SYDNEY

SENSORIMOTOR CONTROL MEETING

TUESDAY
13 DECEMBER 2022

ABSTRACTS + PROGRAMME

TUESDAY
13 DECEMBER 2022

TIME
FROM 12PM AEDT
(OPENING REMARKS 11:55AM)

SUPPORTED BY:

NeuRA
Discover. Conquer. Cure.

ONLINE 2022 SENSORIMOTOR MEETING

TUESDAY 13 December 2022 (via zoom)

PROGRAMME:

PLEASE NOTE: 15 minute presentation slots include 10 minutes for the talk and 5 minutes for questions

Welcome and <u>SESSION A</u> Opening Remarks: 11:55am -
Simon **GANDEVIA**, *NeuRA (Neuroscience Research Australia), Sydney Australia*)

SESSION A (12:00-1:30PM)	**SESSION CHAIR** Martin **HÉROUX**	*NeuRA (Neuroscience Research Australia), Sydney Australia*
12:00-12:15pm	Sophia **JENZ** *Northwestern University, Chicago, USA*	Sex differences in persistent inward currents – the potential role of estradiol
12:15-12:30	Benjamin **GOODLICH** *Griffith University, Gold Coast, Australia*	5-HT_2 receptors play a critical role in motor unit discharge rate in humans
12:30-12:45pm	Sourav **CHANDRA** *Northwestern University, Chicago, USA*	Longitudinal tracking of motor unit activities using novel tattoo electrode
12:45-1:00pm	James **O'LOUGHLIN** *Edith Cowan University, Perth, Australia*	Can virtual scenarios induce acute anxiety within an experimental setting?
1:00-1:15pm	Nishadi **GAMAGE** *University of Adelaide, Adelaide, Australia*	Alterations in bilateral neuromuscular properties following a single bout of acute unilateral resistance exercise training (RET) in healthy older adults
1:15-1:30pm	Harrison **FINN** *NeuRA (Neuroscience Research Australia), Sydney Australia*	Pain during cervical transcutaneous stimulation: anode location matters, waveform frequency might not matter
1:30-1:55pm	**Break**	**Break**

<u>SESSION B</u> Opening Remarks: 1:55pm

SESSION B (2:00-3:30pm)	**SESSION CHAIR** Janet **TAYLOR**	*Edith Cowan University, Western Australia*
2:00-2:15pm	Anne **PALERMO** *NeuRA (Neuroscience Research Australia), Sydney Australia*	Inspiratory muscle training protocol comparison for individuals with SCI: a secondary analysis
2:15-2:30pm	Michelle **HUNTLEY** *Curtin University, Perth, Australia*	Multisensory information: Does it help or hinder motor execution
2:30-2:45pm	Benjamin **MILLER-MILLS** *The University of Queensland, Brisbane, Australia*	Implicit audiomotor adaptation

SESSION B (Cont)		
2:45-3:00pm	Alastair **LOUTIT** *NeuRA (Neuroscience Research Australia), Sydney Australia*	Discriminating object thickness: do we need tactile cues?
3:00-3:15pm	Trevor **ALLEN** *Monash University, Melbourne, Australia*	The contribution of muscle spindles to forearm position sense measured using three different methods
3:15-3:30pm	Georgia **FISHER** *NeuRA (Neuroscience Research Australia), Sydney Australia*	Proprioceptive judgements of grasped objects: consistency is key
3:30-3:55pm	**Break**	**Break**

<u>SESSION C</u> Opening Remarks: 3:55pm

SESSION C (4:00-5:45PM)	**SESSION CHAIR** Harrison **FINN**	*NeuRA (Neuroscience Research Australia), Sydney Australia*
4:00-4:15pm	Tyler **HENDERSON** *Griffith University, Gold Coast, Australia*	The effect of 5-HT_2 receptor antagonism on human corticospinal and spinal-motoneuronal excitability during elbow flexions of different intensities
4:15-4:30pm	Merrick **LIAO** *The University of Adelaide, Australia*	Dorsal premotor cortex influences I-wave excitability in primary motor cortex of young and older adults
4:30-4:45pm	Dylan **CURTIN** *Monash University, Melbourne, Australia*	Dopamine D2 receptor blockade eliminates exercise-induced changes in cortical inhibition and excitation
4:45-5:00pm	Simon **WEBER** *University of Tasmania, Hobart, Australia*	Dissociating attentional capture from action cancelation in the stop signal task
5:00-5:15pm	Samuele **CONTEMORI** *University of Queensland, Brisbane, Australia*	A common subcortical pathway for express and long-latency visuomotor responses in humans?
5:15-5:30pm	Rebecca **HEALEY** *University of Tasmania, Hobart, Australia*	Investigating age-related changes in perceptual and motor inhibition in the upper and lower limb
5:30-5:45pm	Steven **PHU** *NeuRA (Neuroscience Research Australia), Sydney Australia*	Impact of pathological conditions on postural reflex latency and adaptability following unpredictable perturbations: A systematic review and meta-analysis

5:50pm: Closing Remarks
Simon **GANDEVIA**, *NeuRA (Neuroscience Research Australia), Sydney Australia*

ABSTRACTS (in Programme order)

SESSION A:

Chairperson - Martin Héroux
NeuRA (Neuroscience Research Australia), Sydney Australia

Sex differences in persistent inward currents – the potential role of estradiol

Sophia T Jenz[1], James A Beauchamp[1], Matheus M Gomes [1], Tea Lulic-Kuryllo[3], Francesco Negro[3], Colin Franz[1], CJ Heckman[1,] and Gregory EP Pearcey[4].

1. Northwestern University, Chicago, IL, USA.
2. School of Physical Education and Sport of Ribeirão Preto, University of São Paulo, SP, Brazil.
3. Department of Clinical and Experimental Sciences, Universita degli Studi di Brescia, Brescia, Italy.
4. School of Human Kinetics and Recreation, Memorial University of Newfoundland, St. John's, Canada.

Introduction: Motor units (MUs) are well studied in *males* but understudied in *females*. Sex-differences in MU behavior often emerge when enough females are included, but underlying physiological mechanisms remain unclear. Based on the effects of estradiol throughout the nervous system (i.e., on serotonergic receptors in the brain), we hypothesized fluctuating levels of sex hormones alter monoaminergic signaling to spinal motoneurons and cause fluctuations in female MU activity.

Methods: In two separate studies, we decomposed MU spike trains from lower limb muscles of both sexes while participants performed submaximal isometric ramp contractions. Persistent inward currents (PICs), which provide a proxy for the level of monoaminergic signaling, were estimated using the paired-MU analysis technique (ΔF). Linear mixed effects models were used to determine if sex predicted ΔF. Study 1 (N=20, 10 Female) revealed sex-differences in ΔF, which prompted study 2 (N=6, 4 Female, where we examined if ΔF was predicted by sex hormone fluctuations. On three separate days across the female menstrual cycle and on matched days for males, blood levels of estradiol and progesterone were measured before participants performed the abovementioned contractions.

Results: Study 1: ΔF was 0.92pps higher in females than males ($\chi^2_{(1)} = 6.26$, $p = 0.012$). Study 2: preliminary findings suggest that estradiol is a significant predictor of ΔF ($\chi^2_{(1)} = 4.88$, $p = 0.027$).

Conclusion: These findings suggest PICs differ between the sexes, likely due to effects of estradiol on serotonergic signaling. This emphasizes the importance of including both sexes in human neurophysiological studies and considering menstrual cycle phase when studying female participants

5-HT_2 receptors play a critical role in motor unit discharge rate in humans

Benjamin I Goodlich[1], Alessandro Del Vecchio[2], Sean A. Horan[1], Justin J. Kavanagh[1]

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

Introduction: Serotonergic neuromodulation contributes to enhanced voluntary muscle activation. However, it is unknown how the likely motoneurone receptor candidate (5-HT_2) influences the firing rate, and activation threshold, of motor units in humans. The purpose of this study was to determine if 5-HT_2 receptor activity contributes to human motor unit behaviour during voluntary ramped contractions of differing intensity.

Methods: Fourteen recreationally active individuals (age 23.9 ± 2.5 years (mean ± SD), 7 female) performed ramped isometric dorsiflexions of 10%, 30%, 50% and 70% of maximal voluntary contraction (MVC), during which high-density electromyography (HD-EMG) of the tibialis anterior was assessed. Motor unit characteristics were successfully extracted via blind source separation from HD-EMG of 11 participants (4 female) pre- and post-ingestion of 8 mg cyproheptadine and a placebo.

Results: 5-HT_2 receptor blockade caused a reduction in motor unit discharge rate during steady-state muscle activation that was independent of contraction intensity ($p < 0.001$). 5-HT_2 receptor blockade also increased motor unit recruitment threshold ($p = 0.003$) and derecruitment threshold ($p < 0.001$). A reduction in estimates of persistent inward current (PIC) amplitude was observed at 10% MVC ($p < 0.001$) and 30% MVC ($p = 0.003$) that aligned with 5-HT changes in motor unit firing behaviour due to 5-HT_2 receptor blockade.

Conclusion: Overall, these findings indicate that 5-HT_2 receptor activity has a critical role in regulating discharge rate in populations of spinal motoneurones during voluntary contractions. This study provides evidence of a direct link between motor unit discharge properties, PIC activity, and 5-HT_2 receptor activity in humans.

Longitudinal tracking of motor unit activities using novel tattoo electrode

Sourav Chandra[1,2], Jinghua Li[3], Alex Barry[1], Leah O'Shea[1], and William Zev Rymer[1,2]

1. Arms & Hands Laboratory, Shirley Ryan Ability Lab, Chicago, USA.
2. Department of Physical Medicine and Rehabilitation, Northwestern University, Chicago, USA.
3. Department of Materials Science and Engineering, The Ohio State University, Columbus, USA.

Introduction: High-density surface electromyography (HDsEMG) has opened up a new avenue for studying neuromuscular activity at the level of the individual motor unit (MU). However, the functional limitation of the HDsEMG electrodes (e.g. skin-electrode contact quality, gel smearing) imposes major challenges for prolonged recordings. To address these issues we have developed *tattoo electrodes* for HDsEMG applications optimized for MU detection from a given muscle in a healthy individual. We have used tattoo electrodes to track the activity of matched MUs on different days.

Method: The HDsEMG recording was performed during isometric maximal voluntary contraction (MVC) of the medial gastrocnemius followed by submaximal contractions (50%-MVC) during plantarflexion. The force levels were matched during the contraction series. A 64-channel (8×8) tattoo electrode with an electrode diameter of 1mm and inter-electrode distance of 4 mm was placed on the muscle belly. The signal was acquired on two consecutive days at 2000 samples/second, concatenated, and then decomposed with a standard MU decomposition tool.

Result: We obtained 10±2 (Mean±SD) matched MUs from those two days of recording from two subjects. The number of matched MUs was less (40%) than the total number of the MUs detected. The majority of the matched MUs were found to be towards the smaller (size) side of the population with relatively higher firing frequency.

Conclusion: The dry tattoo electrodes ensure superior quality HDsEMG signals for long-term recording, offers the flexibility of layout design, and a secure way of analyzing muscle activity. It will potentially facilitate studying adjustments in MU properties for longitudinal studies.

Can virtual reality scenarios induce acute anxiety within an experimental setting?

James H O'Loughlin[1], Christopher Latella[1] and Janet L Taylor[1]

1. School of Medical and Health Sciences, Edith Cowan University

Introduction: Acute anxiety can increase pupil diameter, which is believed to correlate to noradrenergic activity. Experimentally, mental arithmetic can increase anxiety, although lack of task variability may cause habituation. Alternatively, virtual reality (VR) immersion can provide a variety of anxiety-inducing stimuli which may then allow indirect assessment of the physiological effects of noradrenaline. We exposed participants to different VR scenarios to determine their effectiveness in anxiety production, and concurrent effects on pupil diameter and pain perception.

Methods: Ten healthy, naïve participants, underwent nine 3-min trials comprising six different suspenseful VR scenarios, two calming control VR scenarios, and one mental arithmetic task. Participants self-reported anxiety scores after each trial (1-5 scale). Pupil diameter was recorded throughout each trial and pressure pain threshold (PPT) on the thigh was measured towards the end of each trial.

Results: Repeated measures analysis of variance (ANOVA) showed that PPT ($p=0.008$) and pupil diameter ($p=0.014$) differed across trials. They were lowest in control trials and increased by up to 24±26% and 11.7±5.9% (mean±SD), respectively, for individual suspenseful VR scenarios. Ratings of anxiety (Friedmans ANOVA on ranks, $p<0.001$) also differed across trials, with mean ratings ranging from 1-2.8. Both PPT ($r=0.751$, $p=0.020$) and pupil diameter ($r=0.698$, $p=0.036$) correlated with anxiety scores, but not with each other ($r=0.580$, $p=0.102$).

Conclusion: VR scenarios that produce mild anxiety are accompanied by increased pupil diameter and decreased perception of pain. Both changes are consistent with increased noradrenergic activity. Therefore, VR scenarios seem suitable to induce acute anxiety within an experimental setting.

Alterations in bilateral neuromuscular properties following a single bout of acute unilateral resistance exercise training (RET) in healthy older adults

Nishadi Gamage[1, 2], Abdulmajeed Altheyab[1], John Semmler[2], George Opie[2], Bethan Phillips[1], Philip Atherton[1], Mathew Piasecki[1]

1. Centre of Metabolism, Ageing & Physiology, MRC-Versus Arthritis Centre for Musculoskeletal Ageing Research, Nottingham NIHR Biomedical Research Centre, University of Nottingham, United Kingdom
2. Discipline of Physiology, School of Biomedicine, University of Adelaide, Australia

Introduction: There is contradictory evidence on the effect of unilateral resistance exercise training (RET) on bilateral function (1). It is unclear how opposing limb muscles respond to a single bout of fatiguing exercise. The study aimed to determine the acute effects of a single bout of unilateral RET on bilateral neuromuscular properties of the knee extensors (KE).

Methods: Fourteen participants (7 males) with a mean age (±SD) of 74.3 ±4.9 years underwent bilateral assessments which included KE isometric maximal voluntary contraction (MVC), and force steadiness (FS) quantified as the coefficient of variation of force at 25% of MVC. In the post-RET assessment, two FS values (25% of pre-RET MVC and post-RET MVC) were obtained. The RET consisted of 4 sets of 8-12 repetitions of leg extension of the dominant leg, at 75% of their 1 repetition maximum, performed to failure. Data analysis was performed via two-way repeated-measures ANOVA (leg x time).

Results: There was no significant leg x time interaction on MVC ($p=0.3100$), but force reduced in both limbs following RET ($p<0.001$). For FS, there was no leg x time interaction ($p=0.9692$), but an effect of time, which significantly improved when normalised to pre-RET MVC ($p=0.0119$). There were no differences in FS when normalised to post-RET MVC (leg x time interaction; $p=0.9221$, time; $p=0.7565$).

Conclusion: These findings demonstrate a single bout of unilateral RET is sufficient to induce central fatigue thereby influencing bilateral muscle function. FS differed only when normalised to pre-fatigue force levels, which interestingly improved slightly. This study could have implications for unilateral exercise prescription in older adults following single-leg fracture, post-injury immobilisation and stroke.

References

1. Colomer-Poveda D, Romero-Arenas S, Keller M, Hortobágyi T, Márquez G. Effects of acute and chronic unilateral resistance training variables on ipsilateral motor cortical excitability and cross-education: a systematic review. Physical Therapy in Sport. 2019;40:143-52.

Pain during cervical transcutaneous stimulation: anode location matters, waveform frequency might not matter

Terry Trinh[1,2], **Harrison Finn**[1,2], Annie Palermo[1,2], Elizabeth Bye[1,2], Claire Boswell-Ruys[1,2], Simon Gandevia[1,2], Jane Butler[1,2], Martin Heroux[1,2]

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

Introduction: Transcutaneous spinal stimulation is thought to improve motor function for people with SCI, but it can be painful. Anode placement can lower the required stimulation intensity, and subsequently reduce discomfort. Moreover, high frequency (HF)(10kHz) stimulation may cause less pain than conventional (CON) stimulation. Thus, we compared HF and CON stimulation at two commonly used anode locations. We recorded participant reported pain and the stimulation intensity required to elicit a spinally evoked motor response (sEMR) in biceps-brachii, triceps, wrist-extensors, wrist-flexors, abductor pollicis brevis and first dorsal interossei muscles.

Methods: Sixteen able-bodied individuals participated. Anodes were placed over the shoulder (S) or the anterior superior iliac spine (A). CON (one 400μs biphasic pulse) and HF (ten 40μs biphasic pulses at 10kHz) stimulation were used at each anode location. Cathodes were placed over C3-C7. Double pulses and trains of stimulation (30Hz) were delivered at increasing intensities until sEMRs were present in all muscles. Pain (0-10) was reported at regular intervals during trains of stimulation.

Results: Threshold intensities were lower using shoulder anode position regardless of waveform: CON-S 25 (±SD8) mA vs CON-A 31 (±8) mA ($p<0.001$), and HF-S 116 (±20) mA vs HF-A 133 (±25) mA ($p<0.001$). Pain was lower with CON-S (2.8±1.9) compared to CON-A (4.2±2.5, $p<0.001$), and HF-S (4.3±2.4, $p=0.002$) during trains of stimulation at the average upper-limb threshold intensity.

Conclusion: When stimulation intensity is normalised to threshold sEMR intensity, HF stimulation does not reduce pain. Pain during stimulation can be reduced by placing the anode at the shoulder rather than the hip.

SESSION B:

Chairperson - Janet Taylor
Edith Cowan University, Western Australia

Inspiratory Muscle Training Protocol Comparison for Individuals with SCI: a secondary analysis

Anne E Palermo[1,2] Claire Boswell-Ruys[1,2]

1. Neuroscience Research Australia, [2]UNSW School of Medicine and Health

Introduction: Respiratory complications are a leading cause of mortality in people with spinal cord injury (SCI). Inspiratory muscle training (IMT) improves respiratory health but there is no gold-standard IMT protocol. This small secondary analysis of data compares the change in maximal inspiratory pressure (PI_{max}) from the first 4 weeks of two IMT trials (Palermo et al. 2022 *SCSC* and Boswell-Ruys et al. 2020 *Thorax*).

Methods: Participants in IMT1 protocol completed IMT at 80% of a daily PI_{max} 7 days/week in their homes with supervision once weekly. Participants in the IMT2 trial completed twice-daily supervised IMT sessions 5 days/week at 30-80% of a weekly PI_{max}. Seven pairs of participants from each trial were matched by level of SCI, AIS grade, training adherence, and height. T-Tests analysed differences in training intensity, breaths taken, Work intensity (cmH_2O/% Baseline PI_{max} x breaths), and the change in the PI_{max} (cmH_2O/% change in PI_{max} from baseline).

Results: There was no difference in the percent or actual change in PI_{max} between groups. IMT1 participants trained at a higher intensity (mean: 75.7 cmH_2O 95%CI [62.6, 88.8] vs 22.2 [15.2, 29.3], p = 0.001 and 80% baseline [71%, 90%] vs 60% [43%, 78%], p= 0.038) but took fewer breaths (834 [639, 1029] vs 1479 [1166, 1793], p= 0.017) than IMT2 participants. Work (% Baseline PI_{max}) was similar between groups (p= 0.535).

Conclusions: Our findings support the feasibility of individuals with SCI completing high-intensity IMT at home with intermittent supervision, it required fewer breaths, less participant and therapist time, and there was no difference in the change in PI_{max} between groups.

Multisensory information: Does it help or hinder motor execution?

Michelle K Huntley[1], An Nguyen[1], Matthew Albrecht[2], Susan Morris[3], Welber Marinovic[1]

1. School of Population Health, Curtin University, Perth, Australia
2. Western Australia Centre for Road Safety Research, School of Psychological Science, University of Western Australia, Perth, Australia
3. School of Physiotherapy and Exercise Science, Curtin University, Perth, Australia

Introduction: Many tasks require us to precisely synchronise our movements with external sensory stimuli and to maintain a rhythm (e.g., driving a car). Yet, it is unclear if combined visual-tactile information provides an additional benefit to movement synchrony over separate visual and tactile stimuli. Experiment 1 examined the effect of stimulus modality (visual, tactile, visual-tactile) on movement synchronisation. Experiment 2 examined movement synchronisation ability at different timing intervals (inside vs. outside the temporal binding window, ~ 120 ms).

Method: Experiment 1. 31 participants (M = 20.8 years, SD = 2.3) completed a sensorimotor synchronisation task to examine movement variability between unimodal (visual, tactile) and cross-modal (visual-tactile) stimuli, and a simultaneity judgment task to measure the temporal binding window. Experiment 2. 28 participants (M = 21.1 years, SD = 3.2) completed a sensorimotor synchronisation task to examine temporal error between visual-tactile stimuli presented inside and outside the temporal binding window, and a simultaneity judgment task to measure the temporal binding window.

Results: Experiment 1 found movement variability was lower with the visual-tactile and tactile only stimuli, compared to visual only. Experiment 2 found synchronisation was more accurate with tactile stimuli, regardless of the timing of stimuli, and movement synchronisation was more accurate when only one stimulus in the cross-modal pair was presented inside the temporal binding window than when both stimuli were presented inside the window.

Conclusion: Results from both experiments indicate that tactile information may be prioritised over other sensory modalities during rhythmic tasks. Further, in some circumstances, additional sensory stimuli may hinder movement execution.

Implicit Audiomotor Adaptation

Benjamin Miller-Mills[1], Ken McAnally[2], Li-Ann Leow[2], Brendan Keane[2], Philip Grove[2] and Timothy Carroll[1]

1. School of Human Movement and Nutrition Sciences, University of Queensland, Brisbane, Australia

Introduction: Sensorimotor adaptation has been extensively studied in the visual domain, but the degree to which altered sensorimotor mappings occur in modalities other than vision remains less well understood. Here we manipulated the modality of stimulus presentation to compare motor updates in response to perturbations of visual and auditory feedback location. We compared a) the extent of learning from perturbed sensory feedback for the visual and auditory sensory modalities and b) the magnitude of reach direction aftereffect when the perturbation was removed.

Methods: Participants were required to reach toward targets presented by loudspeakers, headphones (incorporating head-related transfer functions), or a visual display. Each condition contained 24 participants. Following familiarization and baseline blocks, visual or auditory feedback of the reach endpoint was systematically displaced, but participants were informed of the perturbation and instructed to ignore it, and "reach directly toward the target."

Results: Consistent with our predictions and previous literature, a significant change in reach direction from baseline was observed with visual stimuli (3.2°, $p < 0.001$), along with an aftereffect that persisted when participants were instructed that the perturbation had been removed (2.96°, $p < 0.001$). Critically, both auditory conditions also showed significant changes in reach direction upon exposure to perturbed feedback (Loudspeaker = 4.9°, $p = 0.007$, Headphones = 17.3°, $p < 0.001$), and an aftereffect (Loudspeaker = 3.27°, $p = 0.048$, Headphones = 13.12°, $p = 0.008$).

Conclusion: This study provides new evidence that implicit motor adaptation occurs in response to perturbed auditory feedback of reach direction.

Discriminating object thickness: do we need tactile cues?

Alastair J Loutit[1,2], Siddhartha Pande[2], Naqash Afzal[2], Pouya Abdollahzadeh[3], Richard M Vickery[1,2,4], and Ingvars Birznieks[1,2,4,5]

1. Neuroscience Research Australia, Sydney, NSW, Australia
2. School of Biomedical Sciences, Faculty of Medicine and Health, UNSW Sydney, Sydney, NSW, Australia
3. Urmia University of Technology, Urmia, Iran
4. Bionics and Bio-robotics, Tyree Foundation Institute of Health Engineering, UNSW Sydney, Sydney, NSW Australia
5. School of Health Sciences, Western Sydney University, NSW Australia

Introduction: When we turn the pages of a book or count bank notes, we easily notice when we are gripping more than one sheet of paper. But are we explicitly discriminating the thickness or are we perceiving inherent physical properties of such objects, like pliability, or sensing variations in vibrations or heat transfer through the object from our fingertip contact? We evaluated human thickness discrimination when no such cues are available, by using two separated parallel-aligned 0.7 mm steel plates.

Methods: Participants (n = 10) used a pinch grip formed with the thumb and index finger, and were presented with pairs of separation distances and had to indicate which they perceived as wider in a two-alternative forced choice experiment. Each stimulus pair comprised a reference and comparison width, with seven reference widths ranging from 2.5–80 mm.

Results: The smallest median just noticeable difference was 0.55 mm (range 0.40–3.7 mm) with the 2.5 mm reference width. The pinch grip width discrimination did not follow Weber's Law, particularly for reference widths narrower than 20 mm, which did not decrease in proportion to decreasing reference widths.

Conclusion: This suggests that when thickness is greater than ~20 mm, proprioceptive cues are sufficient to make accurate thickness judgements, but tactile cues are required for accurate discrimination when thicknesses are narrower than 20 mm.

The contribution of muscle spindles to forearm position sense measured using three different methods

Trevor J Allen[1], Christopher Roach[2], Christopher Love[2] and Uwe Proske[2]

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

Introduction: The purpose of these experiments was to compare the contribution of muscle spindles to forearm position sense when measured with three different methods and across the full range of elbow angles.

Methods: Eleven adults (5 male, 6 female) participated in the first series of experiments involving two-arm matching and one-arm pointing tasks. Eleven adults (5 male, 6 female) participated in a 2nd series of experiments involving a one-arm repositioning task. Muscle spindle signals were altered by muscle conditioning, comprising 2s voluntary isometric contractions of elbow flexors and extensors at 5° or 125° elbow flexion. Test angles ranged from 5-125°.

Results: For two-arm matching, average position error varied by as much as 17° (from +8.8° to -8.4°) after conditioning the arms at opposite positions. Effects of conditioning on position error were greater for mid-range test angles (35°,65°,95°) and not significant at 5°. Results for one-arm pointing were similar except that all position errors lay in the direction of extension. For repositioning, there was some effect of conditioning on position errors, but effects were smaller and repositioning errors shifted into flexion at more extended test angles (independent of conditioning).

Conclusion: Results suggest a contribution of muscle spindles to position sense for all three measurement methods. However, the magnitude of these effects varied by measurement method and by test angle, with muscle conditioning having its greatest effects at mid-range test angles. The minimal effects of muscle conditioning on position error for test angles near end of joint range should be explored further.

Proprioceptive judgements of grasped objects: consistency is key

Georgia Fisher[1,2], Annie A Butler[1,3], Lovisa H Axelson[1,4], Simon C Gandevia[1,5] and Martin E Héroux[1,3]

1. Neuroscience Research Australia, Randwick, Australia
2. School of Health Sciences, University of New South Wales, Sydney, Australia
3. School of Medical Sciences, University of New South Wales, Sydney, Australia
4. School of Medicine and Health Sciences, Linköping University, Linköping, Sweden
5. Prince of Wales Clinical School, University of New South Wales, Sydney, Australia

Introduction: High-level proprioceptive tasks require people make proprioceptive judgements in different reference frames; e.g., in *proprioceptive-to-visual* judgements, a person uses visual coordinates to report the position of their hidden hand. Errors in high-level judgements vary between people, but are likely consistent for a given person. Errors in inverse high-level judgements, e.g. *proprioceptive-to-visual* versus *visual-to-proprioceptive*, are likely reciprocal. This study estimated the consistency and reciprocal nature of errors in high-level proprioceptive judgements.

Methods: In Experiment 1, 30 healthy adults (mean ± SD, 28 ± 16 years) made *proprioceptive-to-visual* judgements, where they selected from a series of visually presented lines to judge the width of an object grasped between their hidden index finger and thumb. They also made *visual-to-proprioceptive* judgements, where they selected from a series of grasped objects of different widths to judge the width of a visually presented line. In Experiment 2, 30 healthy adults (26.7 ± 6.0 years) made *proprioceptive-to-visual* judgements in four sessions: one with the dominant and non-dominant hand on the same day, and two with the dominant hand one week later.

Results: In Experiment 1, individual participants made consistent errors in *proprioceptive-to-visual* and *visual-to-proprioceptive* judgements, but error magnitude varied between people. There was a negative relationship between errors in the two reciprocal judgements (r = -0.77 95%CI[-0.88 to -0.56]). In Experiment 2, individual participants made consistent errors in judgements made with their dominant and non-dominant hands, and on different days.

Conclusion: Individuals make consistent high-level proprioceptive judgements, and may use similar, but reversed neural transformations to make reciprocal high-level judgements.

SESSION C:

Chairperson – Harrison Finn
NeuRA (Neuroscience Research Australia), Sydney Australia

The effect of 5-HT_2 receptor antagonism on human corticospinal and spinal-motoneuronal excitability during elbow flexions of different intensities

Tyler T Henderson[1], Janet L Taylor[2,3], Jacob R Thorstensen[4], Justin Kavanagh[1]

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

Introduction: Serotonergic mechanisms that promote muscle activation are mostly attributed to activation of 5-HT_2 receptors on spinal motoneurones. However, recent human investigations indicate that 5-HT_2 receptor activity may also influence corticospinal excitability. The purpose of this study was to assess how 5-HT_2 receptor antagonism affects corticospinal and motoneuronal excitability during voluntary contractions.

Methods: Nine participants (age: 24 ± 4yr, mean ± SD) volunteered for the study. Evoked responses were assessed from motor cortical and cervicomedullary stimulation before and after a single 8 mg oral dose of the 5-HT_2 antagonist cyproheptadine. Motor evoked potentials (MEPs) and cervicomedullary motor evoked potentials (CMEPs) were obtained from biceps brachii at rest, and during 20%, 50%, and 80% of maximal elbow flexion torque. "Conditioned" MEPs and CMEPs were also obtained during a TMS-induced silent period when descending drive to the motoneurone pool was inhibited. All data were normalised to biceps brachii M_{max}.

Results: Maximal torque was ~6% lower post-pill compared to pre-pill ($p = 0.005$). During contraction, conditioned MEPs were ~9% lower post-ingestion of cyproheptadine ($p < 0.001$) but unconditioned MEPs were not affected ($p = 0.094$). In contrast, unconditioned CMEPs were ~7% higher post-ingestion of cyproheptadine ($p = 0.028$) but conditioned CMEPs were not affected ($p = 0.948$).

Conclusion: Antagonism of 5HT_2 receptors differentially affects corticospinal excitability and spinal motoneurone excitability during muscle contractions. Decreased conditioned MEPs suggest an increase in long-interval intracortical inhibition whereas changes only in unconditioned CMEPs suggest that spinal motoneurones require ongoing voluntary drive for the influence of 5-HT mechanisms to be observed.

Dorsal premotor cortex influences I-wave excitability in primary motor cortex of young and older adults.

Wei-Yeh (Merrick) Liao[1], George M Opie[1], Ulf Ziemann[2] and John G Semmler[1]

1. Discipline of Physiology, School of Biomedicine, University of Adelaide, Adelaide, Australia.
2. Department of Neurology & Stroke, and Hertie-Institute for Clinical Brain Research, Eberhard Karls University of Tübingen, Tübingen, Germany

Introduction: Previous research using transcranial magnetic stimulation (TMS) demonstrates weakened connectivity between dorsal premotor cortex (PMd) and motor cortex (M1) with age. While this alteration is likely mediated by changes in the communication between the two regions, the influence of PMd on specific indirect (I) wave circuits within M1 remains unclear. The present study therefore investigated PMd influence on early and late I-wave excitability in M1 of young and older adults.

Methods: 22 young (mean ± standard deviation; 22.9 ± 2.9 years) and 20 older (66.6 ± 4.2 years) adults participated in two experimental sessions involving either intermittent theta burst stimulation (iTBS) or sham stimulation over PMd. Changes within M1 following the intervention were assessed with motor evoked potentials (MEP) recorded from right first dorsal interosseous muscle. We applied posterior-anterior (PA) and anterior-posterior (AP) current single-pulse TMS to assess corticospinal excitability (PA_{1mV}; AP_{1mV}; $PA_{0.5mV}$, early; $AP_{0.5mV}$, late), and paired-pulse TMS short intracortical facilitation for I-wave excitability (PA SICF, early; AP SICF, late).

Results: Although PA_{1mV} and AP_{1mV} MEPs potentiated in both groups following PMd iTBS (both $P < 0.05$), the time course of this effect was delayed for AP_{1mV} in older adults ($P = 0.001$). Furthermore, while $AP_{0.5mV}$, PA SICF, and AP SICF facilitated in both groups (all $P < 0.05$), potentiation of $PA_{0.5mV}$ occurred only in young adults ($P < 0.05$).

Conclusion: While PMd influences early and late I-wave excitability in young adults, the strength of the connection with the early (PA) circuits are specifically reduced in older adults.

Dopamine D2 receptor blockade eliminates exercise-induced changes in cortical inhibition and excitation

Dylan Curtin[1], Eleanor M Taylor[1], Mark A Bellgrove[1], Trevor T-J Chong[1,2,3] and James P Coxon[1]

1. The Turner Institute for Brain and Mental Health, School of Psychological Sciences, Monash University, Victoria, Australia
2. Department of Neurology, Alfred Health, Melbourne, Victoria, Australia
3. Department of Clinical Neurosciences, St Vincent's Hospital, Melbourne, Victoria, Australia

Introduction: Although cardiorespiratory exercise is known to affect synaptic plasticity, the neurochemical mechanisms driving this effect are poorly understood. Indirect evidence from Parkinson's disease models point to the dopamine D2 receptor as a candidate mechanism, but the direct interaction of exercise and the D2 receptor on synaptic plasticity is unknown. Here, we examined the effect of a selective dopamine D2 receptor antagonist, sulpiride, on exercise-induced changes in synaptic plasticity.

Methods: We acquired measures of synaptic excitatory and inhibitory activity of the primary motor cortex using transcranial magnetic stimulation (TMS) from 23 healthy adults, both before and after a 20-minute bout of high-intensity interval cycling exercise. We then examined the effect of D2 receptor blockade (800mg sulpiride) on these measures within a randomised, double-blind, placebo-controlled, crossover design.

Results: Sulpiride abolished exercise-induced modulation of the cortical excitation:inhibition balance relative to placebo ($p < 0.001$, Cohen's $d = 1.69$). Sulpiride blocked both the increase in excitation (intracortical facilitation) and reduction in inhibition (short-interval intracortical inhibition) that was observed in the placebo condition.

Conclusion: Our findings provide causal evidence for the role of the dopamine D2 receptor on exercise-induced synaptic plasticity, and have implications for how exercise should be prescribed in diseases of dopaminergic dysfunction, such as schizophrenia and Parkinson's disease.

Dissociating attentional capture from action cancelation in the stop signal task

Simon Weber[1], Sauro Salomoni[1], Callum Kilpatrick[1], and Mark R Hinder[1]

1. Sensory Neuroscience and Aging Research Lab, University of Tasmania, Hobart, Tasmania, Australia

Introduction: Inhibiting ongoing responses when environmental demands change is a critical component of human motor control. Experimentally, the stop signal task (SST) represents the gold standard response inhibition paradigm. However, an emerging body of evidence suggests the SST conflates two dissociable sources of inhibition: An involuntarily pause associated with attentional capture and the (subsequent) voluntary cancelation of action. The extent to which these processes generalise to other response tasks is unknown.

Methods: 24 younger (20-35 years) and 23 older (60-85 years) adults completed tasks involving rapid unimanual or bimanual responses to a visual stimulus. A subset of trials required cancellation of one component of the initial response (i.e., a selective stop task; stop left response, continue right response) or enacting an additional response (e.g., press left button *as well* as right button). Critically, both tasks involved some infrequent stimuli which bore no behavioural imperative (i.e., they had to be ignored).

Results: EMG recordings revealed bimanual covert responses (i.e., muscle activation which was suppressed before a button press ensued), consistent with a pause process, following both stop and ignore stimuli, before the required response was subsequently enacted. Critically, we also observed the behavioural consequences of a similar involuntary pause in trials where action cancellation was *not* part of the response set (i.e., when the additional stimulus required additional action or ignoring, but not inhibition).

Conclusions: The findings shed new light on two distinct inhibitory processes mediating action cancelation, one of which is associated with attentional capture and generalises beyond stopping contexts.

A common subcortical pathway for express and long-latency visuomotor responses in humans?

Samuele Contemori,[1] Gerald E Loeb,[2] Brian D Corneil,[3,4,5] Guy Wallis,[1] and Timothy J Carroll[1]

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

Introduction: Extremely rapid (~90ms) muscle responses that consistently encode the location of visual targets for reaching are proposed to reflect visuomotor transformations conveyed via a subcortical tecto-reticulo-spinal pathway. These express visuomotor responses, however, are flexible to contextual signals of cortical origin. Here, we asked if the express visuomotor response has the same contextual sophistication as the later (>130ms), plausibly cortically-driven, response. If so, it would suggest that these two temporally-distinct visuomotor responses are conveyed via a common sensorimotor pathway, rather than parallel subcortical and cortical circuits.

Methods: The activity of eight upper-limb muscles was recorded during visually-guided reaches toward one of eight potential targets that were executed using a robotic virtual-reality system. One group (n=10) performed the task from an abducted-shoulder posture, and another group (n=10) from an adducted-shoulder posture.

Results: For both the express and long-latency visuomotor responses, and among all muscles, the preferred movement direction was significantly different ($p<0.05$) across the upper-limb postures. Critically, however, the muscle spatial-tuning curves were similar between the express and long-latency visuomotor responses (Pearson correlation coefficient $R>0.8$; $p<0.05$).

Conclusion: The similarity in muscle activation patterns for express and long-latency visuomotor responses suggests similar sensory-to-motor transformations of visual inputs to produce appropriate mechanical outputs for task-goal achievement. A parsimonious interpretation is that a common set of subcortical reticulo-spinal circuits perform these transformations for both early and late components of the reach control signal. This prompts speculation that the subcortical express visuomotor network is an inherent component of the human reach control system.

Investigating Age-Related Changes in Perceptual and Motor Inhibition in the Upper and Lower Limb

Rebecca Healey, Goldsworthy M, Weber S, Salomoni SE, Puri R, Wells M, St George R J, and Hinder MR

School of Psychology, University of Tasmania, Hobart, Australia.

Introduction: Perceptual inhibition (i.e., ability to filter irrelevant sensory information) and motor inhibition (i.e., ability to stop movement) may share attentional and neural resources. We examined whether incongruent perceptual stimuli influence stopping ability during seated finger movements and upright step initiation, in young and older adults.

Methods: Reaction times (RT) of young (n = 23; aged 18-35 years) and older (n = 32; aged 60-90 years) adults were measured during choice RT, Flanker (assessing perceptual inhibition), Stop Signal (assessing motor inhibition), and Combined Flanker-Stop Signal tasks. Concurrently (pending analysis), hand muscle activation was recorded using electromyography, ground reaction forces were measured during step initiation, and prefrontal cortical activity was measured using functional near-infrared spectroscopy (fNIRS).

Results: RT was faster in young than older adults (p <0.001); and faster in the upper than lower limb (p <0.001). However, young participants slowed more than older participants when stopping demands were anticipated, particularly when stepping. Regardless of age, RT slowing occurred on congruent and neutral (but not incongruent) trials of the Combined task. Stop signal reaction time (SSRT) was faster in young than older adults, but did not differ significantly by Flanker congruency (p = 0.116).

Conclusion: Flanker stimuli did not interfere with action cancellation ability, suggesting no interaction between perceptual and motor inhibition at the behavioural level.

Impact of pathological conditions on postural reflex latency and adaptability following unpredictable perturbations: A systematic review and meta-analysis

Steven Phu[1,2,3], Stephen R. Lord[1,2], Daina L. Sturnieks[1,4], and Yoshiro Okubo[1,2]

1. Falls, Balance and Injury Research Centre, Neuroscience Research Australia (NeuRA), Randwick, NSW, Australia
2. School of Population Health, Faculty of Medicine, University of New South Wales, Sydney, NSW, Australia
3. Department of Medicine, Western Health, University of Melbourne, St Albans, VIC, Australia
4. School of Medical Sciences, Faculty of Medicine, University of New South Wales, Sydney, NSW, Australia

Introduction: Pathological conditions may impair sensorimotor functions necessary for effective responses to postural perturbations to avoid falls. This review sought to determine the extent to which postural reflexes are impaired in people with different pathological conditions and whether exercise interventions can shorten postural reflexes.

Methods: MEDLINE, EMBASE, Scopus, SportDiscus and Web of Science were systematically searched for articles comparing muscle activation onset in the leg, thigh and hip/back in people with pathological conditions to healthy controls following unpredictable perturbations including the effect of exercise interventions (registration: CRD42020170861).

Results: Fifty-three articles were included for systematic review. Significant delays in muscle activity onset following perturbations were evident in people with multiple sclerosis (+22 ms, stroke (+34 ms), diabetes (+19 ms), HIV (+9 ms), incomplete spinal cord injury (+57 ms) and back and knee pain (+12 ms), but not in people with Parkinson's disease or cerebellar dysfunction. Exercise interventions resulted in significantly faster onset latencies in the paretic limb of stroke survivors compared to pre-exercise but not Parkinson's disease.

Conclusions: This systematic review and meta-analysis demonstrated that postural reflexes are significantly delayed in people with multiple sclerosis, stroke, diabetes, HIV, incomplete spinal cord injury, back and knee pain; pathological conditions characterized by impaired sensation or neuromuscular function. In contrast, timing of postural reflexes was not impaired in people with Parkinson's disease and cerebellar dysfunction, confirming the limited involvement of supraspinal structures. Furthermore, exercise interventions significantly shortened postural reflex latencies in stroke survivors, but more research is needed to confirm these findings and the effect on other pathological conditions.