

HRRI Symposium 2019 Abstracts

emgGO: An Open-source Toolbox for Optimal Identification of Muscle Activation Intervals in Surface Electromyography

Usman Rashid, Imran Khan Niazi, Nada Signal, Denise Taylor

Surface electromyography (sEMG) is the process of recording muscle electrical signals using electrodes placed on the skin. This technique has a wide range of applications. An example which immediately come to mind is the study of the sequence in which different muscles are activated in a particular task such as walking. Identification of the precise start and end of muscle activation from sEMG is a challenging task. Traditionally, muscle activation intervals in sEMG data are identified in one of the two ways. Either by manual labelling or by automated detection with an algorithm. Manual labelling is reliable and repeatable but time consuming. Automated detection is fast but replete with errors and has to be followed by manual tweaking of the algorithm results¹. Automated detection also requires in-depth understanding of the chosen detection algorithm and continuous update of its parameters with varying signal conditions across muscles within the same participant and across different participants.

In a recently published work, we have proposed a novel approach for identification of muscle activation intervals called *nOptim*². This approach simplifies the sEMG data processing by shifting the focus from understanding the algorithms to understanding the data. It allows the researcher to identify precise muscle activation intervals using any detection algorithm by simply specifying an estimate for the number of muscle activation intervals expected in the signal under consideration. Thus, the researcher is saved from spending time on understanding the algorithm in-depth and continuously changing its parameters. We have implemented this approach as a user-friendly open-source software toolbox with a graphical user interface and have made it available online free of charge. We propose that using this software, sEMG practitioners can improve the time-efficiency of their data processing. This may as well increase the uptake of novel and sophisticated detection algorithms by sEMG practitioners who would rather spend more time processing their data than learning new techniques.

1. Hodges, P. W., & Bui, B. H. (1996). A comparison of computer-based methods for the determination of onset of muscle contraction using electromyography. *Electroencephalography and Clinical Neurophysiology/Electromyography and Motor Control*, 101(6), 511-519
2. Rashid, U., Niazi, I. K., Signal, N., Farina, D., & Taylor, D. (2019). Optimal Automatic Detection of Muscle Activation Intervals. *Journal of Electromyography and Kinesiology*.

Influence of activity participation on upper extremity motor performance: A systematic review

Collis, J., Signal, N., Mayland, E., Wright St-Clair, V.

Background: Following upper extremity injury, exercise-approaches are commonly used to address motor impairments. Occupation-based approaches are also used but less widely promoted. Movement performed during activities and occupations with purpose/meaning may yield better motor performance than during non-purposeful tasks such as exercise. **Objectives:** This review investigates the influence of participation in activities and occupations with purpose/meaning on immediate upper extremity motor performance in healthy and musculoskeletal populations. **Methods:** Four databases were searched for studies in healthy or upper extremity musculoskeletal

injured adults, that compared motor performance during occupations with meaning or purpose against occupations without purpose, simulated activity or rote exercise. Quality evaluation was conducted using a modified version of the Downs and Black Quality Index. **Results:** Twenty-one studies were included. Most were of moderate quality and conducted in healthy populations. Results suggested that upper extremity movement quantity and quality was enhanced when performed during purposeful conditions. In the majority of studies, participants performed a greater number of repetitions when engaged in purposeful or naturalistic activities compared with non-purposeful or simulated tasks. In general, movement and reaction time was quicker, smoother and more direct in purposeful activity groups or conditions. **Implications:** Activities and occupations with meaning/purpose may be used following upper extremity injury to enhance movement and address motor impairments to a greater extent than is currently promoted.

Evaluation of non-contact boxing on aerobic fitness and function in people with Parkinson's disease: A feasibility study

Tone Panassollo, S Lord, G Mawston, D Taylor

Exercise has long been part of treatment for people with Parkinson's disease (PwPD) to improve pathology-related symptoms and to limit secondary changes that occur over time, such as decreased aerobic conditioning, power and strength. The use of non-contact boxing training (NCBT) which incorporates aerobic conditioning and motor re-learning principles relevant to PD is a recent addition to exercise interventions to improve both motor and non-motor symptoms. Non-contact boxing has an advantage over traditional aerobic training in that exercise is performed in high intensity bouts and it challenges strength, speed and co-ordination of both upper and lower limb. Evidence in older adults supports the view that efficient oxygen uptake is associated with a better quality of life and overall function, and also improves general cardiovascular and brain health. PD is an age-related disorder therefore improving VO₂ is also potentially important from this perspective. There is little evidence to date to support NCBT for people with Parkinsons. Combs and colleagues (2013) reported improvements in balance, mobility, gait, activities of daily living and quality of life in 31 participants enrolled in an RCT. However, the boxing programme itself included several other resistance exercises beside boxing movements and did not conform to high-intensity exercise principles. Furthermore, the study did not measure oxygen uptake to determine aerobic fitness. There is currently no literature depicting the influence of an NCBT on oxygen uptake and other relevant measures of motor control in PD, such as rate of force development and reaction time. This feasibility study aims to examine NCBT as a form of high intensity training for PwPD to improve aerobic conditioning. This study aims to recruit 15 participants with PD to a 12 weeks programme of NCBT along with 15 age-matched controls.

Foucauldian Discourse and Design of CPAP Therapy Masks for OSA

Helen Cunningham

Current approaches to personal medical product design address complex governance, technical and functional issues. However, little attention has been given to broader perceptions of the social and interpersonal issues related to medical products despite community attitudes playing an important role in supporting or inhibiting treatment uptake. Rethinking personal medical product design in light of the complex social contexts that they inhabit is needed to improve their desirability and subsequent uptake.

Using the Continuous Positive Airway Pressure (CPAP) therapy mask when used to treat Obstructive Sleep Apnoea (OSA) as one example of a personal medical product, this study explored the social construction of breathing interfaces, by taking a critical approach to the design process. The purpose

was to investigate how identification of the social and, relational understandings that are integrated into the design process and the product itself could be used as a tool to rethink and develop new possibilities for breathing interfaces and people with OSA.

Findings show that the design of the mask is constrained by discourses associated with Western situated cultural aesthetics, masculine occupations and scientific legitimacy. While 'successful' users are almost evangelical about the CPAP therapy mask for treatment of OSA, the analysis shows how the subject position of the 'successful' user is shaped by the CPAP therapy mask design, and that there are multiple tensions for those who do not achieve this subject position. Indeed, data from the community markets reveals the diversity of subject positions that exist in relation to the mask and who participate in its social construction. The market-based interactions highlight subject positions that have been previously overlooked in human-centred design and the discursive tensions that affect device perceptions and potential uptake.

Chest Infection Prevalence following Surgery (CHESTY) – Investigating the current physiotherapy practice at North Shore Hospital following abdominal surgery

Victoria Lai

Post-operative pulmonary complications are one of the main complications following abdominal surgery (Patel et al., 2016), closely followed by cardiac complications (Jin et al., 2014) or wound infections (De Avila & Fenili, 2017). These complications increase hospital length of stay and mortality rates (Scholes, Browning, Sztendur, & Denehy, 2009). This, in turn, imposes a significant financial burden on healthcare resources and patient recovery (Perilli et al., 2018). Physiotherapy aims to prevent and remediate postoperative complications, including PPC's, in patients undergoing major abdominal surgery (Boden et al., 2018). As part of a larger multicenter international observational study, North Shore Hospital has collected data from 100 patients relating to the prevalence of postoperative complications and provision of physiotherapy. This nested study will enable North Shore Hospital to determine its postoperative complication rate, audit interventions to prevent these and determine physiotherapy interventions utilised in patients undergoing major abdominal surgery. In turn, this will guide a review of our service provision and inform a change of policy where/if needed.

Characteristics of Pulmonary Rehabilitation programmes in New Zealand. A survey of current practise.

Candy, S, Taylor D, Reeve J

Introduction: Pulmonary Rehabilitation (PR) is a proven effective intervention for the management of COPD and other chronic respiratory conditions. PR has been shown to improve exercise capacity; health related quality of life and reduce dyspnoea. There are best practise guidelines which aid the delivery of PR. Despite this, it is not known if the delivery of PR is not consistent across or within countries. The current survey aim to establish a baseline of what current PR practise in New Zealand is comprised of. **Method:** The study was a cross sectional, observational design. Ethics approval was granted from Auckland University of Technology Ethics Committee **19/119**. An online survey was send to all PR programme coordinators across NZ. The survey consists of 58 questions which examined programme organisation and structure, assessment, exercise and education interventions, maintenance and programme capacity. **Results:** The survey was completed by 36 programs across NZ; 28 in the North Island and 8 in the South Island. Just over half (55.8%) of the programs were held in hospital outpatient settings, with other services utilising community venues, maraes, churches, gyms

and home based sites. There was consistency in many of the outcome measures used, with variation in measures used between physiotherapy led and exercise physiologist led programs. 32 of the programs provided twice weekly supervised exercise classes, and 86.1% advised participants to complete a home based program on the days between classes. The home based programme was monitored in 16.6% of the services. All programs included education and this was predominantly group based (72.7%). 66.7% of the services reported a wait list and priority was given to people who had a recent admission, were being considered for lung transplant or based on severity of health condition. 52.7% of the services felt they were meeting demand in their area. **Discussion:** There has been much advancement in the provision and delivery of PR since the last survey in 2009. The number of programs has increased and particular attention has been shown to strategies to make programs more accessible and more engaging for all participants. There is potential for PR services to further develop and meet the growing demand for this intervention. Under developed spaces include collaboration with other services to provide multi morbidity rehabilitation. This may allow for increased options for participants (i.e, outside of working hours, water based culture based options) and providing personalised care. The role of telerehabilitation has been explored in other countries to provide alternative methods of delivering PR. This may increase the access for many participants whom would not be able to access centre based care or assist in sustaining the benefits gained from PR and to date has been underexplored in NZ services. Caution must be taken to ensure the services deliver the fundamental components of PR which make this intervention so effective, and to ensure annual evaluation of effectiveness.

Evaluating and refining the combined approach of noisy galvanic vestibular stimulation (nGVS) with balance rehabilitation programme in older adults with moderate to high falls risk.

Preet Kamal Kaur, Denise Taylor & Nicola Saywell

Loss of balance and falls have a devastating effect on older adults by reducing mobility and independence. Falls resulting from impaired balance are expensive, in terms of personal, societal and economic costs. Around one-third of people over the age of 65 years will experience a fall every year, and whilst exercise-based programmes can reduce the risk of falling, they do so by only about one third. Recently, several non-invasive vestibular stimulation approaches have been proposed for improving balance in different populations. Noisy galvanic vestibular stimulation (nGVS) is one such approach. This uses sub-sensory Gaussian noise signals to enhance sensory input signals to the vestibular system that are weak. nGVS has been shown to improve vestibular perception and vestibulospinal reflex function (both essential for balance) in healthy young adults, older adults and people with bilateral vestibular disorders. However, the trials of nGVS are limited to those that are non-RCTs, do not include older adults who present with balance deficit related to falls risk and that have not investigated the repeated use of nGVS as a clinical intervention. Moreover, there is no study investigating the augmented effect of nGVS on a balance exercise programme. Therefore, the purpose of this research is to assess the feasibility of a study protocol designed to combine balance exercise programme with nGVS on postural control in older adults with a moderate to high risk of falls. The study will address feasibility issues related to recruitment, data collection, acceptability and suitability of the planned intervention and outcome measures in preparation for a larger RCT in older adults with moderate to high risk of falls. The findings of study will provide a greater understanding in evaluating a trial processes to determine if the design is feasible for carrying out larger RCT in older adults with moderate to high risk of falls.

Stimulating the cerebellum with transcranial direct current stimulation to influence motor learning in healthy adults

Nitika Kumari, D Taylor, U Rashid, AC Vandal, PF Smith & N Signal

Cerebellar transcranial direct current stimulation (ctDCS), a non-invasive brain stimulation technique, can alter the excitability of the cerebellum to influence motor performance. This study examined the effect of repeated anodal ctDCS on learning a novel split-belt walking task in healthy adults. In a double-blinded, parallel design, 30 healthy adults randomly received 2 mA of active anodal or sham ctDCS over three consecutive sessions of split-belt treadmill walking. Each session involved walking on a split-belt treadmill in three phases based on whether the belts moved together or at different speeds: baseline, adaptation and de-adaptation. Motor performance was measured based on the mean step length symmetry during immediate, early and late epochs using 3-D gait analysis. Data from each intervention session and a follow-up one week later was analysed using a linear mixed model. During the adaptation phase, group analysis revealed a significant difference in the immediate adaptation (first three strides) across session 1 and 2 ($p = 0.01$), and session 1 and 3 ($p = 0.01$). The magnitude of the treatment effect indicated that anodal ctDCS reduced the change in immediate response to differential belt speed across the sessions. During the de-adaptation phase, there was a significant difference in immediate de-adaptation at session 1 ($p = 0.003$) and across session 1 and 3 ($p = 0.02$) indicating anodal ctDCS reduced the immediate response when the belts returned to moving together at the same speed. There was no significant difference between the groups at other epochs. These findings may be related to homeostatic plasticity where repeated sessions of ctDCS may have reversed the facilitatory effects. Future research should compare these findings with the effects of cathodal ctDCS.

Designing a website for people with Mild Cognitive Impairment (MCI): a critical perspective

Guy Collier

Mild Cognitive Impairment (MCI) is a relatively new and controversial diagnosis that describes the intermediate stage between 'normal' age-related decline and dementia. Following increased interest in the developmental stages of Alzheimer's Disease in the 1980s, MCI was first proposed as a concept in 1988 before becoming an official diagnosis in 2004. While MCI is associated with a higher risk of dementia in adults over the age of 65, it does not guarantee progression to more severe forms of impairment, and in effect 'medicalises' what used to be considered normal ageing. Although its definition, clinical use, assessment, treatment, and relationship to dementia remain topics of heated debate, MCI has recently become a topic of interest in the emerging field of 'design for health'.

This PhD research focuses on an ongoing design for health project called 'Living Well with MCI', in which I am working as both a research officer and 'design anthropologist'. In this project, I am working on an interdisciplinary team alongside a User Experience (UX) designer to develop an online resource for people with MCI and their families. The purpose of this PhD is to embed a critical perspective on MCI into the co-design process. It explores how 'designing for people with MCI' intersects with developments in neuroscience and pharmacology, dementia research, geriatric care, design, and broader cultural anxieties about ageing and cognitive decline. In doing so, it investigates how design, as both a future-making activity and field of research, might be better informed about its role in shaping and giving rise to new medical constructs in contemporary society.