA, Randwick, NSW, Australia
2. University of New South Wales, Randwick, NSW, Australia
3. Sydney Medical School, University of Sydney, Sydney, NSW, Australia

The Journal of Physiology and British Journal of Pharmacology jointly published an editorial series in 2011 to improve standards in statistical reporting and data analysis [1]. It is not known whether reporting practices changed in response to the editorial advice. We conducted a cross-sectional analysis of reporting practices in a random sample of research papers published in these journals before (n=202) and after (n=199) publication of the editorial advice. Descriptive data are presented. In both time periods, 76-84% of papers with written measures that summarized data variability used standard errors of the mean, and 90-96% of papers did not report exact p-values for primary analyses and post-hoc tests. 76-84% of papers that plotted measures to summarize data variability used standard errors of the mean, and only 2-4% of papers plotted raw data used to calculate variability. Of papers that reported p-values between 0.05 and 0.1, 56-63% interpreted these as trends or statistically significant. Implied or gross spin was noted incidentally in papers before (n=10) and after (n=9) the editorial advice was published. Overall, there is no substantial improvement in statistical reporting, data presentation or the presence of spin after the editorial advice was published. While the scientific community continues to implement strategies for improving reporting practices, our results indicate stronger incentives or enforcements are needed.

1. Drummond GB, Paterson DJ, McLoughlin P, McGrath JC. Journal of Physiology. 2011;589:1859.

P24 Mixing robotic guidance and unassisted practice for the learning of a sequential movement

Bested SR & Tremblay L
Perceptual-Motor Behaviour Laboratory, Centre of Motor Control, Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, Canada.

Although robotic guidance has yielded limited effectiveness in improving motor functions in neurologically intact and patient populations[1,2], it has typically employed constant practice. Employing variability of practice principles[3], our lab has previously employed robotic guidance to acutely improve movement smoothness of a discrete trajectory[4]. The purpose of the current study was to investigate the impact of physical guidance involving variability of practice on the learning of a sequential movement, namely a golf putt.
The current study employed a pre-test, a training phase, followed by an immediate and a 24-hr post-test. During the pre-test, the kinematic data from the putter's head was collected and converted into robotic coordinates to be executed using a robot arm, which is highly accurate, consistent, and smooth (see Manson et al., 2014). During training, three groups of novice participants performed putts towards 3 targets (i.e., 192, 213, & 234 cm amplitudes), benefiting from robot guidance on 0%, 50% or 100% of training trials. Only the group that trained with the robot 50% of the trials significantly reduced the endpoint distance and variability between the pre-test and the immediate and/or 24-hr post-test. This study demonstrates that—following a single acquisition session—the combination of unassisted and robot assisted practice represents the most optimal approach to facilitating short-term learning of a sequential movement. Such work could be relevant to improving putting performance and other sport skills in addition to other practical areas (e.g., rehabilitation).
Acknowledgements: Natural Sciences and Engineering Research Council of Canada (NSERC), Canada Foundation for Innovation (CFI), Ontario Research Fund (ORF), University of Toronto

1. Kümmel, J., Kramer, A., & Gruber, M. (2014). Robotic guidance induces long-lasting changes in the movement pattern of a novel sport-specific motor task. *Human Movement Science, 38*, 23-33.
2. Krishnan, C., Ranganathan, R., Kantak, S. S., Dhaher, Y. Y., & Rymer, W. Z. (2012). Active robotic training improves locomotor function in a stroke survivor. *Journal of NeuroEngineering and Rehabilitation, 9(1),* 57.
3. Shea, C. H., & Kohl, R. M. (1991). Composition of practice: Influence on the retention of motor skills. *Research Quarterly for Exercise and Sport, 62*(2), 187-195.
4. Manson, G. A., Alekhina, M., Srubiski, S. L., Williams, C. K., Bhattacharjee, A., & Tremblay, L. (2014). Effects of robotic guidance on sensorimotor control: Planning vs. online control? *Neuro Rehabilitation, 35(4),* 689-700.

P25 Safety and Feasibility of an Eccentric Exercise Intervention in People with Multiple Sclerosis with ankle contractures - A Case Series of five subjects

Hoang PD[1,2], Psarakis M[1], Greene D[1], Lord SR [2]
1. Faculty of Health Sciences, Australian Catholic University, Australia
2. NeuRA, Australia

Purpose: The primary aim of this study was to investigate the safety and feasibility of an eccentric exercise program (1) in people with Multiple Sclerosis who have an ankle contracture. Secondary aims were to explore the relationship between eccentric exercise, ankle joint range of motion and functional mobility.

Methods: Five people with Multiple Sclerosis completed two eccentric training sessions a week for twelve weeks (total = 24 sessions). Eccentric training involved walking backwards downhill on an inclined treadmill for up to one hour. Pre-and post-intervention outcomes measured included ankle range of motion (passive and active), distance walked in the six-minute-walk test and spatiotemporal gait parameters.

Results: There was a 100% adherence rate. There were no adverse events during or following the backwards downhill walk training. Subjects reported that they enjoyed the training intervention and experienced low levels of muscle soreness. The training program significantly improved (mean) outcomes of the passive and active range of motion for all subjects.

Conclusions: The current study describes backwards downhill walking as a novel training modality in people with Multiple Sclerosis with ankle contractures. Clinical outcomes (passive and active range of motion) following backwards downhill walking are promising. Demonstration of a clinically meaningful causal effect of backwards downhill walking on gait in this population warrants further examination.

1. Hoang PD, Herbert RD, Gandevia SC. Medicine and science in sports and exercise, 2007; 39(5):849-57

P26 Wearable technology reveals gait compensations, unstable walking patterns and fatigue in people with Multiple Sclerosis

Psarakis M[1], Greene DA[1], Cole MH[1], Lord SR[2}, Hoang P[1,2], Brodie[2,3].

1. Faculty of Health Sciences, Australian Catholic University, Australia
2. NeuRA (Neuroscience Research Australia), University of New South Wales, Australia
3. Graduate School of Biomedical Engineering, UNSW, Australia

People with Multiple Sclerosis (PwMS) often experience a decline in gait performance, which can compromise their independence and increase falls. Ankle joint contractures in PwMS are common and often result in compensatory gait patterns to accommodate reduced ankle range of motion (ROM). Using advances in wearable technology (1) , the aim of this study was to quantify head and pelvis movement patterns that occur in PwMS and determine how these secondary gait compensations impact on gait stability. Twelve healthy participants and twelve PwMS participated in the study. Head and pelvis movements were measured using two tri-axial accelerometers. Measures of gait compensation, mobility, variability, asymmetry, stability and fatigue were assessed during a six-minute walking test. Compared to healthy controls, PwMS had greater vertical asymmetry in their head and pelvic movements (Cohen's d=1.85 & 1.60). Lower harmonic ratios indicated that PwMS were more unstable than controls (Cohen's d=-1.61 to -3.06), even after adjusting for their slower walking speeds. In the PwMS, increased compensatory movements were correlated with reduced ankle active ROM (r=-0.71), higher disability (EDSS) scores (r=0.58), unstable gait (r=-0.76), reduced mobility (r=-0.76) and increased variability (r=0.83). Wearable device technology provides an efficient and reliable way to screen for excessive compensatory movements often present in PwMS and provides clinically-important information that impacts on mobility, stride time variability and gait stability. This information may help clinicians identify PwMS at high risk of falling and develop better rehabilitation interventions that, in addition to improving mobility, may help target the underlying causes of unstable

1. Brodie MA, Psarakis M, Hoang P. Gyroscopic corrections improve wearable sensor data prior to measuring dynamic sway in the gait of people with multiple sclerosis. Computer methods in biomechanics and biomedical engineering. 2016 Sep 9;19(12):1339-46.

P27 Does the way we grasp objects affect how we perceive our hands?

Butler AA, van Eijk T, Héroux ME, Gandevia SG
NeuRA, Randwick, NSW, Australia

Active muscle contraction and its intensity influence perceived joint position of single joints. Here we investigated how grasp intensity, and whether grasp is active or passive, affects perceived grasp aperture (spacing between the thumb and index finger). In experiment 1, 20 subjects grasped a 6.5cm unseen object at three different grasp intensities (1, 5 and 10% of maximal grasp force) either actively (i.e. voluntary) or passively (external force applied to grasping digits). Subjects were asked to report perceived grasp aperture using a visual chart. Experiment 2 addressed whether Experiment 1 results were influenced by the external pressure applied during the passive grasp. Subjects (n=20) grasped the object with either a very light active or passive force, eliminating the need for external pressure on the digits. Compared to published results in single joints, in Experiment 1 there was no effect of grasp intensity on perceived aperture (-0.02 [-0.05 to 0.01]; mean [95% CI]). However, perceived grasp aperture was narrower by 0.34cm [0.13 to 0.54]) when the object was grasped passively compared with actively. Experiment 2 revealed there was no difference in perceived grasp aperture between active and passive conditions (-0.18cm [-0.55 to 0.19]). The intensity of a grasp and whether or not it is performed actively does not impact how we perceive our hand. Although various factors can, in isolation, impact how we perceive our body, our results further support the view that the brain maintains a stable representation of the hand, highlighting its importance in primates.

P28 The role of the otoliths in vestibulo-ocular reflex adaptation

Khan SI & Migliaccio AA
Neuroscience Research Australia, Randwick, NSW, Australia

The aim of this study was to determine the role of the otoliths in vestibulo-ocular reflex (VOR) adaptation. Until recently the role of the otoliths has been difficult to determine because there is no surgical or chemical technique that can selectively ablate the otoliths without damaging the semicircular canals. The tilted mouse (Otop 1) lacks functioning otoliths, but has normal semicircular canals(Hurle et al 2003). In 4 Otop 1 mice and 4 control littermates we measured: 1) baseline ocular counter-tilt about the 3 primary axes; 2) baseline horizontal sinusoidal VOR gain 3) baseline vertical sinusoidal VOR; 4) horizontal VOR after adaptation training; 5) vertical VOR after adaptation training to one side. Counter-tilt responses in tilted mice were significantly reduced compared to controls, confirming that tilted mice had minimal otolith function. Baseline horizontal and vertical VOR gains were similar between the two mouse types, confirming that the semicircular canals in titled mice were similar to normal. Horizontal VOR adaptation was similar between both mouse types, suggesting that otoliths played a minor role during horizontal VOR adaptation. However, there was a significant difference in vertical VOR adaptation between both mouse types. For the control mouse, adaptation of the VOR gain was most evident when the testing context was same as training context, i.e., they showed context-specific adaptation. Whereas context specific adaptation was absent in tilted mouse. Our results suggest that context-specific VOR gain adaptation is almost entirely reliant on otolith input and not to other contextual cues, e.g., proprioceptive signals.

1. Hurle B, Ignatova E, Massironi SM, Mashimo T, Rios X, Thalmann R, and Ornitz DM. Non-syndromic vestibular disorder with otoconial agensis in tilted mice cased by mutatios in Otopertrin1. Hum Mol Genet 2003, 12:777-789

P29 Changes in centre of pressure are encoded by muscle spindles supplying intrinsic muscle of the foot in freely standing humans

Knellwolf TP[1], Burton A[1, 2] and Macefield VG[1, 2, 3]

1. School of Medicine, Western Sydney University, Sydney, Australia
2. Neuroscience Research Australia, Sydney, Australia
3. Baker Heart & Diabetes Institute, Melbourne, Australia

Muscle spindles are exquisitely sensitive length receptors located in virtually all skeletal muscles. The proprioceptive feedback they provide is important for fine motor movement, balance and locomotion (1). Presumably, the spindles of the intrinsic foot muscles would behave differently under the stress of an unstable body weight. Initially, recordings from 26 single-unit muscle spindles were obtained using the posterior tibial nerve microneurography technique (2) in seated subjects, characterizing the supplied muscle, discharge frequency and variability. With a separate group, 10 spindle recordings were obtained in an unsupported free standing position. Subjects were asked to unload and load their foot and balance with mild postural perturbations with their eyes closed. There was a notable increase of spontaneously firing units in the free standing position (50%) compared to the seated population (27%). Interestingly, 6 of the free standing units (2 spontaneous, 4 non-spontaneous) were highly modulated by changes in centre of pressure. This was dependent on the supplied muscle and the direction of motion. Given the indication from these results that muscles spindles provide the body with information about conformations of the foot during natural body sway, it seems logical to presume that disturbances in their signaling may lead to disturbances in the control of upright stance.

1. Macefield VG, Knellwolf TP (2018) Functional Properties of Human Muscle Spindles. J Neurophysiol
2. Knellwolf TP, Burton A, Hammam E, Macefield VG (2018) Microneurography from the Posterior Tibial Nerve: A Novel Method of Recording Activity from the Foot in Freely Standing Humans. J Neurophysiol

P30 Disturbed proprioception at the knee but not the elbow in hereditary sensory & autonomic neuropathy type III

Macefield VG[1,2,3], Smith LJ[1], Palma JA[4], Norcliffe-Kaufmann L[4] and Kaufmann H[4]

1. School of Medicine, Western Sydney University, Sydney, Australia
2. Baker Heart & Diabetes Institute, Melbourne, Australia
3. NeuRA (Neuroscience Research Australia), Sydney, Australia
4. Dysautonomia Center, Department of Neurology, New York University School of Medicine, New York, USA

Hereditary sensory and autonomic neuropathy type III features a marked ataxic gait that progressively worsens over time. We recently assessed whether proprioceptive disturbances can explain the ataxia. Proprioception at the knee joint was assessed using passive joint angle matching in 18 patients and 14 age-matched controls; 5 patients with cerebellar ataxia were also studied. Ataxia was quantified using the Brief Ataxia Rating Score, which ranged from 7 to 26/30. HSAN III patients performed poorly in judging joint position at the knee: mean (+/-SE) absolute error was 8.7+/-1.0deg and the range was very wide (2.8-18.1); conversely, absolute error was only 2.7+/-0.3deg (1.6-5.5) in the controls and 3.0+/-0.2deg (2.1-3.4) in the cerebellar patients. This error was positively correlated to the degree of ataxia in the HSAN III patients but not the cerebellar patients (1). However, using the same approach at the elbow revealed no significant differences in mean error in 12 HSAN III patients (4.8+/-1.2deg; 3.0-7.2) and 12 age-matched control (4.1+/-1.1deg; 2.1-5.5). Interestingly, microelectrode recordings from the peroneal nerve showed a complete absence of spontaneous or stretch-evoked muscle afferent activity (2), confirmed in the ulnar nerve. Clearly, the lack of muscle spindles compromised proprioception at the knee but not at the elbow, and we suggest that the HSAN III patients have learned to rely more on proprioceptive signals from the skin around the elbow. Indeed, applying longitudinal strips of elastic tape around the joint to increase tensile strain in the skin improved proprioception at the knee (3) but not the elbow.

1. Macefield VG, Norcliffe-Kaufmann LJ, Axelrod F & Kaufmann H (2013) Movement Dis 28: 823-827
2. Macefield VG, Norcliffe-Kaufmann L, Gutiérrez J, Axelrod, F & Kaufmann H. (2011) Brain 134: 3198-3208
3. Macefield VG, Norcliffe-Kaufmann LJ, Golding N, Palma JA, Fuente Mora C & Kaufmann H (2015) J Neurophysiol 115: 711-716

P31 The hands are immediately perceived closer to body midline in the absence of vision

Qureshi H[1,2], Butler AB[1,2], Kerr GK[3], Gandevia SC[1,2], Héroux MH[1,2]

1. Neuroscience Research Australia, Sydney, NSW, Australia
2. University of New South Wales, Sydney, Australia
3. Queensland University of Technology, Brisbane, Australia

Our sense of limb position is crucial to plan a motor task such as reaching for an object, interact with our environment and perform daily activities (1). Although we can precisely and accurately perceive the location of our hands when they are visible, we are understandably less accurate when we cannot see our hands. In 30 healthy adults we investigated how horizontal distance of the hand from body midline and the presence of the other hand influences these errors in perceived hand location. Participants reported perceived location of their unseen right hand immediately after it was placed 10, 20 or 30 cm to the right or left of body midline, with or without the left hand also placed 10 cm away from the right hand. Across all positions, the right hand was perceived closer to body midline compared to its actual location. Importantly, the size of this underestimation increased linearly with distance from body midline (slope 0.77 [0.74 to 0.81], mean [95% CI]). Compared to when it was to the left of body midline, the right hand was perceived 2.1 cm [1.6 to 2.7] closer to body midline when it was located to the right. Presence of the other hand did not affect perceived location (-0.54 cm [-1.10 to 0.02]). Without vision, healthy adults make immediate and systematic errors in perceived hand location across the workspace. These results are important to interpret future studies of perceived hand location in patients with motor impairment.

1. Proske U & Gandevia SC (2012) Physiol Rev 92, 1651-1697

P32 The Upper Limb Physiological Profile Assessment (PPA): description and reliability

Ingram LI[1, 2], Butler AA[1, 2], Lord SR[1, 2], and Gandevia SC[1, 2].
1. Neuroscience Research Australia, Sydney, New South Wales, Australia.
2. University of New South Wales, Sydney, New South Wales, Australia

A progressive decline in upper limb function is associated with ageing and disease. A means of quantifying an individual's upper limb motor impairments offers the potential to complement the contemporary 'disease-based/medical' model in providing a precise measurement of overall upper limb function that could be used to guide and evaluate interventions [1]. Here we propose the upper limb physiological profile assessment (PPA), a battery of 14 tests to quantitatively assess the performance of the multiple physiological subsystems that are essential for adequate upper limb function. We provide a brief description and report the test-retest reliability across the healthy adult lifespan for each test.

Thirty participants (15 males) were recruited and classified by age into one of three groups: 20–29, 30–59, and 60 years and over. Participants performed each of the 14 upper limb PPA tests (muscle strength, unilateral movement and dexterity, position sense, skin sensation, bimanual coordination, arm stability and upper limb functional tasks) on two separate occasions approximately one week apart. Intra-class correlation coefficients (ICC) were computed for each test.

Approximately half of the tests had excellent reliability (ICCs > 0.75; CV of 1.2% to 25.1%), while the remaining tests had fair-to-good reliability (ICCs 0.40 to 0.75; CV of 3.3% to 32.7%).
The upper limb PPA tests appear to be sufficiently reliable to screen for motor impairment in clinical groups with compromised upper limb function and evaluate the effectiveness of interventions.

1. 1. Lord SR, Menz HB, Tiedemann A. A physiological profile approach to falls risk assessment and prevention. Phys Ther. 2003;83;237–252.

P33 Respiratory muscle reflex control and dysphagia in incomplete tetraplegia.

Boswell-Ruys CL[1,2,3], Peebles K[4], McNaughton K[4], Witherow J[4], Dupuche C[4], Elphick T[2], Mogg P[3], Barnhart M[3] and Butler JE[1,2,3].

1. NeuRA, Sydney, Australia
2. School of Medical Sciences, University of New South Wales, Sydney, Australia
3. Allied Health Department, Prince of Wales Hospital, Sydney, Australia
4. Faculty of Medicine and Health Sciences, Macquarie University, Sydney, Australia

The short-latency reflex responses of respiratory muscles to muscle loading are inhibitory and act to protect the airway from obstruction (1). This protective reflex is mediated by inspiratory muscle receptors (1,2) and is absent in people with tetraplegia with complete sensory and motor loss (3). The aim of the study was to determine whether this protective reflex is present or absent in people with incomplete tetraplegia and determine if there is any relationship with dysphagia.

Electromyographic (EMG) signals from the diaphragm and scalene muscles, airflow, volume and mouth pressure were recorded in 10 participants with incomplete tetraplegia before and after 250ms inspiratory occlusions during quiet breathing. Non-invasive assessments of swallow included the eating assessment tool (EAT-10), timed water swallow test (TWST) and the test of mastication and swallowing of solids (TOMASs). Measures of lung function, tongue and respiratory muscle strength, and sleep apnoea severity were obtained.

Inhibitory reflex response was present in 60% participants. No relationship was found between any measures of swallow and the presence of the reflex. Compared with normative data participants had increased number of swallows, bites per cracker and masticatory cycle time in the TOMASS test.
The short-latency inhibitory reflex to airway occlusion is present in incomplete tetraplegia and has a higher incidence than in complete tetraplegia (similar to healthy control participants). The presence of the inhibitory reflex may be protective against aspiration.

1. Butler JE et al (1995) J Physiol 487, 273-281
2. Butler JE et al (1997) J Neurophysiol 78, 170-176
3. McBain RA et al (2015) Exp Physiol 100, 216-225

P34 Optimal electrode position for Abdominal Functional Electrical Stimulation

McCaughey EJ[1,2], Boswell-Ruys CL[1,2,3], Hudson AL[1,2], Gandevia SC[1,2,3], Butler JE[1,2]

1. NeuRA, Randwick, NSW 2031, Australia
2. School of Medical Sciences, University of New South Wales, Kensington, NSW 2052, Australia
3. Prince of Wales Hospital, Randwick, NSW 2031, Australia

Background: Abdominal Functional Electrical Stimulation (Abdominal FES) improves respiratory function.(1,2,3) Despite this, clinical uptake remains low. One reason is a lack of agreement on the optimal electrode position to improve respiratory function. Therefore, this study aimed to ascertain the optimal electrode position for Abdominal FES.

Methods: Ten able-bodied participants received Abdominal FES using electrodes placed: 1) posterolateraly on the abdominal wall; and at the motor points of 2) the external oblique muscles 3) the external oblique and rectus abdominis muscles. Gastric (Pga) and esophageal (Pes) pressure were measured using a gastroesophageal catheter. Single stimulation pulses were applied at functional residual capacity during step-wise increments in stimulation current to maximal tolerance or until Pga plateaued.

Results: Stimulation applied posterolateraly on the abdominal wall led to 95% and 56% greater Pga and Pes compared to stimulation of the external oblique muscles alone ($p<0.001$), and 71% and 53% greater Pga and Pes compared to stimulation of the external oblique and rectus abdominis muscles ($p<0.001$). Stimulation of the external oblique and rectus abdominis muscles led to an 18.3% decrease in Pga compared to stimulating only the external oblique muscles ($p=0.040$), with no effect on Pes ($p=0.809$).

Conclusion: Abdominal FES applied via electrodes placed in a posterolateral position on the abdominal wall generated higher pressures than stimulating at the motor points of the rectus abdominis and external oblique muscles. As pressure generation is a good indicator of expiratory muscle strength, and thus cough efficacy,(4) we recommend this electrode position for future applications of Abdominal FES.

1. McCaughey EJ et al. (2016) Spinal Cord 54, 628-639
2. Butler JE et al. (2011) Neurorehabilitation and Neural Repair 25, 158-167
3. Jung JH et al. (2014) J Phys Ther Sci 26, 73-76
4. Lim J et al. (2007) J Appl Physiol 102, 1612-1617

P35 Severe acute hypoxia reduces motor unit firing rate during isometric contractions

McKeown DJ and Kavanagh JJ
Menzies Health Institute Queensland, Griffith University, Gold Coast, Queensland, Australia

Although reducing blood oxygen saturation (SpO2) can cause rapid changes in corticospinal-motoneuronal activity, few studies have examined the direct consequences that hypoxia has on muscle activation. The purpose of this study was to examine how severe acute hypoxia affects firing rate and recruitment characteristics of a population of motor units (MU) in the biceps brachii. Given that the amplitude of interference EMG is often reduced with hypoxia, it was hypothesised that (MU) firing rate would decrease, accompanied by an increase in MU recruitment threshold.

An altitude simulator was used to induce hypoxia, oxygen was titrated until 80% SpO2. Surface EMG was collected before, 1 hr and 2 hr into the hypoxia intervention. EMG was obtained from the biceps brachii during ramped 25% MVC isometric contractions, and MU action potential trains were identified from the EMG data using Delsys dEMG software.

Hypoxia did not affect MVC amplitude or force steadiness. However MU firing rate decreased 1 hr ($p < 0.05$) and 2 hr ($p < 0.05$) after hypoxic exposure, which was accompanied by a concomitant increase in MU recruitment threshold at 1 hr ($p < 0.05$) and 2 hr ($p < 0.05$).

While reducing SpO2 can cause rapid changes in cortical activity, the findings of this study indicate that the control of MUs are also affected by hypoxia. A potential consequence of reduced firing rates is that the control of higher intensity muscle contractions may be compromised, and the capacity to perform work under fatigue may be limited.

P36 The upper airway is most collapsible during expiration in obstructive sleep apnoea

Osman A[1,2], Butler J[2], Gandevia S[2] and Eckert D[1,2]
1. CRC for Alertness, Safety and Productivity, Melbourne. Vic, Australia
2. NeurA, Sydney, New South Wales, Australia

Introduction: Upper airway collapsibility is an important contributor to obstructive sleep apnoea (OSA) pathogenesis. Pharyngeal dilator muscle activity varies throughout the respiratory cycle and may contribute to dynamic changes in airway collapsibility. We have recently shown that an awake test of upper airway collapsibility correlates with upper airway collapsibility during sleep (r=0.8, n=34)1 in OSA. However, whether upper airway collapsibility varies throughout the respiratory cycle is unknown. This study aimed to quantify differences in airway collapsibility and pharyngeal muscle activity during different phases of the respiratory cycle.

Methods: 12 people with OSA (2 female) were equipped with standard polysomnography equipment, a nasal mask, pneumotachograph, two fine-wire intramuscular electrodes into the genioglossus muscle plus epiglottic and choanal pressure catheters. The upper airway collapsibility index (UACI) was quantified as: 100* (choanal-epiglottic pressure)/choanal pressure to brief pulses of negative airway pressure (~-11 cmH2O). ~15 pulses were delivered every 2-8 breaths during each of the following 4 conditions: 1) early-inspiration, 2) mid-inspiration, 3) early-expiration and 4) mid-expiration. Mean genioglossus EMG, 100ms prior to pulse delivery was quantified.

Results: Genioglossus EMG activity varied throughout the respiratory cycle (e.g. mid-expiration was 77±26 whereas mid-inspiration was 126±39% of the early inspiration value, $p<0.01$). Similarly, upper airway collapsibility changed throughout the respiratory cycle (UACI during early-inspiration=44±26, mid-inspiration=29±18, early-expiration=82±20, mid-expiration=94±13%, <0.01).

Discussion: Upper airway collapsibility varies throughout the respiratory cycle. Indeed, the upper airway is more than 3x more collapsible during mid-expiration compared to mid-inspiration. These findings provide insight into the mechanisms of pharyngeal collapse in OSA.

1. Osman A NC, Carberry JC, Burke P, Wijesuriya N, Tong B, Grunstein R, Eckert DJ. Awake upper airway collapsibility is related to airway collapsibility during sleep (Pcrit) in obstructive sleep apnea. Journal of sleep research. 2016;25(2).

P37 Wearable devices reveal impaired respiratory and cardiovascular responses to clinical assessments and activities during daily life in people with chronic obstructive pulmonary disease

Morkos D[1], McNamara RJ[2, 3], McKenzie DK[3, 4], Gandevia S[4, 5] and Brodie MA[1, 5]

1. Graduate School of Biomedical Engineering, University of New South Wales, Sydney, Australia
2. Department of Physiotherapy, Prince of Wales Hospital, Randwick, Australia.
3. Department of Respiratory and Sleep Medicine, Prince of Wales Hospital, Randwick, Australia.
4. Faculty of Medicine, University of New South Wales, Kensington, Australia
5. NeuRA, Sydney, Australia

Chronic obstructive pulmonary disease (COPD) is a progressive lung disease. Patients with COPD often seek medical attention several times a year for exacerbation of their symptoms. [1] This study examines respiratory rate and heart rate changes in response to exercise. The hypotheses tested are: (i) People with COPD will have impaired physiological responses to exercise assessments; (ii) disease severity will affect activities of daily living (ADLs).

Twenty-five participants were recruited (n=9 moderate-COPD; n=10 severe-COPD; n=6 healthy-age-matched). Participants wore the Zephyr Bioharness (chest strap) during clinical assessments (including a 6-minute-walk-test) and for 36 hours of free-living.

Both clinical assessments and ADLs induced time-dependent increases in respiratory and heart rates (dependent on exercise duration and intensity). During clinical assessments: (i) People with more severe COPD had significantly ($p<0.05$) shorter 6-minute-walk-test distances (366 versus 477 meters) and lower blood oxygen levels (90% versus 96% SPO2); (ii) increased disease severity (lower FEV1 % predicted) correlated with more elevated respiratory rates ($r=-0.40$, $p=0.04$) but less elevated heart rates ($r=0.73$, $p=0.002$). During ADLs, people with more severe COPD did significantly less high intensity ADLs (0.6 versus 1.7 hours), but had higher respiratory rates (21 versus 17 BPM).

Physiological responses to exercise (clinical and ADLs) may be impaired by COPD; despite increased breathing rates, people with more severe COPD had lower exercise capacity, blood oxygen concentrations and less elevated heart rates. The concurrent measurement of physical activity, respiratory rate and heart rate may enable early detection of changes in health-status for people with COPD.

1. Bertens, L.C., et al., Development and validation of a model to predict the risk of exacerbations in chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis, 2013. 8: p. 493-9.

P38 Hippocampal modulation of respiratory motor output

Ajayi IE[1], Mills PC [2], Balnave R[3]

1. Department of Veterinary Anatomy, University of Abuja, Main campus, Abuja, FCT Nigeria.
2. The University of Queensland, School of Veterinary Sciences, Gatton campus, QLD, Australia
3. Discipline of Biomedical Sciences, University of Sydney, NSW, Australia

Nuclei in the brainstem are responsible for generating the motor rhythm of respiration and, consequently, maintaining homoeostasis. Emotional responses to actual or potential environmental challenges induce significant changes in respiratory motor rhythm through descending synaptic interactions of the limbic areas with brainstem nuclei. Such descending interactions also maintain homeostasis and shape appropriate responses for the emotion. However, the anatomic pathways and synaptic mechanisms involved are unclear. Discrete neurone populations have been identified in the ventral hippocampus of anaesthetised rats that can modulate eupneic breathing, including the motor expression augmented breaths, which periodically interrupts breathing rhythm. This supports the role of the ventral hippocampus in modulating the emotional expression of anxiety (1). Augmented breaths, also known as sighs, mainly appear as a secondary breath superimposed on a basic breath and the phenomena has strong correlations with the emotional expression of anxiety in humans and animals (2), but without a clear understanding of the underlying anatomic and physiologic substrates. Related neuroanatomical studies have identified the medial nucleus of the amygdala as a potential relay of the ventral hippocampus to bulbar rhythm generators (3) since direct projections do not exist. Thus the need for a clearer description of these hippocampal-bulbar connections forms the basis of investigations in the current study. In searching for alternate descending pathways using classical tract-tracing techniques considering the complexity of anxiety as a behaviour, the potential descending pathways were identified and a possible arousal-setting role was suggested for the augmented breaths in respiratory motor control in anxiety.

1. Zhang, W.N., Bast, T., Xu, Y., Feldon, J., 2014. Temporary inhibition of dorsal or ventral hippocampus by muscimol: distinct effects on measures of innate anxiety on the elevated plus maze, but similar disruption of contextual fear conditioning. Behavioural brain research 262, 47-56.
2. Ajayi, I.E., Mills, P.C., 2017. Effects of the hippocampus on the motor expression of augmented breaths. Plos One 12, e0183619.
3. Ajayi, I.E., McGovern, A.E., Driessen, A.K., Kerr, N.F., Mills, P.C., Mazzone, S.B., 2018. Hippocampal Modulation of Cardiorespiratory Function. Respiratory physiology & neurobiology.

P39 The effect of optic flow on standing balance in young and older people with low and high fall risk.

Sturnieks DL[1, 2], Tan BCY [2], Lord SR[1, 3]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Sydney, Australia
2. School of Medical Sciences, University of New South Wales, Sydney Australia
3. School of Public Health and Community Medicine, University of New South Wales, Sydney Australia

Optic flow stimuli can destabilise posture, and especially so in older individuals with increased visual field dependence (VFD). This may lead to an increased incidence of elderly falls. This study aimed to investigate the differing effects of optic flow stimuli on postural stability between: 1) older and younger adults, 2) low-falls-risk and high-falls-risk older adults.

Seventy-six participants were recruited and grouped into 'young' (20-40 years, n=25), and 'old'(≥65 years, n=51). The latter group was stratified into 'old-LFR' (low fall risk, n=27) and 'old-HFR' (high fall risk, n=24). All participants stood on a force platform in a dark room. Four types of optic flow stimuli were presented on a large screen as moving white dots: radial expansion and contraction, circular (roll vection) anti-clockwise and clockwise. Parameters of postural sway were calculated from participants' centre of pressure (COP) taken from force platform recordings, specifically: change in COP position in the anteroposterior (AP) and mediolateral (ML) axes, path length travelled by COP in AP and ML axes, and total path length. Repeated measures analyses of variance were used to determine if optic flow stimuli influenced postural sway, and if this effect was different between three participant groups.

Optic flow stimuli led to significant increases in path length variables with notable instability in the anteroposterior directions predominantly. Path length analyses revealed larger optic flow-induced increases in sway in older compared with younger participants, most prominently in the old-HFR group. COP position did not show significant changes with optic flow nor across participant groups. These results suggest that optic flow plays a more significant role in reducing postural stability in older than younger adults, particularly so in older individuals with higher fall risk.

Subscribe to the Motor Impairment Blog

https://motorimpairment.neura.edu.au/

- The Motor Impairment Blog communicates the latest research findings on motor impairments with researchers, clinicians, and the lay public.

- Since the start of the blog in 2014, there have been over 100 blog posts, which have generated more than 55,000 views.

- We are now accepting external blog submissions. If you have published a paper within the last year, and would like to author a blog for Motor Impairment, please email us at miblog@neura.edu.au for your idea to be considered.