Poster T1: Use of Inertial Sensors for Determining Kinematic Characteristics of Infant Leg Movement
Motor Rehabilitation

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Our overall goal is to use inertial sensors to determine the quantity, type and quality of infants' leg movements performed across a full-day measurement for further use in the differentiation of infants with typical, delayed or impaired neuromotor development. Here we describe an algorithm to calculate kinematic characteristics of leg movements.

Inertial sensor data were collected from 12 infants with typical development for a period of 8-13 hours per day. There were 2 months between visits and a total of 3 visits per infant. An inertial sensor was attached to each leg, recording simultaneously accelerometer and gyroscope measurements at 20Hz. In previous work, we developed and validated a threshold-based algorithm where each pause or change of direction of the limb is counted as a discrete movement. Here we determined the duration, average acceleration, and peak acceleration of each movement. The duration of each movement was computed by counting the number of samples when the acceleration magnitude was above baseline until it crossed the baseline for a second time. Consequently, acceleration magnitude was obtained for each of these samples and average acceleration and peak acceleration of each movement was calculated.

Infants produced average movement durations that ranged from 0.23 to 0.33 seconds per movement, with average accelerations ranging from 1.59 to 3.88 m/s^2 and average peak accelerations from 3.10 to 8.83 m/s^2.

Our results showed that there is a range of leg movement duration and acceleration values produced by infants across visits. Future work will focus on the analysis of movement features based on the age and developmental level of infants and identification of the differences between infants with typical, delayed or impaired neuromotor development.

Poster T2: Moving Towards Clinical Integration of Accelerometers to Measure Real-World Arm Use After Stroke
Motor Rehabilitation

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Purpose: The ultimate goal of upper limb rehabilitation after stroke is to promote use of the paretic upper limb in everyday activities outside the clinic or laboratory. One way to capture such use is with accelerometers, which have gained growing acceptance as a tool to objectively index upper limb use in real-world environments. This review aims to explore the feasibility of accelerometers to measure upper limb use after stroke and the translation of accelerometers into clinical practice. We will discuss: 1) how accelerometers determine *amount* of use; 2) the *reliability, validity and sensitivity to change* of accelerometry data; 3) how the accelerometer signal can be turned into *clinically meaningful data*; and 4) the practicalities of building an *accelerometry data collection protocol.*

Discussion: Accelerometers determine amount of upper limb use by measuring acceleration and provide an activity count for each instance in time or epoch. Activity counts can be summed to index magnitude of use and epochs of activity can be summed to index duration of use. Accelerometry data have good test-retest reliability and agreement with movement repetitions, standardized measures of upper limb function and brain recovery; but there is conflicting evidence surrounding the sensitivity of accelerometry data to change after upper limb training interventions. Despite growing evidence of their accuracy as a tool to measure upper limb use in real-world environments, a critical challenge to facilitating widespread clinical uptake of accelerometers is the ability to transform the data recorded by the accelerometer into information that has clinical relevance. Most recently, a new method for transforming accelerometry data into clinically-meaningful information has been evaluated. This approach involves second-by-second quantification of the magnitude of use from both limbs; and the relative contribution of each upper limb to the activity count. Outputs from this approach have been used to provide clinically-meaningful information of use in real-world environments for clinicians, patients, family, and caregivers. While this provides the impetus for greater uptake of accelerometers in research and clinical settings, it also increases the need for consistency when building an accelerometry data collection protocol to enable comparison and data pooling. Variables to consider include device selection (uniaxial or multiaxial), epoch length (i.e., <1-sec vs. 1-sec vs. 15-secs), duration of monitoring (i.e., 1-day vs. 3-days vs. 7-days), number of devices to wear and body position (i.e., paretic and non-paretic wrist) and use index metrics (i.e., magnitude, duration).

Conclusion: By growing a consistent pool of data, a deeper understanding of what stroke survivors actually do in their everyday lives will be gained. Such information has the potential to positively impact on the ability of researchers and clinicians to objectively evaluate function, set benchmarks for treatment, as well as develop and adapt rehabilitation protocols on an individual basis.

Poster T4: Brain-Computer Interface Assisted Stroke Rehabilitation with Multimodal Feedback
Motor Rehabilitation

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A brain-computer interface (BCI) allows to analyze brain activity in order to control an avatar or rehabilitation training device. Important for a successful outcome of the rehabilitation procedure is that the mental activity is paired with the avatar movements or rehabilitation device movements.

The study was performed with two patients who had a stroke 4 years earlier (P1, female, 40 years old) or 2 month earlier (P2, female, 61 years old). P1 suffered a complete paralysis of her left hand, but had normal right hand movements. The hand performance of P2 was measured with a 9 hole PEG test and showed that the right arm needed about twice as much time to complete the test.

Both patients performed the motor imagery (MI) session by imagining left or right hand movements according to an instruction on a computer screen. Then the BCI system analyzed the EEG data and controlled an avatar hand movement on the computer screen and simultaneously controlled a functional electrical stimulator (FES) that stimulated the corresponding hand. Therefore, the patients' could see the virtual hand movement and the real hand was simultaneously also moving.

After 10 training sessions of 30 minutes each with P1 and 21 training sessions with P2 the success of the procedure could already be shown. P2 was able to move the paralyzed hand herself without the BCI and FES and P2 could perform the 9-hole PEG test with similar speed for both hands.
This shows that the training is successful and more patients are undergoing further tests currently.

Poster T5: Awareness Assessment and Communication Tool for Patients with Disorders of Consciousness
Disorders of Consciousness

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Up to 43% of coma patients are misclassified as vegetative when actually possessing (at least minimal) conscious abilities. EEG based Brain-Computer-Interfaces (BCI) can detect command following in patients with altered states of consciousness. In this study a BCI system was used that combines three different BCI approaches - auditory P300, tactile P300 and motor imagery (MI) - in one portable tool for bedside awareness detection and (if possible) communication with the goal to enhance correct patient classification.
The electroencephalogram (EEG) yields brain wave patterns which can be assigned to a deliberate response to external stimuli or orders. These intentionally influenced states are detected by mindBEAGLE via a Mann-Whitney U test ($p<0.05$) and provide information about the conscious reaction of the patient. In the case of positive results, modulating these brain wave patterns on purpose allows the patient to answer YES/NO questions for communication means. This can be done by using generic classifiers or by training patient-specific classifiers (training time: P300 ~5min, MI ~20min).
Prototypes of the BCI system have already been evaluated using healthy subjects and patients with locked-in syndrome. For patients the tactile P300 paradigm yields accuracies of 80.0% (σ 33.5%) in a two-stimulator setup (YES questions) and 55.3% (σ 27.3%) in a three-stimulator setup (YES/NO questions). The MI approach gives an accuracy of 80.7% (σ 14.4%) for healthy subjects (YES/NO questions).
With the combination of three different BCI technologies to assess awareness in coma patients, mindBEAGLE is opening doors for locked-in patients to call attention to their conscious mind state and to re-enable basic communication.

Poster T6: Two-Week Administration of Neuropathic Pain Medications Fails to Prevent the Development of Cutaneously Evoked Autonomic Dysreflexia After High Thoracic Spinal Cord Transection in Rats
SCI

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In uninjured, pentobarbital anesthetized Long Evans rats, electrical stimulation of thoracic segmental dorsal cutaneous nerves (DCNs) generates a stimulation frequency and nociceptive afferent subtype specific cardiovascular response. To varying degrees, depressor blood pressure (BP) responses and heart rate (HR) increases are seen. We previously found that cervical (C7) spinal cord crush/incomplete injury gives rise to 3 different pathophysiological BP responses to DCN stimulation at 2 weeks, a normal-like depressor response evoked by all DCNs, a dysautonomia response where mixed depressor and pressor effects are evoked from different DCNs, and a pressor response like autonomic dysreflexia (AD) evoked by all DCNs. In all 3 injury groups, the HR increases evoked by DCN stimulation showed prolonged elevation. We also found that the severity of BP pathology is positively correlated with the extent of DCN C fiber sprouting in the dorsal horn and that the prolonged HR responses are correlated with increases in DCN A fiber sprouting there.

We have now used a complete T2 spinal cord transection model to produce consistent pressor BP and increased HR responses to stimulation across all DCNs. In this model, we have continuously (twice daily for 2 weeks following injury) administered 3 neuropathic pain medications commonly used clinically in spinal cord injury (SCI). We used an opioid (Buprenorphine, 0.05 mg/kg), a non-steroidal anti-inflammatory drug (Meloxicam, 1 mg/kg), and an anti-epileptic medication (Gabapentin, 50 mg/kg) to test the hypothesis that continuously treating "pain" could perhaps limit the development of nociception induced autonomic dysfunction after severe high thoracic SCI. Following injury and treatment, segmental DCN stimulation still generated AD cardiovascular responses with pressor BP and increased HR effects in all 3 drug groups. Buprenorphine generated even greater BP increases with caudal (T12, L1) DCN activation. We are currently evaluating whether A and C fiber sprouting in the dorsal horn of these animals tracks with our physiological findings.

Poster T7: Sildenafil for Stroke Recovery
Stroke

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Introduction: Post-stroke hemiparesis causes long-term disability. Current rehabilitation approaches are limited. Pharmacological agents that may enhance neuroplasticity have the potential for increasing post-stroke motor recovery. Sildenafil citrate, a phosphodiesterase type 5 inhibitor, shows promise for reducing post-stroke motor impairments as it has been shown to promote angiogenesis, axonal growth and reorganization, neurogenesis, and motor function in rodents with stroke. The mechanism of action is proposed to be the increases in cyclic guanosine monophosphate-adenosine monophosphate and vascular endothelial growth factor facilitated by sildenafil, both of which are implicated in neuroplasticity.

Methods: In a pilot, randomized clinical trial, we examined the ability of sildenafil to promote motor recovery from stroke in humans who were within 11 days of stroke. Seven individuals who were admitted to inpatient post-stroke rehabilitation were randomized to either the sildenafil (25 mg) or placebo group based on baseline Fugl-Meyer Assessment scores. Participants took the drug or placebo for 14 days. Each individual completed their usual post-stroke rehabilitation. Their motor skill was tested at baseline, 1 month post-discharge, and 3 months post-discharge. The primary outcome was the Fugl-Meyer Asssment, a measure of post-stroke motor impairment.

Results: Three participants were randomized to the sildenafil group and 4 to the placebo group. Groups were not significantly different in baseline Fugl-Meyer Assessment score [41.25(27.45sd) for sildenafil group; 53.00(25.42sd) for the placebo group; $T(6) = -0.63$, $p > 0.55$]. The 18.5 (13.03sd) point gain in motor ability experienced by the sildenafil group was not significantly different from the 17.25(5.12sd) point gain experienced by the placebo group at 1 month post discharge. However, at the 3 month follow-up testing, the sildenafil group had improved 33.33 (9.24sd) points from baseline on the Fugl-Meyer Assessment while the placebo group only improved 14 (8.04sd) points, $T(6) = 4.55$, $p < 0.005$. There were no drops in blood pressure outside of the expected blood pressure variation experienced after stroke. There were no adverse events while taking the drug. One sildenafil participant did have evidence of new stroke activity at the 1 month follow-up that was deemed due to high levels of cerebral athersclerosis.

Conclusions: The results of this small pilot trial suggest that sildenafil citrate given during acute rehabilitation may promote greater motor recovery from stroke compared to rehabilitation by itself. Further research is needed to confirm this effect and to establish its safety in this population.

Poster T8: Targeted Memory Reactivation to Improve Motor Learning
Motor Rehabilitation

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Background: It is evident that memories are 'replayed' throughout the course of sleep to strengthen neural networks involved with each memory and may occur during quiet wake as well. **Purpose:** To determine whether motor memory reactivation during quiet wake or sleep, via auditory cues classically conditioned to upper extremity (UE) performance during wake, can improve UE motor function. We hypothesize that replaying the same auditory cues experienced during UE motor training will improve throwing accuracy compared to receiving no cues between sessions. **Methods:** The training protocol involves (1) repetitive throwing of a small ball using the non-dominant UE to five unique visuospatial targets, and (2) auditory cues distinctively paired with each target. Spatial metrics of throwing accuracy are collected at 5 time points (baseline, post initial training session, post 8 hour interval, post second training session, and at 1 week retention). We have recruited 17 young, healthy adults and randomized them into the following groups, that are differentiated by the 8 hour between-session time interval: (1) wake with auditory cues, (2) wake without auditory cues, (3) sleep with auditory cues and (4) sleep without auditory cues. **Results:** Data has been collected for six subjects evenly distributed between the wake groups. Preliminary results between the first participant in each wake group demonstrate that auditory cues enhanced spatial accuracy compared to no cues. Further data collection and analysis are planned. Results of this research are expected to serve as the first step towards a follow up study to enhance UE training protocols in individuals post-stroke.

Poster T9: Centralized Open-Access Research (COAR): A Database for Stroke Rehabilitation
Motor Rehabilitation

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Background: There is a wealth of quality experimental data from randomized controlled trials (RCTs) to support evidence-based physical medicine and rehabilitation, but most of these data are "unstructured". That is, these results are published in different formats, to varying degrees of completeness, and across many different journals to which researchers may not have access. Thus, the goal of the current project is to systematically extract data related to participant outcomes, participant demographics, and clinical methods, and organize these data into a machine readable format. Having open-access to such a database will allow clinicians and researchers to quickly and easily visualize results and explore the relationships between variables in hundreds of RCTs.

Method: A systematic search of electronic databases yielded 2,892 results. Screening titles and abstracts by our exclusion criteria left a pool of 398 RCTs (although further manuscripts maybe excluded as data extraction/full text review continues). We are currently piloting data extraction protocols using two independent coders at Auburn University. "Pilot" meta-data from the first n = 42 RCTs, constituting k = 90 independent groups of participants, are presented. Specific aims were to (1) quantify the dose of therapy in groups who received "conventional" therapy and (2) quantify the magnitude of improvement at terminal and follow-up assessments for these groups. Other exploratory graphical analyses are presented to highlight the flexibility of the database for data visualization.

Results (ad interim): Conventional therapy in these RCTs had a median duration of 28 [14, 42] days, shown as median [IQR], with a median time scheduled for therapy of 20 [14.4, 30] hours. The median age for participants in these groups was 64.7 [62.2, 68.2] years and participants started the RCT 38.4 [21.2, 170.7] days following stroke. At the terminal assessment (k = 32), the median Cohen's d was 0.51 [0.25, 0.73] and the median therapy duration was 28 [14, 42] days. At the follow-up assessment (k = 17), the median Cohen's d was 0.86 [0.45, 1.07] and the follow-up assessment came 180 [87, 181] days following the baseline assessment.

Conclusions: Systematic reviews will always be important and necessary; a centralized open-access database will allow clinicians and researchers to quickly aggregate and visualize relationships between prognostic variables on an unprecedented scale. Although data extraction continues, the database has already allowed detailed examination of "conventional" therapies as they are delivered in RCTs. Although data support a benefit to these therapies, shown in terminal and follow-up effect-sizes, it is not clear what aspects/conditions of therapy produce these changes. A current challenge facing the database is how best to systematically quantify exclusion criteria used in different RCTs to effectively describe populations under study.

Prospero Registry: CRD42014009010

Poster T10: Exercise, Cognition and Brain Imaging in Parkinsonism - Study Design
Motor Rehabilitation

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Background: Parkinsonian gait and balance impairments have been associated with cognitive deficits. Hence, it may be helpful to integrate cognitive challenges into mobility training. We present a study design to evaluate a novel, cognitively challenging mobility rehabilitation program in patients with PD and in patients with FGD. Objectives are 1) to determine the effectiveness of a cognitively challenging Agility Boot Camp (C-ABC) exercise program on mobility, cognition, and brain connectivity and 2) to determine whether baseline mobility and cognitive deficits, and the integrity of locomotor brain circuitry predict responsiveness to exercise in patients with Parkinson's disease (PD) and Frontal Gait disorders (FGD).

Methods: Eigthy patients with PD (n=60) or FGD (n=20) will participate in this randomized, crossover design study. The C-ABC intervention will consist of 80 min group exercise sessions, 3 days per week for 6 weeks. Exercises include mobility skills such as fast walking in different directions, boxing, lunging, and navigating an agility course, focused on a variety of postural domains. Cognitive challenge is added by memorizing sequences, dual tasking and inhibiting actions. The education control program will consist of a 90 min education program in a group setting, once a week for 6 weeks, and 5x30 minutes of active relaxation with audiotape at home for 6 weeks. Hence, each program consists of 240 minutes of activities every week. The primary outcome measure is dynamic balance using the MiniBESTest. Secondary outcome measures include of objective mobility measures, cognitive tasks and locomotor functional connectivity. Pre- and post-testing will occur before and after each phase of the cross-over interventions.

Results: The first two groups of subjects have completed the study. Eighteen subjects with PD and two FGD patient were enrolled in the study. Two subjects dropped out because of injury (n=1) and inaccurate diagnosis (1 FGD patient later diagnosed as corticobasal syndrome).

Conclusions: We hypothesize that mobility, cognitive, and functional connectivity of the locomotor circuitry will improve after the C-ABC program but not after the control intervention. We also hypothesize that FGD patients with freezing of gait, executive dysfunction and reduced white matter tracks between the pendunculopontine nucleus (PPN) and frontal cortex will be poor rehabilitation candidates.

Poster T11: Freezing of Gait in Parkinson's Disease: A Stopping Deficit?
Motor Rehabilitation

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Recent studies suggest that patients with Parkinson's disease (PD) with freezing of gait (FOG) are impaired in response inhibition (e.g. Stroop task, GoNoGo task). Moreover, neuroimaging studies show that patients with FOG have loss of white matter in nodes that are part of the "stopping" network, comprising the presupplementary motor area (preSMA), right inferior frontal gyrus (rIFG) and subthalamic nuclei (STN). This network is particularly important for global stopping of motor actions as assessed in stop signal reaction tasks (SSRT). We evaluated the performance of PD patients with and without FOG on the SSRT and related stopping performance to the structural integrity of the neural stopping network.

Methods: 14 patients with FOG (FOG+) and 9 PD patients without (FOG-) completed the SSRT. Probabilistic structural connectivity of the right hemisphere's stopping network was performed to identify quantity and quality of fiber tract connections between 1) preSMA IFG, 2) preSMA STN and 3)IFG STN.

Results: There were no significant differences between FOG+ and FOG- patients on the SSRT (p=.467). Also, microstructural integrity of fibers comprising the stopping network did not differ between FOG+ and FOG-(all p's>.60). Across all participants, we observed a negative association between the SSRT and connectivity quality of the rIFG (r=.452, p=.030) and preSMA (r=0.509, p=.013), but not with STN (.323, p=.133). These significant associations between SSRT and connectivity values were driven by the FOG+ group (r = 0.55, p = 0.04 for both); there were no significant correlations between SSRT and structural integrity of the stopping network in the FOG+ group alone.

Conclusion: Our results do not support a global stopping deficit in PD patients with FOG. Similar to previous work in healthy subjects, in patients with FoG we report a strong association between inhibitory network structural integrity and SSRT performance. This suggests that integrity of the tracts to/from the rIFG and preSMA is related to the ability to stop a prepared motor action in PD patients with FOG.

Poster T12: Upper Extremity Functional Evalulation by Virtual Fugl-Meyer Assessment Using Kinect in Hemiplegic Stroke Patients
Stroke

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Introduction
Virtual home-based rehabilitation is an emerging area in stroke rehabilitation and functional assessment tool is essential to monitor recovery and provide current function-based rehabilitation. We developed the virtual Fugl-Meyer Assessment (FMA) tool using Kincet (Microsoft, USA) and validated it for hemiplegic stroke patients.

Methods
Forty-one patients with hemiplegic stroke were enrolled. Thirteen items were selected among 33 items for motor FMA in the upper extremities (UE). One occupational therapist assessed the motor FMA while recording the UE motion with Kinect. Saved data were analyzed and virtual FMA score were calculated by one postgraduate student who was blind to real FMA score. Principal component analysis and artificial neural network learning were used. Prediction accuracy for each 13 item was calculated and correlations between real and virtual FMA scores were analyzed.

Results
Prediction accuracies ranged from 65 to 87% in each item and were above 70% in 9 items. Correlation of summed score for 13 items between real and virtual FMA was high (Pearson's correlation coefficient=0.873, $p<0.0001$). Correlation between total UE FMA (66 in full score) and virtual FMA (26 in full score) was also high (Pearson's correlation coefficient =0.799, $p<0.0001$).

Conclusion
Virtual FMA using Kinect is valid to assess the UE function of stroke patients and may be useful in the setting of unsupervised home-based rehabilitation.

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Poster T13: Hebbian-Type Motor Cortex Stimulation Promotes Motor Learning in Chronic Stroke Patients
Stroke

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After stroke of primary motor cortex (M1) or its corticospinal projections, plasticity in the peri-infarct tissue supports recovery of hand function. Transcranial magnetic stimulation (TMS) of ipsilesional M1 can enhance cortical plasticity and rehabilitative training-related motor learning. Hebbian-type TMS is a type of TMS that is administered concurrently with motor training. During Hebbian-type TMS, training movement-related increases in electromyographic (EMG) activity triggers subthreshold TMS over the M1 contralateral to the training hand in order to apply stimulation when M1 is involved in generating training movements. Because Hebbian-type TMS is more effective in enhancing motor learning than random TMS (Buetefisch et al., 2004; 2015), there is considerable interest to study the effect of Hebbian-type TMS in rehabilitative training of patients after stroke involving M1 or its corticospinal projections. Here we determine whether Hebbian-type TMS enhances motor training-related improvement of paretic hand function in chronic stroke. 16 patients (9M, 64.37±9.21 years) with impaired hand function due to chronic stroke involving M1 or its corticospinal projections participated in a randomized double-blinded placebo-controlled trial. Participants completed 5 days of motor training where they were asked to execute auditory paced wrist extension movements in a way that a cursor, encoding the movement's velocity and angle, hit a target on a computer screen. Increases in movement-related EMG activity of the extensor carpi ulnaris muscle (ECU), a muscle supporting the training movement, were used to trigger TMS or sham stimulation. Therefore, training movements were paired with subthreshold Hebbian-type TMS (n=8) or sham stimulation (n=8) over the ECU hot spot of ipsilesional M1. The effects of the two interventions on movement kinematics (peak acceleration of wrist extension), motor function (Jebsen-Taylor Test) and M1 reorganization were determined before and immediately after and one month after training. To measure M1 reorganization we extracted the asymptote and slope-parameter of a stimulus response curve collected with TMS (range: 35%-80% stimulator output) over the ECU hot spot (Devanne et al., 1997). At baseline the treatment groups were comparable in respect to their main outcome measures. Participants who received Hebbian-type TMS experienced greater training-related changes in kinematics (acceleration=+74.73%), hand function (Jebsen=-19.84%) and cortical excitability (asymptote=+8.51%, slope-parameter=+14.34%) than those who received sham stimulation (acceleration=+32.42%, Jebsen=-8.72%, asymptote=+2.171%, slope-parameter=-14.50%). The improvement in hand kinematics and function persisted in both groups for 4 weeks. The results suggest that Hebbian-type TMS enhances training-related gains in hand function when applied to patients with chronic stroke affecting primary motor output. Greater functional improvements may be associated with a larger shift in M1 organization as indicated by increased excitability of the ECU representation. Prior to final analysis, 4 additional subjects will be recruited by August 2015 to meet our targeted number of 10 participants in each treatment group.

Poster T14: Capturing Recovery Potential After Severe Stroke: How Individuality Drives the Need for a Multimodal Approach
Stroke

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Background: Determining how to reliably identify with upper limb recovery potential after stroke has received growing attention. People with the greatest recovery potential are more easily identified by the ability to physically move their upper limb early after stroke (e.g., shoulder abduction or finger extension). It is much more challenging to identify the recovery potential of stroke survivors who are unable to demonstrate such physical movements early; typically these individuals suffer from more severe disability. To provide a more sensitive evaluation of recovery potential, transcranial magnetic stimulation (TMS) and diffusion-weighted magnetic resonance imaging (DW-MRI) have been identified as possible tools.

Aim: To explore potential indicators of recovery potential derived from TMS and DW-MRI in a group of stroke survivors with severe (Fugl Meyer Upper Limb [FM-UL] score <26/66 points) and chronic (>6 months) upper limb disability.

Methods: Five stroke survivors (mean: 61 years old, 45 months post stroke) completed a clinical assessment of upper limb impairment (FM-UL) and activity (Wolf Motor Function Test [WMFT] rate). Participants underwent a TMS assessment and DW-MRI, from which the presence of seven potential indicators of recovery potential were documented: TMS, paretic upper limb motor evoked potentials (MEPs) elicited from the ipsilesional hemisphere and transcallosal inhibition (TCI) elicited from both ipsilesional and contralesional hemispheres; DW-MRI, ipsilesional corticospinal tract (CST), ipsilesional posterior limb of the internal capsule (PLIC) and ipsilesional tracts extracted to a constrained motor connectome (CMC). Lastly, participants practiced an implicit motor learning task. Exponential curve fitting was used to categorize individual patterns of change across practice as 'learners' (improved performance) or 'non-learners'.

Results: Stroke survivors demonstrated marked upper limb impairment (FM-UL mean 15, range 7-23) and activity limitations (WMFT mean rate 14 repetitions, range 9-20). TMS assessment provided limited information: an ipsilesional MEP was not detected in any participant, and three did not demonstrate ipsilesional or contralesional TCI. From DW-MRI, three out of five participants had extractable ipsilesional CST tracts, five had extractable ipsilesional PLIC tracts and four had extractable ipsilesional tracts using the CMC. Lastly, four participants were identified as 'learners'.

Discussion: This study demonstrates variability in both the brain and behaviour of people with severe upper limb disability after stroke. Only the most severe participant (FM-UL score of 7) demonstrated consistently poor performance across all indicators. Clinical and neuroimaging outcomes provided the most information to characterise an individual's recovery potential. Novel to this study, we evaluated an individuals 'learning' capacity. Despite, the severity of disability and reduced microstructural properties, the majority of participants were identified as 'learners'. Taken together, this suggests that clinical outcomes combined with neuroimaging metrics and a learning evaluation provide a broader basis upon which to assess the recovery potential of individuals with severe upper limb disability.

Poster T15: Refinement of the PREP Algorithm for Predicting Recovery of Upper Limb Function After Stroke
Stroke

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The PREP algorithm was developed to predict the potential for recovery of upper limb function for individual patients within days after stroke. The original dataset included 40 people with first-ever mono-hemispheric ischemic stroke. This study tested the algorithm with a larger, more heterogeneous sample, in order to refine it prior to implementation in clinical practice. We recruited 85 patients with upper limb weakness within 3 days after stroke, and used the PREP algorithm to predict the level of upper limb function at 12 weeks. Assessments were made at baseline and 12 weeks, and upper limb therapy dose was recorded. Sixty-nine patients completed the 12 week assessments, and were categorised as having achieved the predicted level of upper limb function, over-achieved, or under-achieved. This dataset was then compared with the original dataset from 40 patients. There were three main findings that influenced the plan for subsequent clinical implementation of the algorithm. First, transcranial magnetic stimulation (TMS) could elicit motor evoked potentials in the paretic wrist extensor muscles of all patients with a Shoulder Abduction Finger Extension (SAFE) score of 5, 6 or 7. This means that patients with a SAFE score in this range can be given a prognosis for Notable recovery of upper limb function, without TMS assessment. This reduces the proportion of patients requiring TMS assessment from 58% to 40%. Second, a larger proportion of patients in this study under-achieved relative to their predicted level of upper limb function, compared with the original dataset (25% vs. 5%, $P = 0.005$). This effect was driven by patients with a Complete recovery prognosis (35% under-achieved vs. 6%, $P = 0.035$), as there were no differences between the groups for patients in other prognosis categories (all $P > 0.2$). Patient characteristics with a Complete prognosis were similar between the two datasets, except for a substantially lower recorded therapy dose in the present study ($P < 0.001$). A home exercise programme was implemented to increase therapy dose for patients in this category. Thirdly, we found that a higher proportion of patients in this study over-achieved, and exceeded their predicted recovery of upper limb function (17% vs. 8%, $P > 0.05$). While this was not statistically significant, it indicates that some patients can recover better than expected. Therefore when implementing the algorithm the prognosis is used to indicate the minimum level of function that the patient is likely to achieve, leaving open the possibility that they may exceed this level. The PREP algorithm is now being implemented in clinical practice with these modifications, with prognoses being provided to patients and therapy teams. Results of this implementation study are expected in 12 months.

Poster T16: Post Stroke Sensory Loss is Associated Self-reported Functional Status and Changes in Gait Speed Following Intervention Post Stroke Sensory Loss is Associated Self-reported Functional Status and Changes in Gait Speed Following Intervention

Stroke

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Purpose: While sensation has been reported to be an important predictor of functional outcome following stroke, intervention studies commonly report on subject baseline characteristics and outcomes primarily in motor function and activity domains. It is far less common for sensory status and outcomes to be reported. The purpose of this study was to determine the association of baseline sensory status and outcomes for post stroke participants in an intervention study. **Subjects**: Participants were 15 community ambulators with unilateral hemiparesis secondary to chronic stroke (8.21 + 4.36 years) who participated in a single group pretest-posttest, follow-up design 6-week study involving sensory amplitude electrical stimulation (SES) delivered via sock electrode during standing activities. **Methods**: Baseline sensory scores and change scores on functional outcomes were analyzed using Pearson Product-Movement Correlation Coefficients. Significance $p < 0.05$. Baseline sensory status of the hemiparetic foot was assessed via the Perceptual Threshold of Electrical Stimulation (PTTES) and Monofilament testing. Intervention outcomes were assessed using the 10 Meter Walk Test (10MWT), Activities-Specific Balance Confidence (ABC) test, Berg Balance (BBS), Monofilaments, the Stroke Rehabilitation Assessment of Movement (STREAM), Stroke Impact Scale (SIS) and SIS 16. Effect sizes were calculated for each of the outcome measures. **Results**: Mean baseline sensory scores on the PTTES were 22.5 mA (+ 11.2); mean baseline monofilament scores were 134.53g (+ 203.8). Baseline Monofilament scores were not significantly correlated with baseline PTTES scores (r= -.074). Baseline PTTES scores were significantly correlated with scores on the baseline SIS (r= -.679), SIS 16 (r= -.824), and SIS mobility subscale scores (r=. -715). Baseline PTTES scores were significantly correlated with change scores on the SIS 16 (r=.631) and ABC (r= -.777). Baseline Monofilament scores were correlated with baseline scores on the SIS participation subscale (r= -.649). Baseline Monofilament scores were correlated with change scores on the 10MWT (r=.715). There were moderate effect sizes for changes in Monofilament (0.301), STREAM (0.5) and 10MWT (0.57) scores. **Conclusions**: In this cohort of individuals with chronic stroke, greater sensory impairment was associated with lower self-reported baseline functional status; however larger gains in gait speed. **Clinical Relevance**: Assessing sensory status of stroke subjects may help determine the impact of sensory dysfunction on outcomes and assist clinicians to individualize interventions based on patient characteristics. C**linical Relevance**: Assessing sensory status of stroke subjects may help determine the impact of sensory dysfunction on outcomes and assist clinicians to individualize interventions based on patient characteristics.

Poster T17: Deficits in Visual Search Contribute to Impaired Visuomotor Processing and Executive Function Following Stroke
Stroke

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Introduction: Many activities of daily living require coordination of eye and limb movements to gather visual information needed to make decisions and act on the environment. Executive function (mental processes that organize and regulate perception, cognition and action) is responsible for integrating visual information, working memory, and prior knowledge to organize eye movements (visual search) and limb movements (motor behavior). We know that visual search and motor behavior are commonly impaired following stroke, but our understanding of how post-stroke impairments of visual search contribute to deficits in visuomotor processing and executive function during skilled motor behaviors is limited. Here we combine upper-limb robotics, eye tracking and computational modeling to examine visuomotor processing and executive function during the Trail Making Tests (TMT), a neuropsychological assessment similar to the game of 'connect the dots'. **Methods**: We used the KINARM Endpoint Lab with integrated eye tracking to examine 69 subjects in three groups: Young Controls (21-50 yrs, n = 37), Older Controls (52-77, n=16), and Stroke Survivors (48-85, n=16). Subjects used the robotic device to perform the numeric (TMT-A: 1, 2, 3...) and alphanumeric (TMT-B: 1, A, 2, B…) variants of the TMT in the shortest possible time. Controls used their dominant hand and stroke survivors used their less affected hand to complete the TMT. We measured the total time (Total Time) to complete the test and the number of reaching errors. Total Time was further divided into the times when the hand stayed on a number/letter (Dwell Time) and moved between them (Movement Time). From the eye-tracking data, we measured the number of saccades and fixation duration at each number/letter. A stochastic model was used to examine how visual search contributed to task performance. **Results**: Total Time was greater in TMT-B than TMT-A and increased progressively from young to older to stroke survivors. Dwell Time and Movement Time were also longer in TMT-B than TMT-A and increased progressively between the three groups. The count of saccades to numbers/letters was greater in TMT-B than TMT-A and stroke survivors made more saccades and fixated longer at each number/letter than young and older controls. During both the dwell and movement phases, stroke survivors made more saccades than the young and older controls, including many repeat saccades to numbers/letters that the hand had already traversed in the movement sequence. On average, stroke survivors also covered a larger topographic visual search area between hand movements. **Conclusions**: Our results indicate that impairments of visual search contribute to decreases in visuomotor processing and executive function, as measured by the TMT. The computational model further suggests that deteriorated TMT performance in stroke survivors was related to their inability to combine working memory with topographic strategies during visual search.

Poster T18: Is Infarct Location a Predictor of the Degree of Post-Stroke Motor Recovery?
Motor Rehabilitation

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Stroke is a leading cause of neurological disability and a majority of patients have long-term motor impairments, often as a result of damage to the motor cortex and/or striatum. While both humans and animals show spontaneous recovery following stroke, little is known about how injury location affects the recovery process. This information is essential in order to develop new therapies to enhance recovery.

In this study we used endothelin-1 (ET-1), a potent vasoconstrictor, to produce focal infarcts in the forelimb motor cortex, the dorsolateral striatum or both the cortex and striatum in male Sprague-Dawley rats. The spontaneous recovery profile of the animals was followed over an 8-week period using four behavioural tasks assessing motor function and limb preference to identify how recovery varies depending on injury location. Infarct volumes were derived from MRI 72 hours post-stroke.

All three models resulted in functional deficits on the Montoya staircase ($p < 0.002$), beam ($p < 0.017$), and cylinder ($p < 0.001$) tasks but no significant impairments were seen in the adhesive removal task. The three groups demonstrated distinct patterns of recovery on the behavioural tasks with the combined cortical plus striatal group having the largest and most persistent impairments overall. There were no significant differences between groups for total hemispheric infarct volume.

These results suggest that damage to the striatum is an important predictor of the level of post-stroke motor impairment. Moreover, the pattern of recovery is not simply dependent on lesion volume but on lesion location and the behavioural test employed. All three models produce sustained motor impairments that will be valuable in assessing novel, adjunctive post-stroke therapies.

Poster T19: Sensory-Driven Motor Recovery in Poorly Recovered Subacute Stroke Patients
Stroke

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Stroke continues to be a major public health concern in the United States. Therapeutic interventions after stroke can support motor recovery by capitalizing on neuroplastic change (reorganization of the central nervous system). Intensive, task-oriented motor training is an example of an intervention that aligns with principles governing neuroplastic change. While this type of training has been shown to effect neuroplastic change and improve motor function in stroke survivors with *mild to moderate* motor deficit, no proven benefit has emerged in cases of *severe* motor deficit (ie, virtually no wrist and finger movement). On the other hand, several lines of evidence indicate that sensory input can drive neuroplastic change and that manipulating sensory input via peripheral nerve stimulation (PNS) can enhance outcomes of motor training. Here, we report on our pioneering evidence that in cases of *severe* motor deficit after stroke, PNS can enhance outcomes of intensive, task-oriented training. In this double-blind, sham-controlled, randomized study, 71 subjects with subacute stroke (ie, 3-12 months from stroke onset) received 2 hours of PNS immediately prior to 3 hours of intensive, task-oriented training (18 sessions total). PNS condition (active versus sham) was the only independent variable. We evaluated motor performance according to the upper extremity motor score of the Fugl Meyer Assessment (FMA) score at baseline; immediately after completion of the total intervention period; and at 1- and 4-month follow-ups. Results indicated that active PNS can enhance outcomes of motor training significantly more than sham PNS. Also, only the active PNS group had continuous improvement evident at all longitudinal follow-ups. Our forthcoming analysis of data collected via transcranial magnetic stimulation will substantiate potential correlations between neuroplastic change and motor performance change. The overall impact of this study is to help expand effective rehabilitation options for stroke survivors with highest need. Our long-term goals include enhancing the translational potential of this paired intervention (ie, development of portable PNS for clinic and home use; streamlining PNS protocols for time-sensitive environments, such as home exercise or reimbursement-dependent settings).

Poster T20: Assessing Cognitive Function Following Medial Prefrontal Stroke in the Rat
Cognitive/Language Rehabilitation

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Cognitive impairments are prevalent following clinical stroke. However, to date, preclinical research has focused almost exclusively on motor deficits. In order to conduct systematic evaluations into the nature of post-stroke cognitive dysfunction and recovery, it is crucial to develop focal stroke models that affect cognition while leaving motor function intact. Furthermore, in order to investigate potential cognitive post-stroke treatments, it is important that deficits are persistent in the chronic phase. This experiment was performed to evaluate a focal medial prefrontal cortex (mPFC) stroke model using a battery of tests that examined a range of cognitive functions 1-4 months following stroke. Male Sprague-Dawley rats weighing 250-300 g underwent focal ischemia induced in the mPFC using bilateral intracerebral injections of endothelin-1, or sham surgery. Beginning at 1 month post-stroke, cognitive function was assessed using open field, temporal object recognition, object-context recognition, object-placement recognition, attentional set-shifting, light-dark box, spontaneous alternation, Barnes maze, and win-shift/win-stay tests. Prefrontal cortex injury resulted in bilateral damage to the prelimbic and cingulate cortices, extending typically between 4.22 to 1.34 mm anterior to bregma. Animals that underwent stroke surgery exhibited significant changes in all object recognition functions compared to Sham animals ($p<0.05$). Stroke animals also exhibited impaired performance on the Barnes maze ($p=0.012$), and took significantly more trials to learn the second rule in the win-shift/win-stay test ($p=0.013$). Further, they exhibited reduced anxiety-like behaviour in the open field ($p=0.049$). Spontaneous alternation behaviour and locomotion in the open field were not affected. The deficits observed are consistent with some of the key characteristics of prefrontal stroke in humans. Our results show that this model produces persistent deficits in multiple prefrontal cognitive functions, and therefore may be useful for identifying and developing potential therapies for improving cognitive dysfunction in the chronic phase following stroke.

Poster T21: Does the Attentional Status Affect the Efficacy of the Neurofeedback-Based Rehabilitation?: Preliminary Analysis Using Functinoal-NIRS-Mediated (Neurofeedback) System

Neural Repair Mechanisms

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Background:

Balance impairment is a major problem for patients with stroke and other neurological diseases, which limits their activities of daily living (ADL). We previously reported that the supplementary motor area (SMA) potentially plays an important role in balance recovery after stroke. Based on the hypothesis that the SMA facilitation would augment balance recovery after stroke, we have confirmed that the SMA facilitation by functional near-infrared spectroscopy mediated neurofeedback (fNIRS-NFB) have positive effect on balance ability in healthy subjects (ASNR annual meeting 2014, Washington DC). Thus we have started the proof-of-concept study to confirm the favorable effect of SMA facilitation by fNIRS-NFB on balance recovery in stroke patients (the results of interim analysis would be presented in 45th SfN annual meeting 2015).

Aim:

The aim of this study was to assess whether the attentional status as assessed by Frontal Assessment Battery (FAB) and Digit Span (DS) affects the efficacy of the fNIRS-NFB for balance recovery in stroke patients.

Methods:

Ten stroke patients (7 males, Age : 59.8± 9.5, 115.7± 18.6 days from onset) with subcortical lesions, who admitted to Morinomiya hospital (Osaka, JAPAN) for inpatient intensive rehabilitation participated in this study. Clinical assessment including Berg Balance Scale, 10m walking test (10MWT), 3m-Timed Up-and-go test (TUG), and FAB or DS were assessed before (t0), immediate after (t1), and two weeks (t2) after fNIRS-NFB based intervention. In addition to standard rehabilitation therapy up to 180min/day for 7days per week, all patients participated 6 sessions of fNIRS-NFB targeting the SMA activity combined with mental practice using motor imagery of gait and postural related task (3 times /week x 2 weeks). Based on the FAB and DS, patients were divided into high (FAB≧15) and low attention (FAB<15 or backward DS≦2) group.

Results:

Age and post-stroke duration were comparable for two groups. The value of each clinical assessment at t0 was set as 100%. At immediately after and 2 weeks after the fNIRS-NFB, 10MWT was 68.5% (t1) and 57.5% (t2) in high group, and 77.0% (t1) and 71.7% (t2) in low group. TUG was 72.8% (t1) and 66.3% (t2) in high group, and was 85.6% (t1) and 73.6% (t2) in low group. Although high group showed a trend for better gait improvement than low group, it did not reach the statistical significance.

Conclusion:

Although there was several limitations in this study including small number of patients, our finding suggest that attentional status might affect the efficacy of fNIRS-NFB intervention in stroke patients.

Poster T22: Effectiveness of Active Pedaling Combined with Sensory Electrical Stimulation on Gait Performance in Subacute Stroke Patients: A Multicenter, Sham-Controlled Randomized Controlled Trial
Motor Rehabilitation

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Background. Pedaling is used for locomotor training because it induces muscle activities very similar to locomotion. Recent studies have shown that sensory electrical stimulation (ES) combined with additional therapy is behaviorally more effective than ES alone in the rehabilitation of patients following stroke. Thus, it has been hypothesized that ES during pedaling can improve gait performance more than ES or pedaling alone in patients with stroke. The aim of the study was to examine the combined effects of pedaling and ES on gait performance in subacute stroke patients.
Methods. This study was a multicenter, randomized, assessor masked, sham-controlled clinical trial. Participants were randomly allocated to one of the following three groups: pedaling plus ES (P-ES), pedaling plus sham ES (P-sham ES), and ES alone. P-ES and P-sham ES groups performed 15 min of pedaling at their comfortable speed. ES was applied to the affected leg via surface electrodes over the quadriceps and tibialis anterior muscle without muscle activation throughout the pedaling. In ES alone, ES was applied for 15 min while sitting on the chair. All groups received each treatment 5 days per week for 3 weeks in addition to the conventional inpatient rehabilitation. Outcome measures included 10-meter walking test (10mWT) and 6-minute walking test (6MWT) recorded at baseline, after 3 weeks of the treatment, and at 6-week follow-up.
Results. Of the 69 participants, 23, 24, and 22 individuals were assigned to the P-ES, P-sham ES, and ES alone, respectively. Two patients dropped-out during interventions. Ten patients discontinued the study before the follow-up assessments. Following an intention-to-treat approach, data from 57 participants were analyzed. No significant differences were found between groups at baseline. A mixed-model analysis showed a significant interaction of the group and times ($p < 0.05$). All treatments resulted in significant improvements in 10mWT (P-ES: from 0.52±0.27 m/s to 0.70±0.29 m/s, P-Sham ES: from 0.38±0.23 m/s to 0.46±0.27 m/s, ES: from 0.58±0.26 m/s to 0.69±0.34 m/s) and 6MWT (P-ES: from 168.2±115.7 m to 237.2±107.5 m, P-Sham ES: from 138.6±91.5 m to 159.5±107.6 m, ES: from 171.0±80.1 m to 223.5±140.2 m) after 3 weeks of the treatment compared to baseline ($p < 0.05$). Post hoc analysis showed that the P-ES and ES groups showed significantly better improvement in comparison with the P-sham ES group at the end of the 3-week treatment and in the 6-week follow-up ($p < 0.05$).
Conclusion. Pedaling combined with ES and ES alone in addition to inpatient rehabilitation can induce greater improvement in gait performance than pedaling alone in subacute stroke patients.

Poster T23: Prevalence of Growth Hormone Deficiency in Chronic Traumatic Brain Injury
TBI

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This study examined the prevalence of growth hormone deficiency (GHD) in patients with traumatic brain injury (TBI) during the post-acute phase of recovery and whether GHD was associated with increased disability, decreased independence and depression. A secondary objective was to determine the accuracy of insulin-like growth factor-1 (IGF-1) levels in predicting GHD in patients with TBI. Anterior pituitary function was assessed in 235 adult patients with TBI through evaluation of fasting morning hormone levels. Growth hormone levels were assessed through provocative testing, specifically the glucagon stimulation test. GHD was diagnosed in a significant number of patients, with 45% falling into the severe GHD (<3 ug/L) category. IGF-1 levels were not predictive of GHD. Patients with GHD were more disabled and less independent compared to those patients who were not GHD. Those patients with more severe GHD also showed decreased levels of cortisol and testosterone. Symptoms of depression were also more prevalent in this group. In addition, patients with severe GHD had delayed admission to post-acute rehabilitation. This study confirms the high prevalence of GHD in patients with TBI and the necessity to monitor clinical symptoms and perform provocative testing to definitively diagnose GHD.

Poster T24: Study Design: Identifying Carpal Tunnel Syndrome in Stroke Recovery using Ultrasound
Peripheral Nerve/Plexus/Neuromuscular Diseases

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Purpose:
There is a lack of recognition of CTS during stroke recovery, although early literature suggests it is prevalent and inhibits mobility, rehabilitation and recovery. The symptoms of CTS can be difficult to identify in the setting of coexisting neurologic deficits due to stroke. Gold standard electrodiagnostic testing can be uncomfortable and costly. Median nerve ultrasound (US)is now widely accepted as a useful tool for CTS diagnosis that is painless and inexpensive. In this proposed, prospective pilot study, median nerve US will be used to screen stroke patients for development of CTS during their acute presentation and subsequent recovery.

Study design and Procedures:
This single-site study will evaluate the incidence of US-identified CTS in patients following stroke. Patients will be assessed within 72 hours of stroke onset, then at their 1 month and 3 month clinic visits. Subjects will be evaluated using the MRC strength score. Subjects who are hemiplegic (MRC of 0) will be placed into one group. Hemiparetic patients who demonstrate an MRC score of 1 to 4 at one arm will be placed in another group. We will also recruit patients that have monoparesis or monoplegia at one arm will each be placed into separate groups. Investigators will perform a focused neurologic exam including Tinel's and Phalen's test on the extremities.

Patients will undergo median nerve US of bilateral median nerves, performed by trained personnel in the Duke Electromyography Laboratory, where this testing has been offered as a standard service since 2006. Our primary outcome is evidence of CTS on ultrasound, based upon pre-existing laboratory established normative values. Median nerve CSA (cross sectional area) at the distal wrist crease of 10-12mm^2 will be considered at risk for CTS, while values >12mm^2 and a ratio of median nerve CSA at the wrist/median nerve CSA at the forearm of >1.5 are considered consistent with CTS. The presence of intraneural blood flow will also be recorded as normal or increased. All abnormal US results will be referred back to the subject's primary neurologist for management, including if additional electrodiagnostic tests are warranted versus treatment.

Our secondary outcome will be based on change in patient reported functional status. Patients will complete the Boston Carpal Tunnel Questionnaire (BCTQ), a widely-used self-reported functional status and symptom severity scale at baseline and during follow-up visits. Our goal enrollment is 20 patients for each study group for a goal of 80 patients. We anticipate completion of enrollment and preliminary data of hospitalized patients by October 2015.

Poster T25: Comparing Stimulation of Bihemispheric Motor Sites on a Reaching Task in Mild and Severe Arm Impairment After Stroke
Stroke

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Stroke affects over 610,000 people in the United States every year and many are left permanently disabled. Chronic poststroke arm impairment is particularly disabling and existing treatments are of limited efficacy. There are sites in each hemisphere that it may be beneficial to "prime" in order to enhance the effects of a subsequently applied rehabilitation treatment . One such region is the dorsal premotor cortex (PMd). Previous research demonstrates that PMd has a role in motor control of the ipsilateral arm, direct ipsilateral and contralateral projections to the spinal cord, and the ability to flexibly compensate for asymmetries in function between hemispheres. The role of PMd in poststroke arm impairment, how it may differ from that of other cortical areas and with severity of poststroke arm impairment is not known. The hypothesis are that nlPMd, not lPMd, has a greater role in recovered reaching function in severe more than mild patients and that nlPMd, but not nlM1, has a greater role in recovered reaching function in severe patients.

30 individuals with (n=15) or without (n=15) active wrist and finger movements after poststroke arm impairment participated in a reaching task. Participants were asked to reach as quickly as possible with the affected arm to one of the targets in response to a visual 'Go' signal. TMS was applied between the 'Go' signal and movement onset. Doublepulse TMS (ISI 25 ms) was delivered to nlM1, nlPMd and lPMd at 120% of the individual's Resting Motor Threshold (RMT) for unaffected biceps. Change in movement time was greater with TMS applied to nlPMd than to lPMD in the severely impaired but not mildly impaired participants. A trend in the data shows an interaction effect between severity and hemisphere. Within only the severe group, change in movement time was greater with TMS applied to nlPMd but not to nlM1. Data suggest that nlPMd has a greater role in recovered arm reaching in severely impaired patients than lPMd and that this effect is not present in mildly impaired patients. Additionally, data show that this is not an effect of the contralesional hemisphere as a whole, but a site specific effect to nlPMd as shown through comparison with disruption of nlM1. This study evaluates the role of nlPMd in recovery of arm function. The results of this study lay the foundation to explore nlPMd as a potential site for upregulation as an adjuvant to traditional therapy in severe patients after stroke. Identification of sites to enhance rehabilitation outcomes of severe patients are essential as there are no currently validated treatments and longterm disability is costly to both personal quality of life and national health care costs.

Poster T26: A Constrained Motor Connectome Characterizes Post-Stroke Upper Extremity Motor Function
Stroke

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Purpose: Animal models of stroke have shown that white matter distant from the lesion may impact function. Thus, structural reorganization of both hemispheres post-stroke may contribute to motor function. Multimodal neuroimaging that combines structural and functional measures may provide insight into how the residual whole-brain motor network contributes to functional recovery and learning after stroke better than single regional approaches. This study's purpose was to examine whether: 1) a constrained motor connectome (CMC) derived from a multimodal neuroimaging approach could differentiate between healthy individuals and stroke, and 2) the CMC relates to motor function or impairment.

Methods: All participants underwent diffusion imaging at a 3T magnetic resonance imaging (MRI) centre. A bilateral sensorimotor network mask, created from a functional MRI connectivity analysis in healthy participants during motor task retention test, was used to constrain white matter. The clusters from our functional MRI analysis represent an idealized motor network and were used as seed regions to construct a CMC for each participant. Subsequently, diffusion metrics (tract number, fractional anisotrophy [FA], apparent diffusion coefficient [ADC]) were calculated to characterize the CMC. The Wolf Motor Function (WMF) and Fugl-Meyer (FM) upper extremity tests characterized paretic arm function and impairment, respectively. For the WMF, movement time to complete the 15 items was determined and a task rate was calculated. The WMF was also divided into fine (WMF-f) and gross (WMF-g) motor tasks with separate task rates calculated. A one-way between subjects analysis of variance (ANOVA, $p \leq 0.05$) was performed to compare the effect of group on diffusion metrics. Pearson's correlations were calculated for WMF, FM, and diffusion metrics.

Results: Twenty-nine individuals with stroke (age 65.6±10.7 years, 68.1±66.5 months post-stroke) and 18 healthy individuals were scanned. On average, participants with stroke were moderately impaired (FM 48.0±16.8). The ANOVA revealed significant differences between individuals with stroke and healthy for number of tracts [$F(1,45)=11.67$, $p=0.001$], mean FA [$F(1,45)=17.58$, $p<0.001$], and mean ADC [$F(1,45)=3.93$, $p=0.05$] in the CMC. For individuals with stroke, the nonparetic WMF-f correlated with ADC ($r=-0.41$, $p=0.04$), but not with FA ($r=0.27$, $p=0.18$) or tract number ($r=-0.002$, $p=0.99$). The FM did not correlate with diffusion metrics within the CMC.

Discussion: A bilateral CMC is able to differentiate individuals with stroke from healthy. Additionally, the CMC correlated with motor function but not impairment, which suggests that it may be related to functional motor network recovery. As this CMC reflects a large functional motor network, it may capture the compensatory plasticity thought to be involved in post-stroke recovery of motor function. Applying a constrained motor connectome to the post-stroke brain may provide a biomarker for sensorimotor function. Further, this work lends support to the theory that connectivity between hemispheres is likely important for recovery of function after stroke.

Poster T27: Effect of Taping on Hand Functions in Spastic Hemiplegic Children.
Motor Rehabilitation

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Background: Skilled hand movements involving grasping usually develop poorly in children with spastic hemiplegic cerebral palsy and even with mild spasticity the range of wrist joint begun to decrease in relation to normal children.

Objective: The purpose of the study was to investigate the effect of taping on the hand functions in spastic hemiplegic children.

Study design: Randomized controlled trial. Study Participants and Setting: Fourteen spastic hemiplegic children. The setting was in the clinic of faculty of physical therapy-Cairo University.

Material and Methods: The children were randomly divided into two groups (A&B) of equal numbers. Group A (Control group) received especially designed therapeutic exercise program, Group B (Study group) received especially designed therapeutic exercise program in addition to application of taping. Both groups were evaluated for their hand functions prior and after a course of 3 months-training program specified for each group using the Peabody Developmental Motor Scale-2 (PDMS-2).

Results: There was a significant improvement in both groups also significant difference was recorded between the two groups post treatment in favor of the study group.

Conclusion: Use of taping can be helpful as an additional therapeutic modality for improving the hand functions in hemiplegic children.

Key words: Spastic, Hemiplegic and Taping

Poster T28: Impact of Motor Practice on Neuromodulation for Stroke Rehabilitation
Motor Rehabilitation

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Neuroplasticity is an important factor for upper-extremity stroke rehabilitation. Recent trends in stroke rehabilitation research have focused on influencing neuroplasticity with neuromodulatory techniques such as repetitive transcranial magnetic stimulation (rTMS) and coupling those with motor practice. However, the amount of neuromodulation achieved with an acute session of motor practice is not fully characterized. The objective of this pilot study was to determine how engaging in motor practice with a similar time sequence as a rTMS intervention influences motor control, dexterity, and neuromodulation. Five survivors of stroke participated in this pilot study with a mean age of 60.4 (range 43-84). Each participant completed a motor practice intervention protocol with their stroke-affected arm and hand including 30 bouts of isometric contractions in a customized wrist device for 6 seconds followed by a 30 second rest. Assessments included force steadiness and electromyography during a wrist extension task, the Box and Block Test (BBT), and transcranial magnetic stimulation (TMS) before and after the intervention. The force steadiness task was two trials of at least 10 seconds at 5, 10, and 20% of the maximum voluntary contraction. The BBT is a measure of dexterity assessed as the number of small blocks moved in a minute. The TMS measures included 12 stimulations each at suprathreshold test stimulus (TS, 116% of resting motor threshold), short-interval intracortical inhibition (SICI), and intracortical facilitation (ICF) with motor evoked potentials (MEP) recorded from the extensor carpi radialis (ECR) and extensor carpi ulnaris (ECU) muscles. Data were analyzed with a paired *t*-test. The variability of force steadiness decreased following the intervention for the 5 and 20% conditions ($p < 0.05$). Muscle activity increased from pre-test to post-test with significant increases during the 10% condition ($p = 0.04$) and a trend during the 5 and 20% conditions ($p = 0.06$, and 0.05, respectively). Participants were able to move significantly more blocks with their stroke-affected hand following the intervention ($p < 0.02$), but no changes were observed with the less-affected hand ($p = 0.3$). TMS data was only collected on three subjects. Two of the subjects had increases in MEP amplitude of the TS only stimulations and all three subjects had more inhibition (SICI). These results suggest that a short intervention of isometric wrist extension can influence motor control, dexterity, and neuromodulation. This demonstrates the importance of better understanding how possible rehabilitation interventions contribute to influencing neuroplasticity and promoting greater functional improvements.

Poster T29: Bilateral vs. Unilateral Therapy for Chronic Stroke Patients with Varying Degrees of Motor Impairment: A Crossover Repeated-Measures Design of Neurophysiologic Response
Stroke

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INTRODUCTION: For patients with chronic stroke, it is believed excitation of the primary motor cortex of the non-lesioned hemisphere (NLH) exacerbates motor deficits by exaggerating transcallosal inhibitory interactions (TCI) upon the lesioned hemisphere (LH). However, recent evidence suggests the NLH may play a compensatory role in recovery for patients with greater motor impairment. If true, then therapies recruiting the NLH would elicit a more adaptive role of the NLH for recovery. Therefore, we tested the hypothesis that therapy involving the NLH (bilateral) would lower TCI exerted upon the LH compared to therapy only involving the LH (unilateral); an effect that would become more pronounced with increasing impairment. **METHODS:** In a crossover repeated-measures design, six chronic stroke patients with varying degrees of motor impairment (Fugl-Meyer [clinical measure of motor impairment]: 15 [more impaired] to 59 [less impaired]) underwent a single session each of unilateral and bilateral therapy. We measured excitation of the NLH and TCI it exerts upon the LH using transcranial magnetic stimulation. TMS uses electromagnetic induction to depolarize neurons in the cortex and assesses recruitment of hemispheric output to the muscle as motor evoked potentials and the transcallosal inhibition imposed upon the primary motor cortex. **RESULTS:** Overall, bilateral therapy resulted in greater NLH and LH excitability when compared to unilateral therapy (NLH: 15.35 ± 33% vs. -6.81 ± 20.2%; LH: 6.51 ± 25% vs. -14.49 ± 21%, $p < .05$). Further, bilateral therapy resulted in a greater reduction of TCI (-27.9 ± 18.6% vs. -5.16 ± 10.2%, $p < .05$), where the effect was more pronounced in the more impaired patients ($r = .829$, $p < .05$). **CONCLUSION:** Our preliminary results show that bilateral therapy may invoke an adaptive rather than inhibitory influence of the NLH with greater motor impairment. Future work will test whether behavioral outcomes following bilateral therapy is superior to unilateral therapy for patients with greater motor impairment.

Poster T30: Clinically Approved Daidzein Improves Ipsilesional Visual Acuity in Subcortical Stroke in Mice
Stroke

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Objectives: Stroke induces visual impairment and spatial neglect. Since the deficits hinder patients' recovery and rehabilitation, early detection of visual deficits is important in implementing a strategy for intervention. Accordingly, identifying pharmacological agents that improve the visual deficit would promote functional recovery and rehabilitation processes. Daidzein is a major component of widely consumed soy products. It is an isoflavone and shows numerous health benefits against obesity, cancer, and vascular disease. The current study investigated the effect of daidzein on visual function in mice with subcortical stroke.

Methods: C57bl/6 mice were subjected to 30 min transient middle cerebral artery occlusion and were treated with vehicle or daidzein (10 mg/kg, subcutaneous) at 10 min after reperfusion. Treatments were conditioned daily for 7 days and then every other day up to 1 month. Infarct size was determined 3 days and 1 month after stroke. Visual function was assessed by optokinetic tracking response (OKT) testing, which is a sensitive integrated sensory motor function that determines visual acuity by spatial frequency (SPF) threshold.

Results: Infarct volume at 3 days after stroke or analyses of tissue volume to estimate infarct size at 1 month post-ischemia revealed no differences between vehicle and daidzein-treated groups (Vehicle vs daidzein 3d, 43.4±3.3 vs 36.1±3.4, ns n=18/group; 1m 22.7±3.8 vs 22±03.0 ns n-13-15), suggesting that daidzein does not affect infarct size. Baseline pre-ischemic visual acuity was similar between vehicle- and daidzein-treated groups. While stroke caused significant deficits in visual acuity in the ipsilateral side at 1m post-ischemia, daidzein treatment rescued the visual deficit (Vehicle vs daidzein 0.368±0.003 vs 0.383±0.002, $p<0.001$, n=13-15). Longitudinal OKT testing in a subset of animals revealed that visual acuity declined sharply within one hour post-stroke and sustained until 4-5 hours. A final visual acuity was established by 6h post-ischemia, which remained constant for the rest of the recovery period until 1 month post-ischemia.

Conclusions: The findings suggest that OKT is a simple and quantifiable tool to predict visual deficit independent of infarct size. The timeframe of improved OKT responses by daidzein at the acute phase of stroke further implicates that early intervention by daidzein has long-lasting benefit in visual function. A possibility of stroke-induced retinal dysfunction to account for the visual deficit warrants further investigation.

Poster T31: Improved Upper Limb Skilled Functional Task Performance is Predicted by Mitigated Spasticity in Response to Intensive Motor Learning Therapy in Chronic Stroke Survivors
Motor Rehabilitation

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PURPOSE: Spasticity is a significant problem for individuals in the chronic stage after stroke or in other types of central nervous system injury. It causes pain and discomfort, and limits effective voluntary movement. Physical or occupational therapy interventions can decrease spasticity. However, it is still uncertain whether there is a relationship between reduction in spasticity and change in function. The purpose of this study was to establish whether there was a relationship between mitigation of spasticity and gain in complex functional task performance, following intensive upper limb rehabilitation.

METHODS: We recruited 80 chronic stroke survivors (>6 months post-stroke) with upper limb motor deficits (Fugl-Meyer mean = 23.8 ± 9) and spasticity. Upper limb motor learning therapy was provided for 5 hours/day, 5 days/week for 12 weeks and included progressed practice of functional tasks and their components. Outcome measures were collected before and after rehabilitation and included: modified Ashworth scale (mASH); mASH for wrist/hand muscles (mASH W/H); Arm Motor Ability test, function domain (AMAT-F); and AMAT-F wrist/hand (AMAT-F W/H). mASH was obtained and summed for nine muscles of the upper limb: shoulder internal rotators, elbow flexors and extensors; forearm pronator and supinators, and wrist and digit flexors and extensors. Pre- vs post-rehabilitation scores were compared with Wilcoxon Signed Rank Test. We conducted regression analysis to determine the effect of spasticity mitigation in response to treatment on recovery of functional task performance.

RESULTS: Subjects were 57.6±11.9 years old, 31.4±23.4 months after stroke and 33.7% were female. Following rehabilitation, summated AMAT-F score for whole arm improved from 87±33 to 110±39 ($p<0.001$); AMAT-F W/H improved from 25±15 to 33±17 ($p < 0.001$); mASH improved from 8.5±3.6 to 6.1±3.3 ($p<0.001$). After adjusting for age and baseline AMAT-F W/H score, improved spasticity predicted gain in AMAT-F W/H (parameter estimate coefficient, $\beta = 0.31$ ($p=0.009$)). In exploratory analysis, we found first, that mitigated mASH in digit flexor muscles significantly predicted AMAT-F W/H gain (parameter estimate coefficient $\beta = 0.3$ ($p=0.01$)). Second, we found that mitigated mASH in wrist flexors ($\beta = 0.27$ ($p=0.02$)) predicted improvement of the AMAT-F overall score for the whole arm performance.

CONCLUSION: Intensive motor learning for the upper limb mitigates abnormal muscle tone. Furthermore, there is a significant relationship between mitigation of spasticity and gain in motor function for upper extremity. Specifically, reduced spasticity in distal arm muscles, i.e. digit and wrist flexors predicted gains in skilled functional tasks, for the wrist/hand components of those tasks.

Poster T32: Contralaterally Controlled Functional Electrical Stimulation and Hand Therapy Video Games for Cerebral Palsy
Motor Rehabilitation

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Purpose: We describe a novel intervention for children with upper extremity hemiplegia due to cerebral palsy.

Intervention: Our home-based intervention integrates a novel electrical stimulation approach with custom video games.

Contralaterally Controlled Functional Electrical Stimulation (CCFES) is a unique form of neuromuscular electrical stimulation that allows children to control the timing and amount of hand opening. A sensor glove is worn on the unimpaired hand that proportionally controls stimulation to surface electrodes on the extensors of the paretic hand. Stimulation is configured so that paretic hand opening mirrors that of the unimpaired hand. This allows children to use CCFES to assist their paretic hand while playing video games.

We developed four hand therapy video games that are controlled by impaired hand opening/closing. Each game trains different motor skills and is designed to engage children in goal-oriented training that require motor planning, control, and concentration.

Paddle Ball trains control of graded hand opening. A paddle's vertical position is controlled by hand aperture. Difficulty is adjusted by changing paddle size and ball speed. Performance feedback is provided by score, hit rate, and motor repetitions.

Skee Ball trains control of hand opening speed. Players launch balls toward rings at speeds proportional to hand opening rate. Rings move, requiring control of hand opening speed. Difficulty is adjusted by changing ring size. Performance feedback is provided by score, accuracy, and motor repetitions.

Marble Maze trains maintenance of hand opening. Players rotate mazes to guide marbles out - often needing to hold the maze still while marbles roll. Maze rotation is proportional to hand opening angle. Difficulty is adjusted by bucket size and adding concurrent marbles. Performance is provided by completion time.

Sound Tracker trains continuous precise hand opening. Players control a cursor's vertical motion with hand opening/closing to follow a path generated by a series of songs. Difficulty is adjusted by track width and new songs are presented with 90% accuracy. Performance feedback is provided by accuracy.

Feasibility Study: We have an ongoing feasibility study to establish a protocol for administering the treatment and to estimate its effect on hand impairment and function. The period is 6 weeks, which consists of therapist-guided sessions in lab and self-administered sessions at home. Weekly lab sessions consist of 45 min of CCFES-mediated video games and 45 minutes of CCFES-mediated functional task practice. Daily home sessions consist of 90 mins CCFES-mediated video games.

Poster T33: Connections Between Posterior Parietal and Sensorimotor Cortices Predict Postural Adaptation in People with Multiple Sclerosis
MS

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Introduction: People with Multiple Sclerosis (PwMS) have increasingly well-characterized deficits in gait and balance. As yet, rehabilitation strategies to improve these deficits have limited effectiveness. Studies suggest that PwMS can learn upper limb motor skills; however, it is unknown whether PwMS are able to improve their responses to postural perturbations. Therefore, the first aim of this study was to assess short- and long-term postural motor adaptation in PwMS and healthy controls (HC). The second aim was to identify neuroanatomic networks underlying short- and long-term adaptation of postural responses within PwMS.

Methods: 24 patients with relapsing-remitting MS and 14 age-matched HC stood on a platform that translated horizontally forward and backward, eliciting postural perturbations in the opposite direction. Testing on the first day consisted of five blocks of trials with rest periods between blocks. To separate temporary performance effects from more permanent changes in behavior, participants returned on a second day to assess long-term adaptation. Performance on the perturbation platform was assessed as the relative phase lag of the body center of mass relative to platform motion. Diffusion weighted images (DTI) were also acquired and whole brain tract-based spatial statistics (TBSS) were used to identify associations between white matter microstructural integrity and postural adaptation.

Results: Despite significant deficits in postural motor performance at baseline related to the relative phase measure in PwMS ($P < 0.01$), they demonstrated a similar ability to improve postural control with training compared to HC. TBSS analysis revealed a widespread network of decreased white matter microstructure in PwMS compared to HC, with specific deficits noted in the corpus callosum. Further, TBSS correlation analysis revealed strong associations between short-term adaptation and fiber tract quality within the corpus callosum (genu, body and splenium) as well as white matter tracts connecting the posterior parietal cortices with the primary somatosensory and motor cortices, principally within the left hemisphere ($P \leq 0.05$; corrected for age, brain volume & EDSS). These neuro-behavioral relationships were strongly driven by PwMS.

Conclusions: PwMS have the capacity to improve the use of a feed-forward postural strategy with practice and retain the learned behavior despite their significant postural response impairments. Further, we show that interhemispheric callosal connections and those connecting the posterior parietal cortices with the sensorimotor cortices are strongly related to a given individual's ability to adapt their behavior. The posterior parietal cortex plays an integral role in voluntary movements by assessing the context in which they are being made and integrating somatosensory and visual inputs to determine positions of the body in space. It thereby produces internal models of the movement to be made, suggesting that PwMS who are able to engage this circuitry to a greater extent may benefit more from gait and balance training.

Poster T34: Activation Training Alters Corticomotor Excitability of the Gluteus Maximus
Motor Rehabilitation

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Objectives: To determine whether a short term (6 hours) activation training program targeting gluteus maximus (GM) results in neuroplastic changes in the primary motor cortex (M1).

Study Design: Within subject - repeated measures

Background: It has been proposed that strengthening and skill training of GM may be beneficial in treating various knee injuries. Given the redundancy of the hip musculature and the small representational area of GM in M1, learning to activate this muscle prior to prescribing strength exercises and modifying movement strategy would appear to be important.

Methods: Using Transcranial magnetic stimulation (TMS), motor evoked potentials (MEPs) were obtained in 12 healthy individuals at 5 different stimulation intensities while they performed a double-leg bridge. Participants then completed a home exercise program for approximately 1 hour/day for 6 days that consisted of a single exercise designed to selectively target GM. Baseline and post-training input-output curves (IOCs) were generated by graphing average MEP amplitudes and cortical silent period (CSP) durations against corresponding stimulation intensities. Linear slopes of the IOCs were compared pre and post training using a paired t-test.

Results: Following GM activation training, the linear slope of the MEP IOC increased from 14.89 to 21.51 ($p = .01$). For CSP duration, the linear slope of the IOC increased from 13.74 to 22.64 ($p = .04$).

Conclusion: Short term GM activation training resulted in a significant increase in corticomotor excitability as well as changes in inhibitory processes of GM. We propose that the observed corticomotor plasticity will allow for better utilization of GM in the more advanced stages of a rehabilitation/training program.

Key words: transcranial magnetic stimulation, motor-evoked potential, recruitment efficiency, cortical silent period, inhibition

Poster T35: Methodological Study to Identify Trunk and Hip Muscle Representation in Motor Cortex
Motor Rehabilitation

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Background: Trunk and hip muscles contribute significantly to postural control, balance and locomotion. With aging, changes in activities of these muscles are evident. While modifications in motor behavior are linked to altered muscle representational areas in motor cortex, the relationship between motor cortex organization of the trunk and hip muscles and changes in motor behavior in older adults has yet to be established. Transcranial Magnetic Stimulation (TMS) has been used to identify muscle representation in the motor cortex. Mapping the trunk and hip muscles is challenging due to the small representations of these muscles in the medial motor cortex.

Purpose: Establish a methodology to quantify the spatial representation of trunk and hip musculature in young and older adults.

Method: Six young females participated in the study. Motor evoked potentials (MEPs) were quantified in the external oblique (EO), lumber longissimus (LES) and gluteus medius (GEMD) using a double cone coil and surface electromyography. After, motor thresholding, mapping of a 6 by 4cm grid over the pre-central gyrus was conducted using neuronavigation during a submaximal active contraction (20% of maximum voluntary isometric contraction) for all three muscles. Average peak-to-peak amplitude of MEPs was calculated for each map location and utilized to determine the center of gravity (COG) for each muscle.

Results: MEPs were elicited consistently in all three muscles. The average COG for GMED was medial to that of LES and EO. COG for all three muscles was localized within primary motor cortex (approximate x, y, z coordinates; GMED 12, -17, 63mm , LES 15, -17, 63mm, EO 14, -17, 63mm in Tailarach space). However, in some individuals the caudal supplementary motor area also contributed significantly to the motor maps.

Conclusion: Initial data demonstrate that this methodology is feasible and can identify distinct trunk and hip representations in the motor cortex.

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Poster T36: The Efficacy of Wii-Based Movement Therapy Upper-Limb Rehabilitation in Chronic Stroke is Accompanied by Ancillary Cardiovascular Benefits
Motor Rehabilitation

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Financial constraints in the health sector make the search for more effective and efficient post-stroke rehabilitation more urgent. Wii-based Movement Therapy (WMT) uses the Nintendo Wii and Wii Sports as a tool in a structured 14-day rehabilitation program that targets movement quality of the more-affected upper-limb and increased independence in activities of daily living. We compared dose-matched trials of Wii-based Movement Therapy (WMT) and modified Constraint-induced Movement Therapy (mCIMT) in two studies, i) an assessor-blinded randomised controlled trial of upper-limb therapy efficacy with 42 patients 2-46 months post-stroke; and ii) a post hoc analysis of the cardiovascular benefits of therapy in 46 patients receiving either WMT (n=29) or mCIMT (n=17) from 3-264 months post-stroke (mean 34.8±9.3 months) of whom 28 were studied during the RCT. Primary outcome measures for the RCT were the Wolf Motor Function Test timed-tasks (WMFT-tt) and Motor Activity Log Quality of Movement scale (MALQOM) assessed at pre-baseline (14-days pre-therapy), baseline, post-therapy, and 6-month follow-up. Patients in the cardiovascular study were assessed in the same way with the addition of peak heart rate (HRpeak) and heart rate recovery (HRR) measured during therapy sessions at early (day 2) and late (~day 13) therapy. There were no adverse events. For the RCT there were no differences at any time point between groups for the primary outcome measures. Motor-function was stable between pre-baseline and baseline assessments ($p>0.05$); improved with therapy between baseline and post-therapy ($p<0.001$); and these improvements were sustained at 6 months ($p>0.05$). WMFT-tt log times improved from 2.1 (1.5-2.7) to 1.7 (1.1-2.3) s after WMT and 2.6 (1.9-3.2) to 2.3 (1.7-3.0) s after mCIMT. MALQOM scores improved from 67.7 (51.1-84.4) to 102.4 (84.4-120.3) and from 64.1 (43.6-84.5) to 93.0 (76.5-109.5), respectively (mean, 95% confidence intervals). HRpeak was higher during mCIMT than WMT, but increased by late-therapy only for the WMT group ($p<0.001$). Similarly, HRR was always faster for mCIMT but changed significantly by later-therapy only for the WMT group ($p=0.037$). These data suggest that WMT provides a cardiovascular challenge that improves the cardiovascular fitness of stroke patients in the chronic phase whereas mCIMT induces a cardiovascular stress response. Patient preference and acceptance for WMT were higher than mCIMT with higher levels of sustained therapeutic activities at 6 months. Patients in the WMT cohort reported fewer falls, and greater levels of physical activity and social engagement at 6 months. This study demonstrates that WMT is as effective as mCIMT for upper-limb rehabilitation and increased independence in everyday life but WMT alone confers a cardiovascular benefit. WMT can be implemented across a broad spectrum of post-stroke impairment to provide prolonged therapy intensity and increased physical activity.

Poster T37: Optimal Timing for Combined Neuromodulation Techniques to Enhance Motor Training in Chronic Stroke with Severe Motor Deficit

Motor Rehabilitation

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Peripheral nerve stimulation (PNS) and transcranial direct current stimulation (tDCS) are neuromodulation techniques that can increase neuroplasticity and aid in motor recovery after stroke. Only a few studies to date have investigated the effects that tDCS combined with PNS has on outcomes of motor training after stroke. In these studies, the tDCS protocol overlapped with the end of each PNS session. It is conceivable that delivering tDCS at the start (rather than the end) of a PNS session would enhance the effects of PNS. Alternatively, delivering tDCS at the end of PNS could be optimal due to motor training taking place while the motor cortex is still depolarized from tDCS. Because no studies have investigated alternate timing configurations of tDCS combined with PNS, we conducted a proof-of-concept study in which subjects with severe post-stroke hemiparesis received 2 hours of PNS and 20 minutes of anodal tDCS concurrently. tDCS was delivered according to 1 of 2 timing configurations: 1) during the first 20 minutes of PNS ("Start" group; n=4); or 2) during the last 20 minutes of PNS ("End" group; n=6). All subjects received 2 hours of robotic-assisted upper extremity motor training immediately following stimulation. We hypothesized that the "Start" group would have greater improvements in motor function than the "End" group. Outcome measures, taken 1-7 days before starting interventions, and again at 1-7 days after completing interventions, included the upper extremity motor score of Fugl-Meyer Assessment (FMA), Stroke Impact Scale (SIS), and cortical map volume as measured by transcranial magnetic stimulation. We analyzed data using an independent sample t-test. Results indicated modest improvements in FMA for both groups, with slightly greater improvements in the Start group. Though SIS scores improved in both groups, there was a trend towards significantly greater improvement for the Start group compared with the End group ($p=0.062$). Cortical map volume for both hemispheres decreased in the End group, while both increased slightly in the Start group. These results suggest that delivery of tDCS at the start of PNS offers more benefit than tDCS at the end of PNS. A possible explanation is that tDCS at the end of PNS overstimulates the cortex, thus negating potentially therapeutic effects of neuromodulatory intervention. A larger study is needed to substantiate these preliminary results.

Poster T38: Biomarkers of Stroke Recovery Study (BIOREC) Methodology
Neural Repair Mechanisms

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Efforts to improve recovery from stroke are currently limited by a poor understanding of neural injury and repair mechanisms in humans. Here we describe the methodology for the Biomarkers of Stroke Recovery Study (BIOREC), designed to identify potential molecular markers of neural injury and repair in humans. In this pilot study, we capitalize on recent advances in the field of metabolomics to gain a window into neural remodeling after stroke. These advances have made it possible to accurately detect tiny metabolites, many of which pass through an intact blood-brain-barrier. Subjects in BIOREC undergo blood draws at 5, 15, and 30 days post-stroke - a time period during which the majority of neural recovery occurs based on stroke recovery curves. We also carefully measure functional recovery at 5, 15, 30, and 90 days post-stroke using tests of motor, speech, and cognitive abilities. Motor testing includes the upper extremity Fugl-Meyer (UE-FM), nine-hole peg test, and kinematics using the Zebris 3D-motion detector. Inclusion criteria, which are strict to reduce blood sample variability, include ischemic middle cerebral artery stroke larger than 25cc on neuroimaging, age 50-70, pre-stroke mRS < 2, and presumed cardioembolic source. BIOREC recently received IRB approval and will start recruitment at MedStar Georgetown University Hospital and MedStar Washington Hospital Center in Washington, DC. We anticipate 1 year to reach our recruitment goal of 24 stroke patients and an equal number of age-matched controls. Blood samples will be analyzed at study conclusion. BIOREC will identify novel metabolites that have a different concentration in the blood of stroke patients in comparison to age-matched controls. We suspect that metabolite changes detected early after stroke (day 5) will primarily reflect neural injury, while those detected late (day 15, 30) will reflect neural repair. This hypothesis will be tested in a larger follow up study aimed at linking specific metabolite changes with good and poor recovery using UE-FM as the primary outcome measure. This work was supported by grant 1U10NS086513-01.

Poster T39: Investigating Dynamics of Motor Evoked Potentials During Isometric Contraction
Motor Rehabilitation

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The amplitude of muscle potentials evoked by transcranial magnetic stimulation is often used to describe the overall state of the corticomotorneuronal system. Paired-pulse stimulation evokes potentials that allow exploration of inhibitory effects on motor cortical effectiveness. In order to tease out the effect of a behavioral condition on paired-pulse evoked potentials, it then becomes necessary to attempt to adjust for the effects of the behavior on the test and conditioning evoked activity separately. This is most often done by adjusting the stimulation intensity to match motor evoked potential amplitudes across behavioral conditions. While this method of adjustment is well established, it is limited by the presumption that the behavioral condition, such as voluntary muscle contraction, has linearly correlated effects on test and condition evoked potentials. It may also be practically difficult to match stimulus responses across non-linear recruitment curves. To overcome this limitation, we have developed a method by which a recruitment curve across stimulation intensities for one muscle is defined first, and then paired pulses are applied across stimulation intensities for both conditioning and test evoked potentials. These recruitment curves, taken at both rest and during isometric muscle contraction, can be compared, controlling for respective changes in evoked potentials and behavioral condition. This method allows us explore the dynamics of interhemispheric inhibition during unimanual isometric muscle contraction.