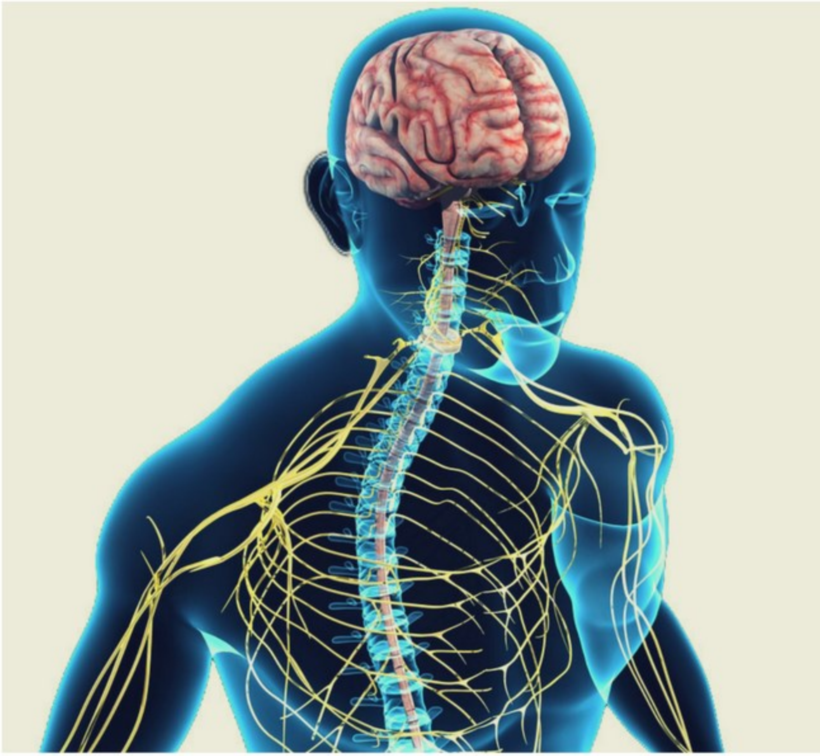
OFFICIAL SATELLITE OF ANS SYDNEY 2017

AUSTRALASIAN NEUROSCIENCE SOCIETY INCORPORATED

SENSORIMOTOR CONTROL SATELLITE MEETING

PROGRAMME + ABSTRACTS

SATURDAY 2 DECEMBER 2017



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SATELLITE OF ANS SYDNEY 2017

SENSORIMOTOR CONTROL SATELLITE MEETING

Contents

PROGRAMME	
8:30am	Meeting Registration Opens
9:00am	Welcome and Opening Remarks (Professor Simon Gandevia)
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ANNA HUDSON Neuroscience Research Australia *Task-dependent recruitment of intercostal motor units – insights into the selection of synergistic muscles for different motor tasks*	**CLAIRE BOSWELL-RUYS** University of New South Wales *Impact of respiratory muscle training on respiratory muscle strength and function in cervical spinal cord injury*
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RUTGER DE ZOETE University of Newcastle *No differences in cervical sensorimotor control between individuals with chronic idiopathic neck pain and healthy individuals*	**MUNTASEER MAHFUZ** Neuroscience Research Australia *The effect of stimulus repetition rate and duration on human vestibulo-ocular reflex adaptation*
HUGO MASSÉ-ALARIE University of Queensland *Organisation of the nociceptive withdrawal reflex of the trunk muscles is tuned to the stimulation location*	**PAUL STAPLEY** University of Wollongong *Performance on pro and anti saccade eye movement tasks predicts stability across different postural configurations*
MARK HALAKI University of Sydney *Altered glenohumeral and axioscapular muscle patterning in people with chronic shoulder pain*	**TIMOTHY CARROLL** University of Queensland *Fast visuomotor responses reflect the relative value of potential targets*
DAVID KENNEDY University of Technology, Sydney *Does feedback from the central nervous system contribute to fatigue in the arm after high intensity exercise of the leg?*	**HEATHER McGREGOR** University of Western Ontario *The somatosensory system supports motor learning by observing*
AFTERNOON TEA (3:30pm – 4:00pm)	**EVENING DRINKS AND NIBBLES** (5:30pm – 6:30pm)

Session 1: 9:15—10:45am

Neuromechanics of the foot

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The human foot is characterised by a pronounced longitude arch that compresses and recoils in response to loading. Along with the known passive structures that are intrinsic to the foot, the activation of the plantar intrinsic foot muscles appears to further stiffen the foot to regulate energy absorption, particularly during walking and running. Experiments that show how activation of these muscles increases with increasing postural demand will be presented (1). Locomotion studies from our laboratory that have provided the first in-vivo evidence of the activation of the plantar intrinsic muscles during walking and running will also be presented (2, 3). The results will reveal that in combination with changes in the longitudinal arch, the intrinsic foot muscles contribute to the absorption and return of mechanical power. Overall the results will show that these muscles have the capacity to control foot posture and arch stiffness which have important implications for how forces are transmitted during locomotion and postural activities, as well as have consequences for metabolic energy saving and injury prevention.

References:

1. Kelly, L.A. et al., (2014) J R Soc Interface. 11, 20131188.
2. Kelly, L.A. et al., (2015) J R Soc Interface. 12, 20141076.
3. Kelly, L.A. et al., (2016) J R Soc Interface. 13, 20160174.

Task-dependent recruitment of intercostal motor units – insights into the selection of synergistic muscles for different motor tasks

Anna L. Hudson, Simon C. Gandevia and Jane E. Butler

Neuroscience Research Australia and University of New South Wales, Sydney Australia.

The human parasternal intercostal muscles are multifunctional muscles, active in both inspiration [1] and ipsilateral rotation of the chest wall [2]. However, it is not known if the differential recruitment of parasternal intercostal motor units across the first-to-fifth interspaces during inspiration [1] is preserved in a non-respiratory task of chest wall rotation.

Intramuscular recordings were made from parasternal intercostal muscles in the 1st, 2nd and 4th interspaces while subjects (n=5; all male) performed quiet breathing and ramped 'isometric' ipsilateral rotations of the chest wall during apnoea. The recruitment behaviour of single motor units (SMUs) was compared as the tidal volume (% inspiratory capacity) or rotation torque (% maximal) and the time that SMUs were recruited during quiet breathing and rotations.

For SMUs in the 1st (n=23), 2nd (n=44) and 4th (n=56) interspaces, differential activity during quiet breathing was indicated by earlier recruitment in the 1st and 2nd interspaces, compared to the 4th space in inspiration ($p<0.01$). In contrast, during trunk rotation, the same motor units showed an altered pattern of recruitment as SMUs in the 1st interspace were recruited later and at a higher rotation torque than those in the 2nd and 4th interspaces ($p < 0.05$).

With voluntary drive for the rotation task, there was divergence from the differential recruitment observed during inspiration. This suggests that parasternal intercostal motoneurone output at different spinal levels can change depending on task and supports a spinal mechanism that integrates and distributes descending drive to different human inspiratory muscles.

References:

1. Gandevia, S.C. et al. (2006) J. Physiol. 573, 263-75.
2. Hudson, A.L. et al. (2010) J. Neurophysiol. 103, 1622-29.

Beta frequency corticomuscular coherence is reduced during walking in people with Parkinson's disease

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Gait difficulties are a common symptom of Parkinson's disease (PD), even at early stages of the disease [1]. Alterations in the structure and function of multiple cerebral regions, including basal ganglia and cortico-frontal networks, may contribute to gait disorders in PD [2]. This study aimed to investigate the role of the motor cortex and the corticospinal tract in Parkinsonian gait disorders.

Healthy young (n=22; 25±3 years), healthy older (n=24; 65±7), and people with early-stage PD ON medication (n=20; 67±7) participated in this study. Participants performed overground and treadmill walking at a self-selected speed while EEG, EMG from tibialis anterior (TA) muscle (left/right), and temporal gait cycle events via foot switches were recorded. Time-dependent coherence was estimated pairwise between bipolar EEG signals and the contralateral TA-EMGs relative to heel strike of the left/right foot.

We found significant CMC at 13-21 Hz (beta) during the double support phase of the gait cycle for overground and treadmill walking in all groups ($p<0.003$). People with PD showed significantly reduced beta CMC compared to healthy young ($p=0.002$) but not compared to healthy older controls ($p=0.2$). There was a trend towards reduced beta CMC in healthy older compared to healthy young people, although the effect was not statistically significant ($p=0.052$).

These results suggest deficiencies in afferent and efferent corticospinal processes during walking in people with early-stage PD. Beta CMC during walking could serve as physiological marker for diagnosis of PD. This research provides valuable information for improving neuromodulating treatments for PD and for developing neuro-prosthetic devices.

References:

1. Peterson DS & Horak FB (2016). Physiology 31, 95-107.
2. Bohnen NI & Jahn K (2013). Mov Disord 28, 1492-1500.

Muscle contracture in children with cerebral palsy: a diffusion tensor imaging investigation

Arkiev D'Souza[1,2], Bart Bolsterlee[1,2], Ann Lancaster[3] and Rob Herbert[1,2]

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Muscle contracture is a loss in passive joint range of motion caused by increases in the passive stiffness of muscles. It commonly occurs in people with cerebral palsy (CP). The mechanisms that cause contracture are not well understood. This work in progress investigates whether the increase in muscle stiffness is related to changes in muscle architecture.

MRI techniques were used to study muscle architecture in the medial gastrocnemius muscles of 14 children with hemiplegic CP who had ankle contractures (mean age 11±2, GMFSC 1.1) and 18 typically developing children (mean age 11±4). All children were scanned in a 3T MRI scanner (Philips Achieva TX). The scan protocol consisted of an mDixon and a DTI scan. The mDixon scan was used to measure muscle volume. Using DTI tractography, three-dimensional fascicle lengths and pennation angles were measured [1]. A torque-controlled measurement of dorsiflexion was also recorded. Linear mixed models compared (1) the more affected and less affected legs of children with CP, and (2) the more affected legs of children with CP and legs of typically developing children.

In CP children, the more affected leg had 14^{o} less dorsiflexion ($p<0.001$), 5.8mm shorter fascicles ($p<0.05$), and 42cm^3 smaller muscle volume. When compared to legs of typically developing children (mean of both legs), the more affected leg had 9.7^{o} less dorsiflexion ($p<0.01$) and 52cm^3 smaller muscle volume ($p<0.001$).

This study demonstrates hemiplegic CP children have reduced dorsiflexion, fascicle length and muscle volume in the gastrocnemius muscle on the affected side.

Reference:

Bolsterlee, B., et al., (2017), J Appl Phys, 122 (4) 727-738.

Site-specific variations in cerebral cortical oxygenation in response to passive postural change

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Cortical oxygenation has been measured during passive postural change in the orbito -frontal cortex (OFC) (1) and dorso-lateral pre-frontal cortex (DLPFC) (2) but not in both concurrently. Since orthostatic hypotension (OH) influences cognition (3) it is likely the alteration in oxygenation is inconsistent across the cerebral cortex when shifted from recumbent to upright. This investigation measured cortical oxygenation concentrations across the pre-frontal cortex (PFC) to determine if change in oxygenation is consistent across the PFC when passively shifted from supine to an upright posture.

Healthy older people (HOP) and PD participants where instrumented with finger cuff photoplethysmography, 3-lead electrogradiograph (ECG) and 4 channel functional near infrared spectroscopy (fNIRS) to measure, blood pressure, heart rate and cortical oxygenation, respectively. Baseline measures were recorded at rest while participants were positioned supine on a tilt table. The tilt table was moved to an upright position and the change in variables was recorded.

Participants were categorised as having OH according to clinical criteria (4) (HOP No OH 13; HOP OH 9; PD No OH 6; PD OH 14). The change in oxy- and deoxyhaemoglobin concentrations in response to being moved to upright posture were calculated. A group (4) × location (4) ANOVA determined there were no differences between groups. However, lateral locations had larger changes compared to anterior.

There is a particular pattern of site specific changes in oxygenation across the cortex regardless of PD or OH. Further investigation is required to determine if other cortical regions have similar oxygenation changes due to postural repositioning.

References:

1. Krakow, K., et al (2000) European Neurology. 43, 39-46.
2. Suzuki, K., et al (2008) Internal Medicine. 47, 1681-1687.
3. Sambati, L., et al. (2014) Neurological Sciences. 35, 951-957.
4. Freeman, R., et al. (2011) Clinical Autonomic Research.21, 69-72.

Session 2: 11:15am – 12:45pm

Strength training for the partially-paralysed muscles of people with spinal cord injuries

L.A. Harvey

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Weakness due to partial paralysis is a major impairment of spinal cord injury. It limits its mobility, upper limb function and independence. Numerous interventions are administered by therapists in an effort to increase strength. These invariably involve progressive resistance training, electrical stimulation and/or repetitious practice of functional activities. Yet little is known about the effectiveness of any of these interventions. Our group has now conducted 5 randomised controlled trials involving 184 participants (246 limbs), all aimed at understanding the effectiveness of different interventions for increasing strength in partially-paralysed muscles of people with spinal cord injury. Our first two trials provide some of the first evidence to support the use of progressive resistance training (1, 2). Our third trial failed to demonstrate any benefit of electrical stimulation on strength (3), and our fourth trial suggests that very weak muscles are not as responsive to strength training as commonly assumed (4). Our fifth trial conclusively showed no effect from repetitious practice of functional hand activities (5). This work has led us to our current trial called The 200 Rep Trial. The aim of this trial (n = 120) is to determine whether 200 contractions per day for 8 weeks can increase the strength of very weak muscles (< grade 3). In this presentation I will discuss all these trials in the light of the work of others (6), and explain how our findings challenge some long held assumptions about the responsiveness of partially-paralysed muscles to various types of strength training.

References:

1. Harvey LA, *et al*. (2010) *Spinal Cord*. 48, 570-5.
2. Bye EA, *et al.* (2016) *Spinal Cord*. 55, 460-5.
3. Glinsky JV, *et al.* (2009) *Clin Rehabil*. 23, 696-704.
4. Glinsky JV, *et al.* (2008) *Aust J Physiother*. 54, 103-8.
5. Harvey LA*, et al.* (2017) *J Physiother*. 63, 197-204.
6. Harvey LA, *et a*l. (2016) *Spinal Cord*. 54, 914-23.

Impact of Respiratory Muscle Training on Respiratory Muscle Strength and Function in Cervical Spinal Cord Injury

C.L. Boswell-Ruys[1,2,3], R.H.C. Lewis[1,2,3], N. Wijeysuriya[1], R.A. McBain[1], D.K. McKenzie[2,3], S.C. Gandevia[1,2,3], J.E. Butler[1,2].

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Respiratory muscle weakness following spinal cord injury (SCI) impairs lung function and the ability to cough effectively. Respiratory complications are one of the leading causes of morbidity and mortality in people with acute and chronic SCI (1). Inspiratory muscle strength has been identified as the best discriminator to predict the likelihood of developing pneumonia in individuals with SCI (2). The predicted pneumonia risk threshold is 115% maximal inspiratory pressure (MIP), based on lesion-specific reference values (2). We hypothesised that progressive respiratory muscle training (RMT) would increase inspiratory muscle strength, measured as MIP, and improve respiratory function. Sixty-two adults with cervical SCI were randomized to perform active or sham RMT which involved breathing through a resistive threshold-loaded inspiratory muscle trainer (Respironics, USA). Participants performed 3-5 sets of 12 breaths at 30-70% of their MIP, supervised twice daily for 6-weeks. Comparative analyses of pre and post data were performed using the general linear model of univariate analysis using baseline values as the covariate. After 6-weeks there was a greater improvement in MIP in the active group compared with the sham group ($p<0.001$), with a 32% increase in MIP in the active group. There were no significant improvements in maximal expiratory pressure or measures of respiratory function. There were significant correlations ($p<0.05$) between the change in MIP and inspiratory capacity, vital capacity and peak expiratory cough flow. Progressive RMT does increase inspiratory muscle strength. The 32% improvement exceeds the lesion-specific MIP threshold value which would indicate a reduced risk of pneumonia in SCI.

References:

1. DeVivo, M.J., Krause, J.S., Lammertse, D.P. (1999) Arch Phys Med Rehab 80, 1411-9.
2. Raab, A.M., Krebs, J, Perret, C., Michel, F., Hopman, M.T., Mueller, G. (2016) Resp Care. 61, 1636-43.

Late I-waves induced by transcranial magnetic stimulation are modified in older adults.

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Previous research has reported that neuroplasticity assessed using transcranial magnetic stimulation (TMS) is reduced in older adults. While this deficit is often assumed to represent an alteration to synaptic modification processes, age-related changes in the interneuronal circuits activated by TMS may also contribute. Within the current study, we assessed characteristics of the corticospinal indirect (I) waves as a means of investigating if healthy ageing modifies interneuronal circuitry. In 15 young (22.5 ± 2.9 years) and 18 older (70.1 ± 6.0 years) adults, I-wave recruitment was tested by changing the direction of the cortical current used to activate the motor cortex, whereas short-interval intracortical facilitation (SICF) was recorded as a means of assessing facilitatory I-wave interactions. Variations in the onset latency of the motor evoked potential (MEP) produced using different coil orientations (measure of preferential I-wave recruitment) were not different between age groups ($P = 0.6$). However, older adults demonstrated significant reductions in MEP facilitation at all 3 SICF peaks (all P-values < 0.05). In addition, elderly subjects showed a reduction in peak frequency ($P = 0.001$), and increased latency of the second and third SICF peaks (all P-values < 0.05). These findings suggest that temporal characteristics are delayed for late, but not early, I-waves in older adults despite the maintenance of I-wave recruitment with TMS. These alterations to the interneuronal circuitry may contribute to age-related reductions in the TMS-induced plasticity response.

Where are my fingers and are they mine?

M. E. Héroux, N. Bayle, A. Butler and S. C. Gandevia

Perceived body position and ownership are fundamental to our ability to sense and interact with the world. Previous work indicates that temporally congruent, repetitive multisensory stimuli are needed to alter the sense of body ownership. In the present study 30 subjects passively grasped an artificial rubber finger with their left index and thumb while their right index finger, located 12 cm below, was lightly clamped. Fingers with varied physical characteristics were also passively grasped to determine how these characteristics influenced perceived body position and ownership. Subjects immediately felt their hands to be 5.3 cm [3.4 to 7.3] (mean [95%CI]) closer, a feeling that remained after 3 min (6.0 cm [4.5 to 7.5]). By the end of the trial, perceived ownership increased by 1.2 [0.6 to 1.9] points on a 7-point Likert scale, with the group average moving from 'neither agree or disagree' at the start to 'somewhat agree' at the end. Compared to grasping a control rubber finger, grasping a cold, rough, oddly shaped or rectangular shaped finger-like object reduced perceived ownership. These results provide new insights into the role of cutaneous sensory receptors in defining these aspects of proprioception, and the speed with which these effects occur. Static touch rapidly induces large, sustained changes in perceived body position and prolonged exposure to these cutaneous inputs, alone, can induce a sense of body ownership. Also, certain physical characteristics of grasped objects influence the sense of body ownership.

Cortical EEG Representation of Tactile Stimulus Patterns

W. Seah, I. Birznieks and R.M. Vickery

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Neuroscience Research Australia

Tactile afferents convey information about our physical environment through the features of neuronal spike patterns. The neural codes of tactile encoding and cortical processes that lead to perception of touch are still not well understood. The cortical response to simple vibrotactile stimuli has been examined using EEG, demonstrating stimulus-related frequency peaks in coherence (1). However, naturalistic tactile stimuli are known to generate complex vibrations in the skin resulting in complex spike patterns, and it is unknown how these are represented cortically. Recent psychophysics experiments have demonstrated a novel neuronal code for complex vibrotactile stimuli, where perceived frequency corresponded to the longest inter-spike interval (2), as opposed to more commonly known parameters: spike rate and periodicity. By examining the frequency composition of cortical activity and correlating it with stimulus-related frequencies in the complex vibrotactile stimulus, we may gain deeper understanding of how tactile signals are processed in the cortex. Electroencephalograms were recorded from ten human subjects in response to complex and simple electrotactile stimuli to a finger, simulating vibrotactile stimuli. Time-frequency decomposition was performed to extract the power and coherence spectra of the stimulus-driven cortical response. We observed 20 Hz peaks in coherence for a complex and simple vibrotactile stimuli with a common feature of 20 Hz periodicity, with a higher coherence level elicited for the complex stimulus. No other stimulus-related frequencies of the complex stimulus were found such as longest inter-spike interval, within-burst spike rate or overall spike rate.

References:

1. Langdon, A. J., Boonstra, T. W. & Breakspear, M. (2011). *Prog Biophys Mol Biol*, *105*(1), 58-66.
2. Birznieks, I. & Vickery, R. M. (2017). *Curr. Biol*, *27*(10), 1485-1490.

Session 3: 2:00pm – 3:30pm

How does pain cause motor impairment?

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People with pain move differently. The simplest interpretation is that in acute pain the change in movement/motor function reduces load on painful tissues to reduce pain and potential for further injury (1). In the presence of persistent pain the relationship is more complex as there is no clear biological "benefit" of the change in movement in most cases. This presentation aims to discuss two recent lines of research that provide insight into the mechanisms underlying changes in motor behaviour when exposed to pain and/or injury. The first tests the assumption that exposure to acute pain leads to a purposefully search for a movement strategy that reduces load on injured/painful tissues. We tested this hypothesis with an experimental paradigm in which participants were exposed to an acute noxious experimental stimulus, but were provided with an option to perform the movement with no/minimal pain. We sought to determine whether participants searched for, found and then maintained this new movement strategy. The second addresses the interaction between pain/injury and the immune system. Immune function (e.g. neuroimmune interaction) has a potential role in pain neurobiology and could contribute to changes in motor function. This work involves data of immune system function in a longitudinal study after an acute back pain episode, and animal studies of the immune system response to back injury plus the potential impact of exercise. Findings of these two lines of research provide new understanding of the mechanisms underlying motor system changes in pain and provide important implications for prevention and rehabilitation.

Reference:

1. Hodges, P.W. & K. Tucker, Moving differently in pain: a new theory to explain the adaptation to pain. *Pain*, 2011. **152**(3 Suppl): S90-8.

No differences in cervical sensorimotor control between individuals with chronic idiopathic neck pain and healthy individuals

R.M.J. de Zoete[1,2,3], P.G. Osmotherly[1,2,3], D.A. Rivett[1,2,3], and S.J. Snodgrass[1,2,3]

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[3]*Hunter Medical Research Institute, Newcastle, Australia*

Background: Sensorimotor control has been suggested important in the assessment of individuals with neck pain.[1] However, as studies have small sample sizes and often use different sensorimotor outcomes, it is difficult to compare results.[2,3] The objective of this study was to compare cervical sensorimotor control outcomes between individuals with chronic idiopathic neck pain and healthy individuals.

Methods: Case-control study: 50 participants with chronic idiopathic neck pain and 50 age and gender-matched controls completed cervical sensorimotor control tests: joint position error, joint position error torsion, postural balance, subjective visual vertical, head tilt response, the Fly, smooth pursuit neck torsion, and head steadiness. Mann-Whitney U tests determined between-group differences, and correlations between tests and levels of neck pain and disability were investigated. Proportions of 'poor performers', defined as the highest 10% of observations, were determined.

Results: There were no differences in sensorimotor control between individuals with neck pain and healthy controls (p-values ranged from p=0.203 to p=0.981). Correlations were weak between tests and levels of pain (r values ranged from 0.010 to 0.294) and disability (0.007 to 0.316). For each test, the proportion of poor performers for individuals with and without neck pain was similar.

Conclusion: These findings suggest that cervical sensorimotor control tests do not discriminate between individuals with chronic idiopathic neck pain and healthy individuals, spawning debate on the clinical usefulness of these tests. These tests may not be adequately sensitive, or alternatively, differences may not be large enough to be detected and thus may not be clinically meaningful.

References:

1. de Zoete, R.M.J. et al. (2017) Arch Phys Med Rehab. 98:1257-71.
2. Röijezon U. et al. (2011) Manual Ther. 16:273-8
3. Woodhouse A. et al. (2008) BMC Musculoskelet Disord. 9:90

Organisation of the nociceptive withdrawal reflex of the trunk muscles is tuned to the stimulation location

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Noxious stimuli induce a nociceptive withdrawal reflex (NWR) to protect the tissue from injury. Although the NWR was considered as a stereotyped response (1), recent studies report distinct responses depending on the stimulation site and context for limbs (2, 3). We aimed to determine whether noxious stimuli over the trunk produced adaptable NWRs. We hypothesized that organization of the NWR of the trunk muscle would vary with the site of noxious input and would differ between body and spine postures, which modify the potential for specific muscles to remove threat. Fourteen participants were tested in sitting and three lumbar spine postures in side lying (neutral, flexion and extension). Noxious electrical stimuli were applied over the sacrum, spinous process of L3 and T12, lateral side of the 8th rib, and anterior midline. NWR latency and amplitude were recorded with surface EMG electrodes over different trunk muscles. Distinct patterns of muscle activation were depended on the stimulation site and were consistent with motor strategies needed to withdraw from the noxious stimuli. The NWR pattern differed between body positions with less modulation observed in sitting than side lying. Spine posture did not affect the NWR organisation. Our results suggest the trunk muscle NWR is organized in a similar manner to that of the limbs, and presents with adaptability as a function of body position and stimulation site. This suggests that the CNS uses multiple adaptable strategies that are unique depending manner in which the noxious stimuli are applied.

References:

1. Sherrington, C.S. (1910) J Physiol. 40, 28-121.
2. Anderson, O.K. et al. (1999) Muscle Nerve. 22, 1520-30.
3. Andersen, O.K. et al (2003) Exp. Brain Res. 152, 434-43.

Altered Glenohumeral and Axioscapular Muscle Patterning in People with Chronic Shoulder Pain

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[1] *Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney*
[2] *School of Science, Faculty of Health Sciences, Australian Catholic University*
[3] *Regent Street Physiotherapy, Newcastle*
[4] *Discipline of Anatomy and Histology, Sydney Medical School, The University of Sydney*

Optimal exercise therapy for people with shoulder pain is unknown due to limited information regarding specific changes in shoulder muscle function associated with pain. Timing of muscle activity with respect to movement can provide information about muscle recruitment patterns without requiring electromyography data normalisation, which is proven problematic in the with presence of pain. The aim of this study was to compare the timing of glenohumeral and axioscapular muscle recruitment in people with and without shoulder pain during cyclical shoulder movement. Fourteen people with shoulder pain and 14 without pain were recruited. Electromyography from nine shoulder muscles was recorded. Approximately 20 cycles of small range (30°-45°) rapid shoulder flexion/extension task wereas performed in standing with the arm by the side. Shoulder movement was measured using a draw-wire. A cross-correlation and spectrographic analysis (1) provided a measure of phase (relative timing of muscle activity with respect to movement) at the movement frequency per muscle per subject. T-tests were used to compare mean phase values between groups. Subjects with shoulder pain had greater variability in the relative timing compared to no pain group. The relative timing was significant different between groups in all muscles ($p<0.05$) except subscapularis ($p=0.64$) and latissimus dorsi ($p=0.11$). People suffering from chronic shoulder pain recruit axioscapular and glenohumeral (including rotator cuff) muscles in patterns which differ from asymptomatic subjects. Exercise strategies focusing on the restoration of normal motor patterning and not simply muscle strengthening should form part of the rehabilitation of chronic shoulder pain conditions.

Reference:

1. Bendat, J.S.; Piersol, A.G. (1971). Random Data: Analysis and Measurement Procedures. Wiley-Interscience, New York.

Does feedback from the central nervous system contribute to fatigue in the arm after high intensity exercise of the leg?

D.S. Kennedy, E.C, Raper, H.T. Finn, J.L. Taylor

Aim: The development of 'cross-over' fatigue occurs when there is a decrease in the ability to generate force in non-exercised muscles within the same limb (1) or between lower and upper limb muscles (2,3). The decrease in muscle force is thought to arise from afferent feedback from the exercised muscle. The aim of this study was to determine whether maintained fatigue-related group III/IV muscle afferent feedback from the quadriceps results in cross-over fatigue to the ipsilateral elbow flexors.
Methods: Sixteen subjects (mean age = 23, female=9) attended on two days. On both days, they performed a 2 min sustained quadriceps maximal voluntary contraction (MVC). Following this contraction, on one day blood flow to the quadriceps was occluded for 2min to maintain muscle afferent feedback. During that time, subjects performed elbow flexor contraction sets.
Results: Voluntary activation (VA) using transcranial magnetic stimulation (TMS), force (MVC), biceps electromyography (EMG) responses, and pain (Borg scale) were recorded. Maintained group III/IV afferent firing of the quadriceps had no effect on VA or torque of the elbow flexors ($p=0.74$; $p=0.75$, respectively). Furthermore, there was no effect on biceps EMG ($p=0.095$). Subjective pain ratings during maintained quadriceps ischaemia were higher (mean±SD; Borg: 6.0±1.6; $p<0.001$) compared to when the muscle was allowed to recover (2.6±2.1).
Conclusion: The findings of this study suggest that, at least during multiple brief elbow flexor MVCs, cross-over fatigue from the leg to the upper limb is not likely mediated by group III/IV muscle afferent feedback.

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3. Sidhu SK, Weavil JC, Venturelli M, Garten RS, Rossman MJ, Richardson RS, Gmelch BS, Morgan DE & Amann M. (2014). Spinal μ□opioid receptor□ sensitive lower limb muscle afferents determine corticospinal responsiveness and promote central fatigue in upper limb muscle. *J Physiol* **592,** 5011-5024.

Session 4: 4:00pm – 5:30pm

Strength training and cerebral palsy: what is it good for?

Professor Nick Taylor

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Strength training has been proposed as an intervention that can address the impairment of muscle weakness often observed in young people with cerebral palsy. The evidence from recent randomised controlled trials will be presented. While strength training for young people with cerebral palsy can improve the ability to generate muscle force, this increased strength does not carry over into an improved activity. Issues such as whether we should expect an impairment –based intervention to affect a complex activity will be discussed. "

The effect of stimulus repetition rate and duration on human vestibulo-ocular reflex adaptation

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The vestibulo-ocular reflex (VOR) is the main gaze stabilising system during rapid head movements. The VOR is highly plastic and its gain (eye / head velocity) can be increased via training that induces an incrementally increasing retinal image slip error signal to drive VOR adaptation. Using the unilateral incremental VOR adaptation technique and horizontal active head impulses as the vestibular stimulus, we sought to determine the factors important for VOR adaptation including: the total training time, ratio and number of head impulses to each side (adapting and non-adapting sides; the adapting side was pseudo-randomized to be left or right) and exposure time to the visual target during each head impulse. We tested 12 normal subjects, each over 5 separate sessions. For each session we measured the active (self-generated, predictable) and passive (manually imposed, unpredictable) VOR gain before and after the training. Our data suggest that the total training time and the visual target exposure time for each head impulse affected adaptation, whereas the total number and ratio of head impulses did not. These data have implications for vestibular rehabilitation, suggesting that quality and duration of VOR adaptation exercises are more important than rapid repetition of exercises.

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The effect of stimulus repetition rate and duration on human vestibulo-ocular reflex adaptation (Cont…)

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Performance on Pro and Anti Saccade Eye Movement Tasks Predicts Stability Across Different Postural Configurations

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Saccadic eye movements underlie shifts in fixation between visual targets. Pro- and anti-saccade tasks have been used to study both reflexive and voluntary saccadic eye movements (1). A pro-saccade task involves a reflexive eye movement to an illuminated target whereas in an anti-saccade task, subjects are instructed to move the eye away from the target. The latter task involves an additional neural 'cost' of inhibiting a reflexive behaviour. Our previous work showed that a standing position (compared to sitting) delayed eye movement onset latencies in older adults (2). To understand why different postures may result in changes to saccade dynamics due to competing neural resources, we recorded pro- and anti-saccades in four different postures: 1) sitting, 2) standing, 3) narrow stance and 4) tandem stance. Our results showed that young (18-35 years) subjects could be divided into two clear groups based on differences in their pro- and anti-saccade latencies measured during sitting: Group 1 (no differences during sitting) demonstrated no changes in postural instability across the 3 remaining postures. The second group (significantly longer latencies for anti- vs. pro-saccades) showed significant relationships between increases in centre of pressure paths and delays in eye latency across the different postures. These results suggest that: 1) Postural stability can be predicted based on performance in an anti-saccade task, and 2) significant interactions exist between the neural control of eye movements and balance.

References:

1. Hallett, P.E. (1978). *Vision Res.*18, 1279-1296.
2. Jimenez, S., Hollands, M., Palmisano, S., Kim, J., Markoulli, M., McAndrew, D., Stamenkovic, A., Walsh, J., Bos, S. & Stapley, P. (2016) *Exp. Brain Res.* 234. 1599-1609.

Fast visuomotor responses reflect the relative value of potential targets

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A key feature of skilled motor behaviour is the ability to make rapid and appropriate feedback corrections when movements are unexpectedly perturbed. Recent work shows that a lateral shift in visual feedback of limb position during movement leads to an involuntary corrective response with a latency of ~150 ms (1,2). The size of this fast and automatic corrective response is nonetheless affected by the nature of the task being performed; such as its accuracy and timing requirements (1,2). In many natural movement contexts, however, movements may be initiated with a number of potential goals in mind, so it should be advantageous to tune feedback responses according to the expected values of various alternative goals. Here we examined this issue in a virtual reality reaching task. Because value is the product of the reward associated with an outcome, and the frequency with which that outcome occurs, we varied both the reward and frequency distributions of targets in a series of experiments. Fast feedback responses were smaller when the limb was perturbed towards high value potential targets, and greater when perturbed away from high value potential targets. A statistical model showed that an estimate of relative value, that includes a term for risk aversion, was linearly related to feedback response magnitude. Thus, feedback control policies can be tuned according to the relative values of potential future goals, suggesting that outputs from even the lowest levels of the visuomotor control hierarchy reflect variables associated with value-based decision making.

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The somatosensory system supports motor learning by observing

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An influential idea in neuroscience is that the sensory-motor system is activated during action observation [1]. This idea has recently been extended to motor learning; action observation promotes behavioural changes in both the motor and somatosensory domains [2,3]. However, it remains unclear how the brain maps visual information onto motor circuits for learning. Here we present two experiments testing the hypothesis that the somatosensory system is involved in motor learning by observing.

In experiment 1, we tested the idea that motor learning by observing changes S1 excitability. Subjects observed a learning video showing a tutor adapting her reaches to a force-field or a control video showing a tutor reaching in an unlearnable, randomly-varying force-field. We show that S1 excitability, as measured by somatosensory evoked potentials (SEPs), increased from pre- to post-observation only for those subjects who observed learning. Moreover, SEP increases predicted subsequent behavioural measures of motor learning by observing. This suggests that S1 plasticity supports motor learning by observing.

In experiment 2, we tested if the somatosensory system plays a necessary role in motor learning by observing. We used median nerve stimulation to interfere with somatosensory cortical processing while subjects observed the learning video. Stimulation disrupted motor learning by observing in a limb-specific manner; stimulation delivered to the right arm (the same arm used by the tutor) disrupted learning whereas left arm stimulation did not. This is consistent with the idea that a somatosensory representation of the observed effector must be available during observation for learning to occur.

References:

1. di Pellegrino, G., Fadiga, L., Fogassi, L., Gallese, V., & Rizzolatti, G. (1992). Understanding motor events: A neurophysiological study. *Exp. Brain Res.*, 91, 176-180.
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Poster Presentations 12:45pm – 2:00pm

P1. Perception of object size and grasp configuration

Annie A. Butler, Martin E. Héroux, Tess van Eijk, Simon C. Gandevia

Neuroscience Research Australia and the University of New South Wales

When grasping objects, we are able to perceive the aperture of our hand (the distance between our thumb and fingers), even without vision. However, this perception is not stable. For example, it can be influenced by a change in the weight of the object (1). We investigated how grasp configuration and subjects' attentional focus influence this perception. Without vision, 20 subjects grasped a 6.5 cm-stationary object with two grasp configurations; thumb with all fingers, and thumb with index finger. For both configurations, subjects were asked to attend to and report perceived grasp aperture or perceived object width using a visual chart. Additional objects of 5.5 cm and 7.5 cm were included as distractors. Overall, subjects underestimated object width and grasp aperture by 0.42 cm [95% CI 0.18, 0.67]. Across the two grasp configurations, there was a 0.38 cm [0.28, 0.47] difference in perception (thumb with all fingers: 6.27 cm [6.16, 6.38]; thumb with index finger: 5.89 cm [5.78, 6.00]). In contrast, there was no effect of attention (grasp aperture: 6.10 cm [5.98, 6.21]; object width: 6.06 cm [5.95, 6.16]). Thus, perception of the hand and object is closer to reality when grasping an object with all digits. Furthermore, judgements of hand configuration and object size may access the same perceptual ruler.

Reference:

Butler AA, Héroux ME, Gandevia SC (2015). PLoS One. 10:e0127983.

P2. A target-tracking videogame for the assessment of balance

L.E. Cofré Lizama[a], T. Perera[b,c] and M. Galea[a].

[a]*Department of Medicine (Royal Melbourne Hospital), University of Melbourne.* [b]*The Bionics Institute. Melbourne.* [c]*Department of Medical Bionics, University of Melbourne.*

The mediolateral balance assessment (MELBA) has been found to be a reliable and sensitive tool to determine subtle impairments of the balance control system (1). It uses center-of-mass (CoM) tracking of predictable and unpredictable targets from which phase-shift, gain and coherence between the CoM and the frequency content of the target are calculated to determine the bandwidth of adequate tracking (2). However, this method relies on laboratory-grade equipment (e.g. VICON motion capture system), which makes it difficult for clinical translation. Therefore, we developed a simpler and portable version of MELBA using a Kinect sensor (MELBA-K) and transformed the assessment into a videogame. The aim of this study is to determine the level of agreement between CoM calculated with a VICON system and the developed videogame while performing MELBA tasks. Four subjects (30.5±3 y/o) performed 3 predictable (135 s) and 3 unpredictable (132 s) MELBA-K trials while an 8-camera VICON system was used to record full-body kinematics. A plug-in-gait model was used to calculate CoM whereas MELBA-K CoM was obtained using a model previously described (1,2). For all frequencies contained in the targets signals (0.1-2.0 Hz) coherence between CoM-VICON and CoM-MELBA-K was above 0.8. These results demonstrate that MELBA-K can be used as an alternative for the assessment of balance in clinical settings. Furthermore, it offers the advantages of videogames such as short setting-up time and inexpensive implementation as well as patients' engagement. Further studies exploring the use of MELBA-K in orthopedic and neurological populations are currently in progress.

References:

1. Cofré Lizama L.E. et al. (2014) PLoSOne (9)10: e110757.
2. Cofré Lizama L.E. et al. (2015) Gait Posture (42) 79-84.

P3. Proprioception: do we really know it like the back of our own hand?

L.A. Ingram, A.A. Butler, L.D. Walsh, S.C. Gandevia

Neuroscience Research Australia and the University of New South Wales, Sydney, NSW, Australia

Previous studies reveal that healthy individuals consistently misjudge the size and shape of their hidden hand during a localisation task. Specifically, they overestimate the width of their hand and underestimate the length of their fingers [1]. This would also imply that healthy individuals misjudge the actual location of at least some parts of their hand during the same localisation task. Therefore, the primary aim of the current study was to determine whether healthy individuals could accurately locate the actual position of their hand when hidden from view. Sixteen healthy participants performed a hand localisation task which involved both pointing to and verbally indicating where they perceived the position of various landmarks were located on their hidden hand. Hand position was consistently misjudged as closer towards the wrist (0.66 Bookstein units [0.53, 0.78] proximal error) and, to a lesser extent, away from the thumb (0.12 BU [0.02. 0.22] ulnar error) (mean [95% confidence interval]) [2]. In addition, the magnitude of proximal error progressively increased throughout the experiment, with only a minor drift away from the ulnar. Participants were more accurate when pointing to the perceived location of their hidden hand when measured along the proximo-distal axis, but less accurate when measured along the radio-ulnar axis compared to when they verbally indicated the perceived position of their hand. Furthermore, while participants underestimated the length of their fingers, hand width was overestimated during the pointing localisation task only. Judgments of hand width were accurate during the verbal localisation task.

References:

1. Longo MR, Haggard P. An implicit body representation underlying human position sense. Proc Natl Acad Sci USA. 2010;107: 11727–11732.
2. Bookstein FL. Morphometric tools for landmark data: Geometry and biology. Cambridge UP: Cambridge; 1991.

P4. Concurrent transcranial magnetic stimulation and short duration resistance training enhances early-phase corticospinal excitability without muscle strength gain: A Case Study

Darryl J. McAndrew[1], Joel A. Walsh[1], Paul J. Stapley[1]

[1] *Neural Control of Movement Laboratory, IHMRI, School of Medicine, Faculty of Science, Medicine and Health, University of Wollongong, Australia*

Early-phase increases in skeletal muscle strength following commencement of resistance training have been attributed to neuromuscular adaptations (1). However, conflicting evidence suggests muscle strength increases without change in corticospinal excitability (2). This case study examined how early corticospinal excitation occurs compared to muscle strength using concurrent application of TMS and resistance training (TMS+MVCt), compared to MVCt alone. One healthy participant (male, 38 years) completed two four-week training protocols; 1) MVCt, and 2) TMS+MVCt, separated by three weeks of detraining. Each session included 4x3 MVC repetitions separated by 24 hours. Force output, MEP amplitudes and voluntary activation (VA) were assessed from the dominant vastus lateralis two hours prior to session one (PRE), two hours post session three (P1) and the final (P2) training sessions. Magnetic pulses were delivered at the point of maximal force production during knee extension for the TMS+MVCt protocol. Data are expressed as percentages of PRE values. Mean MEP amplitudes were greater for TMS+MVCt (P1 = 20.9±6.4%; P2 = 32±7.9%) than MVCt (P1 = 4±1.9%; P2 = 11.2±4.3%) compared to PRE. MVC force output increased at P2 (TMS+MVCt = 55.3% vs MVCt = 32.4%), compared to PRE. Voluntary activation was higher at P1 (TMS+MVCt = 7.0% vs MVCt = 2.2%) and P2 (TMS+MVCt = 7.3% vs MVCt = 4.4%) compared to PRE. These results show enhanced corticospinal activity occurring with TMS+MVCt at P1 over MVCt alone, after only three training sessions, suggesting that neuromuscular adaptations can be accelerated when voluntary neural drive is supplemented with TMS.

References:

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2. Folland, J.P. & Williams, A.G. (2007) *Sports Med*. 37, 145-168.

P5. Noninvasive cerebellar stimulation for adults with cervical dystonia

A.B. McCambridge[1] and L.V Bradnam[1]

[1]University of Technology Sydney, Graduate School of Health, Sydney, Australia

Cervical dystonia (CD) is the most pervasive form of dystonia and is characterized by painful, involuntary twisting of the neck, and sometimes tremor. Recent evidence implicates cerebellar dysfunction in the pathophysiology of CD. This study examined the effect of 5 consecutive days of anodal transcranial direct current stimulation (tDCS) over the cerebellum of adults with CD. Patients received 5 sessions of anodal tDCS and sham tDCS in a randomised, cross-over design that was double-blinded. We hypothesised that tDCS would improve patient's clinical features and modulate neural excitability of the cerebellum. Currently, 9 out of 12 patients have completed both real and sham 5-day blocks. Clinical features were examined using the TWSTRS2, CDQ-24, cervical range of motion, and visual analogue scales of pain. Neural excitability was inferred using eye-blink conditioning to examine cerebellar excitability and transcranial magnetic stimulation (TMS) over the motor cortex to examine corticomotor excitability and intracortical inhibition. Motor evoked potentials (MEP) and cortical silent periods (cSP) were recorded bilaterally from upper trapezius (UT) and first dorsal interosseous (FDI). All dependent measures were assessed on day 1 and day 5, and follow up questionnaires were completed at 1 and 4 weeks later. There was a minimum washout period of 5 weeks between treatment blocks, and patients undergoing botox were tested 4 weeks post injections. The outcome of this research may lead to the development of an alternative or adjuvant intervention for the management of CD and improve our understanding of the dysfunctional neurophysiology in this condition.

P6. Perturbation training to improve balance recovery responses to slips and trips in older adults: a randomized controlled trial

Yoshiro Okubo, Daina L Sturnieks, Matthew A Brodie, Lionne Duran, Stephen R Lord

Falls, Balance and Injury Research Centre, Neuroscience Research Australia

Falls among older adults cause serious challenges for the individual and health care systems. Our recent systematic review and meta-analysis has shown that perturbation training can reduce falls by approximately 50%[1]. However, the methods to generate perturbations (e.g. slips) in previous studies have limitations to training reactive balance control. We have developed a novel perturbation walkway which can generate both slips and trips that are ecologically valid, unpredictable and standardized. It therefore offers an excellent means of training balance recovery response (i.e. reactive balance control) as opposed to proactive balance control or prediction. In a double-blind randomized controlled trial, we are examining the effectiveness of perturbation training using slips and trips in older adults. Forty healthy and active older adults (aged 65-90 years) are randomly allocated to a balance recovery training (BRT) group or a target step training (TST) group. The BRT group members undertake three 40-minute training sessions: (1) training recovery from trips, (2) training recovery from slips and (3) training recovery from a mix of trips and slips. The TST group members are asked to step on the target tiles, with the accompaniment of music with a beat reflecting the desired cadence, in one 40-minute session. All participants will walk at 90% of their normal gait speed and experience 70cm-long slips and 14cm-height trips at random locations. Fall incidence (defined as ≥30% of body weight on the harness) after slip- and trip-perturbations in the laboratory comprises the main outcome measure. Latest results from the trial will be presented.

Reference:

Okubo Y, Schoene D, Lord SR. (2017) *Br J Sports Med*. 51:586-93.

P7. Individual Factors that Impact Stable Dynamics on a Ladder: Protocol

E.P. Pliner[1,2], D.L. Sturnieks[2], S.R. Lord[2]

[1]*Department of Bioengineering, University of Pittsburgh*
[2]*Falls Balance and Injury Research Centre, Neuroscience Research Australia*

Ladders are the leading cause of fatal falls to lower levels (1). The majority of ladder fall incidents occur in the non-occupational setting (2) amongst older adults (3). Ladder fall literature has focused on improving ladder setup for the occupational setting (4), but ladder fall rates continue to increase (2). This may be partially due to limited attention towards non-occupational ladder falls and ladder falls from unstable ladder user dynamics. The purpose of this study is to determine individual factors that influence ladder fall risk from unstable user dynamics.
Participants aged 65+ years will be recruited because they are at increased risk of a ladder fall injury and aging affects may assist in determining physical, psychological, and cognitive features that are critical for maintaining stable dynamics during ladder use. Ladder fall risk will be measured from task performance, judgment error and behavioral risk, corresponding to three ladder tasks that are commonly performed: changing a light bulb, cleaning a gutter, washing the windows. Ladder fall risk will be validated from center of mass displacement (i.e. risk of participant falling) and force distribution between the ladder feet (i.e. risk of ladder tipping). Individual factors will be measured from physical, psychological, and cognitive assessments.
Understanding the relationship between ladder fall risk and individual factors will assist ladder fall interventions. Such interventions may be devices that alert ladder users of unstable movements, training programs to improve physical, psychological and cognitive abilities, and health screenings to inform the public of their ladder fall risk.

References:

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P8. Crossing body midline affects perceived spacing between hands when passively grasping an artificial finger

Hassan G. Qureshi[1,2], Annie A. Butler[1,2], Graham K. Kerr[3], Simon C. Gandevia[1,2], Martin E. Héroux[1,2]

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When the hands are vertically separated, passively grasping an unseen artificial finger leads to a grasp illusion: perceived ownership over the artificial finger and reduced perceived spacing between hands (1, 2). We aimed to investigate the effect of distance and crossing body midline when the hands are horizontally separated. Thirty healthy participants were tested in two conditions, grasp and no grasp. During the grasp condition, participants' right index fingers were lightly clamped at body midline while they passively grasped an artificial finger with their left thumb and index. The tip of the left index finger was positioned 15 or 24 cm on either side of body midline. During the no grasp condition, both hands were placed in the same positions without a grasp. With the hands crossed 15 cm, grasping an artificial finger reduced perceived spacing between the hands by 3.2 cm [0.7 to 5.7] (mean [95% CI]). Perceived ownership was between 'Disagree' to 'Somewhat disagree' at all test positions. Compared to when the hands were vertically separated, there was a smaller effect for spacing and no effect for ownership in the horizontal plane. This differential effect may be due to the greater distance between hands used in the present study or it may reflect a difference in how proprioceptive signals are processed when the hands are separated vertically versus horizontally.

References:

1. Héroux, M.E., et al. J. Physiol. 591, 5661–5670 (2013).
2. Héroux, M.E., et al. J. Physiol. In press. (2017).

P9. It Pays to Prepare: Human motor preparation depends on the relative value of potential response options

E. Reuter[1], W. Marinovic[1,2], J. Beikoff[1] and T.J. Carroll[1]

[1]Centre for Sensorimotor Performance, School of Human Movement and Nutrition Sciences, The University of Queensland
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Alternative motor responses can be prepared in parallel. Here, we used electroencephalography (EEG) to test whether the parallel preparation of alternative response options is modulated by their relative value. Participants performed a choice response task with three potential actions: isometric contraction of the left, right, or both wrists. An imperative stimulus (IS) appeared after a temporal warning cue, so that the initiation time of a required action (but not what to do) was predictable. To encourage advanced preparation, the target was presented 200 ms prior to the IS, and only correct responses initiated within ±100 ms of the IS were rewarded. At baseline, all targets were equally rewarded and probable. Then, responses with one hand were made more valuable, either by increasing the probability that the left or right target would be required (Exp1; n=31) or by increasing the reward magnitude of one target (Exp2, n = 36). We measured reaction times, movement vigour, and an EEG correlate of action preparation [contingent negative variation (CNV)] prior to target presentation. Participants responded earlier to more frequent and more highly rewarded targets, and movements to highly rewarded targets were more vigorous. The CNV was more negative over the hemisphere contralateral to the more repeated/rewarded hand, implying an increased neural preparation of more valuable actions. Thus, changing the value of alternative response options can lead to greater preparation of actions associated with more valuable outcomes. This preparation asymmetry likely contributes to behavioural biases that are typically observed towards repeated or rewarded actions.

Reference:

Cisek P. & Kalaska J.F. (2005). *Neuron* 45:801-814.

P10. The role of fingertip-object surface events in providing frictional information in the context of object manipulation

J.G. Sanchez, R.M. Vickery, I. Birznieks

School of Medical Sciences, UNSW
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When holding an object, a correct balance of grip and load forces is required so that the object is safe within the grip and would not slip. A more slippery or heavier object would require a stronger grip force. From the point of view of control this can be achieved in two ways. One way is that the correct amount of grip force could be determined by explicit information about friction obtained at the initial contact and updated later during the manipulation and encountered load forces. In the second scenario explicit knowledge of friction at the initial touch is not necessary as the motor control may rely on triggered grip force increase in response to discrete events like microslips localised to a small part of contact area serving as early warning signals before the object is lost. The aim of the study is to explore the capacity of the human subjects to sense differences in tactile input due to changes in friction between the object and fingertip skin at the initial contact. The ultrasonic friction modulation device was brought in contact with the fingertip either perpendicular to the skin surface 0° or at 20°. Using a two-alternative-forced-choice paradigm, subjects had to select which surface was felt as more slippery. The performance of the majority of subjects was at the chance level, indicating that consciously subjects are not able to perceive frictional differences at the initial contact; however it is possible that this information is only available to motor control mechanisms.

P11. Corticospinal excitability is not altered when varying the randomization of assessment protocols

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This study determined relationships between Increasing Block (IB), Random Block (RB) and Random Random (RR) protocols in generating Input-Output (IO) curves by recording motor evoked potentials (MEP) elicited via transcranial magnetic stimulation (TMS). Measurements were taken from the right first dorsal interosseous (FDI) muscle of 9 subjects (21.2 years ± 1.5) who completed three IO curve protocols: increase block, stimulator output increases from lowest to highest (IB); random block, stimulator output randomised in blocks of trials (RB); and inter-trial randomisation, in which each individual stimulation was randomised (RR). Stimulator output intensities ranged from 90 to 140% active motor threshold (aMT) and were delivered with a 5 s inter-trial interval. Reliability was tested 24 hours after the first session in 4 subjects. IB, RB and RR protocols elicited IO curves with no significant differences between MEP amplitudes across intensities. MEP standard deviations, for each protocol, averaged across intensities were lowest in the RR protocol (0.17), compared to IB (0.24) and RB (0.21) protocols. Reliability was assessed through intra-class correlation coefficients and was highest in RB protocol (0.71), compared to IB (0.55) and RR (0.69) protocols. IO curves generated through RB and RR protocols displayed matched responses across tested intensities whereas the IB protocol displayed a trend to underrepresent corticospinal excitability, perhaps due to inhibition from the prior stimulation. The RR protocol is therefore preferred due to its lower variability across trials. When assessed for reliability, the RB should be used due to its lower variability between test days.

P12. Corticospinal Excitability Does Not Reflect Variations in Hand Dexterity

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The hand is capable of performing complex fine motor movements and has a large representation in the motor homunculus. Improvements in motor performance from training and rehabilitation interventions have found increases in the area of representation in the motor cortex (1). Furthermore, muscles with fine control have a higher density of neurons in the M1 area, compared to those with lower control (2). Little is known about the differences in corticospinal excitability between high and low dexterity motor performance. This study therefore investigated if people with high dexterity motor performance had lower motor thresholds. Five male subjects (21.8 ±2.4 years) were assessed for dexterity (Digital Finger Tapping Test and Dexteria iPad applications). Transcranial Magnetic Stimulation (TMS) was applied over the M1 hotspot of the right first dorsal interosseous (FDI). Corticospinal tract (CST) excitability was determined as the minimum stimulator output (SO) required to evoke MEP amplitudes of ≥100μV, in at least 5 of 10 trials. Pearson's correlation coefficients were used to assess if motor performance was correlated to CST excitability. No correlations were found between the two measures of performance and CST excitability (FTT and SO, $r = 0.1$; DS and SO, $r = 0.16$). CST excitability did not reflect variations in dexterity. Differences between participants in terms of high vs low dexterity may be reflected in neural organisation and excitability around the peripheral areas of the cortical representation.

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