IXth International Symposium / Symposium international
Progress in Motor Control
Progrès de la recherche en contrôle moteur

Overview:

The three-day meeting brings together experts in diverse areas of Motor Control including the performing arts, such as dance, circus arts and music. The following areas have been addressed:

- Cortical and spinal mechanisms of motor control
- Variability and redundancy in motor control
- Equilibrium-point control and perception-action coupling
- Motor control of speech and language
- Motor control and recovery from injury
- Motor control and the performing arts

Suite à un appel de candidatures des étudiants du RS#1: Réadaptation en maladies cérébrovasculaires, le REPAR a octroyé 7 bourses de 200$ aux étudiants qui ont soumis un abrégé au Congrès Progress in Motor Control IX qui s'est tenu à Montréal du 13 au 16 juillet, 2013. La remise des bourses a été faite par madame Julie Côté, Ph.D, lors du congrès. Le tableau présente la liste des gagnants, leur niveau d'études et leur Université ainsi que le nom de leurs directeurs. Les résumés des présentations sont joints dans les pages suivantes. L'étudiante au doctorat Séléna Lauzière s'est mérité le prix pour la meilleure affiche.

Étudiants	Niveau	Directeurs	Université
Aravind, Gayatri	Ph.D	Lamontagne, Anouk	U. McGill
Banina, Mélanie	Ph.D	Levin, Mindy F.	U. McGill
Hernandez, Alejandro	M.Sc	Levin, Mindy F. / Feldman, Anatol G.	U. Montréal
Lauzière, Séléna**	Ph.D	Nadeau, Sylvie / Aissaoui Rachid	U. Montréal
Mullié, Yannick	M.Sc	Duclos, Cyril	U. Montréal
Robert, Maxime	M.Sc	Levin, Mindy F.	UQAM
Villeneuve, Myriam	M.Sc	Lamontagne, Anouk	U. Montréal

** Madame Lauzière a reçu le prix d'excellence (500$) pour la meilleure présentation affichée dans le thème V: Motor Control and Recovery from Injury, tous niveaux confondus (maîtrise, doctorat et post-doctorat).

Nom et prénom du présentateur ou de la présentatrice Aravind, Gayatri

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regroupement stratégique- 1,3

Statut : Doctoral Year 2

Responses of subjects with visuospatial neglect to dynamic obstacles while walking

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Background: Collisions with static objects on the neglected side and deviated walking trajectories hinder independent ambulation in persons with visuospatial neglect (VSN). Constantly changing spatial positions of dynamic objects may further challenge ambulation in these persons.

Methods: Twelve subjects with VSN were tested in a virtual environment consisting of a target and 3 obstacles, one of which randomly approached from head-on or 30° left/right. Subjects pressed a joystick button on perception of a moving obstacle (perceptuo-motor task) and walked towards the target while avoiding a collision with the obstacle (walking task). Detection times (perceptuo-motor task) and minimum distances (MD) from obstacles (walking task) were measured.

Results: Comparing responses to contralesional (C) versus ipsilesional (I) obstacles, one group of subjects (n=7) showed longer detection times (C: 3.2±1.2, I:2.5±0.9 s) and maintained smaller MDs (C:1.3±0.4, I:2.0±0.6 m) for contralesional obstacles. Contralesional collisions (4.8/subject) were more frequent than ipsilesional collisions (2/subject). The 2nd group (n=5) showed comparable detection times (C:1.5± 0.4, I:1.3 ±0.4 s), MDs (C:1.1±0.3, I:1.1±0.5 m) and collisions (C:2.5/subject, I:1.9/subject) for contralesional and ipsilesional obstacles. While group I preferentially deviated ipsilesionally (90%), group II veered to either sides (C: 40%, I: 60%). **Discussion:** We suggest that in group I, inattention of the neglected side leads to a delay in detection of the contralesional obstacle, which translates into small MDs and larger collision rates. The fewer collisions in group II coincide with earlier obstacle detections. Results indicate that perceptuo-locomotor abilities related to obstacle circumvention are affected by VSN, especially for obstacles approaching from the contralesional side.

#x

Altered obstacle avoidance behaviour in individuals with good arm recovery after stroke

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ABSTRACT

After stroke, individuals with good sensorimotor recovery of their affected arm report decreased use of the arm in activities of daily living. Decreased use of the affected arm may be associated with undetected motor deficits which may be identified when individuals attempt higher-order tasks that require complex interjoint and intersegment coordination. One higher-order motor task, the ability to avoid obstacles while reaching, commonly occurs in everyday environments but is not routinely assessed by clinical scales. We hypothesized that well-recovered people after stroke would be less successful in avoiding an obstacle in the reaching path compared to age-equivalent healthy controls. Obstacle avoidance ability during reaching in a virtual environment (VE) was compared between well-recovered stroke subjects and healthy controls. A VE simulating a grocery store aisle and a commercial refrigerator stocked with bottles on 2 shelves having double sliding doors was developed. Subjects reached as fast as possible with their affected/dominant arm for a bottle on one shelf (non-obstructed reaching – template). In random trials (RAND, 30% of 60 trials), the door ipsilateral to the reaching arm closed and partially obstructed the bottle at reach initiation. Subjects were instructed to touch and retrieve the bottle without the hand or arm hitting the door. Arm and trunk movements were recorded with 24 active markers by an Optotrak system. Outcome variables were overall success rates, movement performance (endpoint tangential velocity, ETV; endpoint trajectory length, ETL) and movement quality variables (arm joint and trunk angles) for template (T), successful (Succ), and failed (Fail) trials, and Succ/Fail divergence points of the endpoint trajectory from template profile (DP=% of reach distance). Even in T trials, stroke subjects used less wrist flexion, wrist abduction and shoulder rotation compared to controls. In RAND, 36% of controls and 12% of stroke subjects were successful more than 65% of the time ($z=2.248$; $p<0.05$). For both groups, successful door avoidance was characterized by DP occurring closer to the starting position (control: $DP_{Succ}=11.2\pm7.0\%$, $DP_{Fail}=34.1\pm37.3\%$, $p<0.05$; stroke: $DP_{Succ}=20.5\pm16.1\%$, $DP_{Fail}=60.4\pm33.7\%$, $p<0.05$). However, stroke subjects had a smaller margin of error to avoid the door, as shown by DP and ETL values. DP_{Succ} occurred further from the start position in stroke compared to controls ($p<0.05$). In order to successfully avoid the door, both groups had to increase their ETL. However, since the ETL of stroke subjects was already longer than controls, increasing ETL did not result in successful door avoidance.Stroke subjects had residual movement deficits and made more errors compared to controls that were revealed through a challenging motor task. The potential of using challenging UL tasks to identify deficits in higher order motor control should be considered when assessing motor recovery after stroke.

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Patterns of residual corticospinal influences in post-stroke spasticity

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ABSTRACT

Spasticity, weakness and abnormal co-activation in post-stroke patients result from limitations in the range of regulation of stretch reflex thresholds. We investigated whether the deficits in residual corticospinal influences contribute to the limitation in the regulation of reflex thresholds and as a result to spasticity in post-stroke subjects. Spasticity zones in the elbow range of motion were identified as the angular ranges in which flexor or extensor muscles became active during passive muscle stretches, despite the instruction to fully relax elbow muscles. A single-pulse transcranial magnetic stimulation (TMS) was applied to the site of the motor cortex projecting to motoneurons of elbow flexors and extensors. Responses to TMS (motor evoked potential or MEPs) were recorded at a flexion and an extension position of the elbow joint. To exclude the influence of background motoneuronal excitability on the evaluation of corticospinal influences, MEPs were elicited during the EMG silent period produced by brief muscle shortening prior to TMS. MEPs were recorded at the two elbow positions established passively, by the experimenter, or actively, by the subject. In control subjects, MEPs at different positions established passively were substantially smaller than those obtained at the same positions established actively. In these subjects, the corticospinal facilitation of flexor motoneurons was usually larger whereas that of extensor motoneurons was smaller at the actively maintained flexion than at extension position (reciprocal pattern of position-related changes in flexor and extensor MEPs). In most post-stroke subjects with high clinical spasticity scores, the corticospinal facilitation of both flexor and extensor motoneurons was greater at the actively established flexion than extension position (co-facilitation pattern). In subjects with lower spasticity scores, the pattern of position-related modulation of corticospinal influences on extensor but not flexor motoneurons resembled that in control subjects. Results show that spasticity is associated with substantial changes in the corticospinal influences on flexor and extensor motoneurons. Corticospinal co-facilitation of the two

groups of motoneurons may be related to the necessity to overcome resistance of spastic muscles during active changes in the elbow joint angle.

Proc. 10th International Conference on Virtual Rehabilitation (ICVR 2013)

Philadelphia, PA, USA, 26–29 Aug. 2013

 ISBN 978-1-77136-119-4

Title : Post-adaptation kinetic changes following walking on a split-belt treadmill with asymmetrical belt speeds in healthy individuals

Authors: Séléna Lauzière, pht, M.Sc., Carole Miéville, M.Sc., Rachid Aissaoui, Eng., Ph.D., and Sylvie Nadeau, pht, Ph.D.

Introduction: Recent studies have shown a reorganization of the locomotor pattern after walking on a split-belt treadmill. The leg on the faster belt presented a longer step length compared to the other leg when both belts returned to the same speed, therefore resulting in asymmetrical step length in healthy controls and reduced step length asymmetry in post-stroke individuals. However, no study has ever reported the biomechanical causes of these changes. The aim of this study was therefore to characterize the kinetic aftereffects of the lower limbs following a perturbation on the dominant side imposed by a split-belt treadmill in healthy individuals.

Methods: Twelve healthy individuals (≥65 years) participated in the study. Participants walked under 3 conditions: 1) with the speed set 30% slower than their comfortable speed (baseline); 2) with the speed of the right belt set at twice the speed of the left belt for 6 minutes (adaptation); and 3) with both belts set at baseline speed (post-adaptation). Kinematic data were obtained using the Optotrak system and ground reaction forces were collected via the instrumented split-belt treadmill (Bertec FIT). An inverse dynamics approach was used in conjunction with biomechanical analysis to quantify the net moments of the lower limb joints. Baseline and post-adaptation data from 5 gait cycles were compared with the Wilcoxon test for paired samples.

Results: The preliminary results (n=8) revealed that the joint moments for both lower limbs differed between baseline and post-adaptation performance. For the right limb, the plantarflexor moment was reduced by 20% between 25% and 60% of the gait cycle ($p = 0.012$). The knee moment was also significantly modified towards extensor moment compared to baseline, while a slight increase of the extensor moment at the beginning of the stance phase was observed at the hip ($p = 0.017$). For the left limb, a slight increase of the plantarflexor moment was observed during the stance phase ($p = 0.035$), while the knee extensor moment only increased during early stance ($p = 0.025$).

Conclusion: These results showed that motor adaptation occurs in both limbs due to the bilateral kinetic changes observed post-adaptation, which could explain the step length asymmetry previously observed in the post-adaptation period among healthy individuals. The reduction of the right plantarflexor moment and the increase of the left plantarflexor moment could explain this asymmetrical step length since one of the most important factors in generating step length is the forward propulsion of the contralateral limb during stance by the plantarflexors. The increased plantarflexor moment on the left side is interesting as it is often reduced in hemiparetic gait. Future studies in stroke individuals will help determine whether this kind of perturbation can be used to train the plantarflexors and better understand the biomechanical changes associated with step length asymmetry.

We thank CIHR, MENTOR, OPPQ, REPAR and SMRRT for financial support.

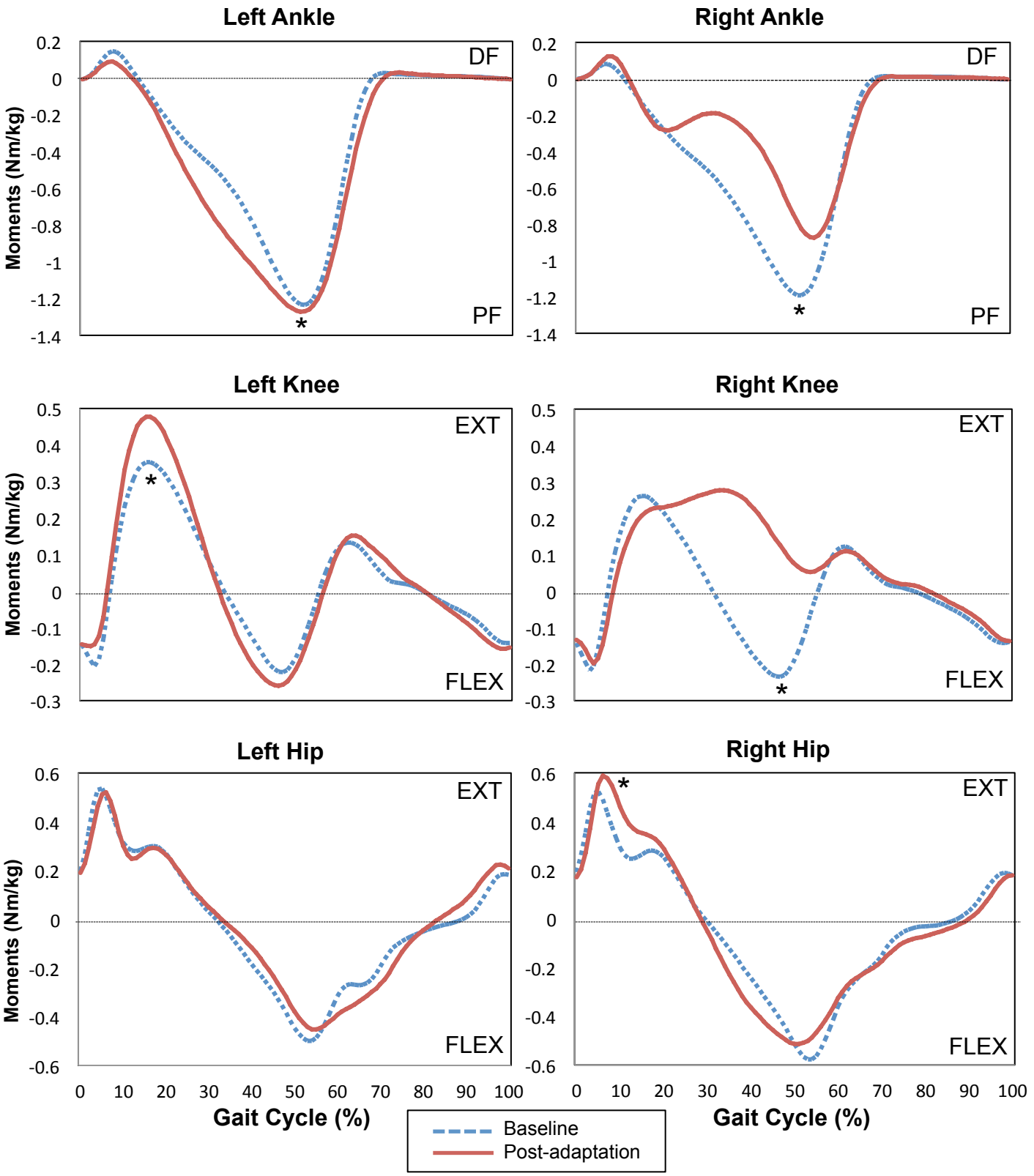

Figure 1. Average (five cycles) joint moment profiles (normalized to body mass) for the ankle, knee, and hip on the right and left side. (*) = significant difference between peak values at baseline and post-adaptation. DF = dorsiflexor moment; PF = plantarflexor moment; EXT = extensor moment; FLEX = flexor moment.

#101

Role of proprioceptive information on stability during gait with healthy and hemiparetic people

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ABSTRACT

Proprioceptive stimulations through muscle vibration have been shown to alter EMG activity, joint movements, direction and speed during walking, to different extents depending on the stimulated muscle group. Despite its known role in balance control during standing, no study has assessed the role of proprioception in balance control during gait. The aim of this study was to evaluate how neck and ankle proprioceptive information affects balance during gait in persons with intact and reduced sensorimotor capacities.

Fifteen participants were included in two groups: Healthy group (n=11, 43.8 (16.3) years old, Body mass index = 24.0 (4.6), Natural gait speed= 1.54 (0.17) m/s); and Hemiparetic group (n=4, 52.8 (12.4) years old, BMI= 24.3 (3.8), Natural speed= 1.09 (0.31) m/s, Chedoke McMaster Stroke Assessment median score leg = 5 and foot= 4). Continuous or phasic vibrations were applied to the non-dominant or paretic triceps surae and on posterior neck muscles during one minute walking trials at comfortable speed on an instrumented Bertec treadmill. Whole-body three dimensions kinematics was also quantified with a motion analysis system (NDI Certus). The contour of the base of support was digitalized. Postural and dynamic stability was quantified using the theoretical destabilizing and stabilizing forces, that are necessary to bring to or stop the center of mass at the limit of the base of support, respectively. These two forces are computed from kinematics and centre of pressure position within the limit of the base of support. A repeated measure ANOVA was used to compare the experimental conditions in healthy participants, and *a priori* contrasts were applied when possible to test whether any vibration condition differed from the condition without vibration. The effect of vibration was analyzed individually in stroke participants.

The results were significant ($F_{(3.2)}$=3.2 and p <.05) regarding destabilizing forces when vibrations were applied to triceps. However, there were no significant results with neck vibrations in any condition. Regarding the stabilizing force, no significant results were found either whatever the conditions of stimulation. In the stroke group, participants only demonstrated response to the vibration of the triceps during swing phase.

During a dynamic task like gait, only distal proprioceptive inputs were taken into account in our experimental conditions. Postural stability, evaluated by the destabilizing force, was increased with triceps surae vibration during gait, but was not affected by neck muscle vibration. These results are coherent with backward-leaning responses to triceps vibration in the standing position. Hemiparesis might reduce the integration of proprioceptive information during gait.

Proc. 10th International Conference on Virtual Rehabilitation (ICVR 2013)

Philadelphia, PA, USA, 26–29 Aug. 2013

 ISBN 978-1-77136-119-4

[188]

The effectiveness of a reach-to-grasp task for motor learning in children with cerebral palsy.

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Children with cerebral palsy (CP) have limited movements in upper limbs due to their limited range of motion, tone and sensation impairments, leading to functional problems. Learning new motors skills in adults can be related to sensory feedback. It is recognized that sensory deficits occurs in children with cerebral palsy which can impact movement production. Our aim was to determine if improved upper limb kinematics in children with cerebral palsy (CP) during a reach-to-grasp task could be retained and transferred to a similar task. We also characterized the relationship between sensation and motor learning. We used a prospective, single-subject research design with 16 children (7 males; 6-11 years old; spastic hemiparesis; Manual Ability Classification System, MACS 2-4). Children were randomly allocated to one of two groups: task-oriented training with or without trunk restraint. Children were paired by age and MACS scores. Intervention consisted of three 1-hr sessions per week for 5 weeks (total 15 hours). Interventions were performed in physical and virtual environment (order randomized). Evaluations consisted of sensory modalities (tactile threshold, touch, proprioception, stereognosis) and upper limb kinematics during reach-to-grasp of an object located near and far from the body (5 assessments: three pre-intervention, immediately post-intervention and 3 months post-intervention). Seven to 12 trials per target (close and far target) were recorded. The evaluators and subjects were blinded to group assignment. The upper limbs kinematics were recorded (Optotrak 3020, 100Hz; Northern Digital Waterloo) using 10 infrared-emitting diodes positioned at the arm and at the trunk. The kinematics measures consisted of the performance (Endpoint velocity, trajectory smoothness) and/or quality of movement (Elbow extension, shoulder flexion). To determine whether changes occurred for each kinematics parameters, linear regression was used and effect sizes was computed. No differences were found between groups in the number of children who retained or transfer their improvements in any of the four kinematics variables. Therefore, children in both groups were combined. Motor improvements could be retained 3 months after the intervention and transferred to a similar task in children with CP. Proprioception and tactile thresholds were associated with retention of improvements in endpoint velocity

(F2,13=4.832, p=0.027). Practice of activities aimed at improving upper limb kinematics led to better learning and retention of movement patterns for both performance and quality of movement in children with CP. Our results underline the importance of sensation for motor learning in children with CP.

Proc. 10th International Conference on Virtual Rehabilitation (ICVR 2013)

Philadelphia, PA, USA, 26–29 Aug. 2013

 ISBN 978-1-77136-119-4

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Coordination of finger movements improves after piano training sessions in chronic stroke

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ABSTRACT

Little is known about the potential benefit of musical training on the ability of chronic stroke survivors to learn and reproduce coordinated finger movements. The purpose of this pilot study was to estimate the effects of a 3-week piano training program on piano performance measures, including speed of execution and note accuracy, in persons with chronic stroke. Four chronic stroke participants without musical experience participated in a 3-week piano training program that combined structured lessons (9 sessions of 60min) to home practice. Songs involving all 5 digits of the paretic hand were displayed by a MIDI program (Synthesia) and were played on an electronic keyboard. As the participant progressed, frequency (beat per minute [bpm]), complexity (finger sequences) and duration of songs increased. Within each song, the participants started at a tempo of 30bpm. When reaching a note accuracy and timing score of 80%, the tempo increased by steps of 10% up to 60bpm. Speed and accuracy were collected using Synthesia. Fine and gross manual dexterity was assessed pre and post-intervention using the Nine Hole Peg Test (NHPT) and Box and Block Test (BBT). Participants completed 3 to 4 songs during the training period, progressing through finger sequences of increasing complexity (consecutive fingers to intervals) and duration (from 17s to 38.5s). Each song was practiced on average 25 times before reaching a note accuracy >80% at a 60bpm. A mean reduction of 24.8s on the NHPT and mean increase of 6 blocks on the BBT was observed at post-intervention compared to pre-intervention scores. These preliminary results support the use of a piano training program to improve timing and accuracy of finger movements as well as manual dexterity of the paretic hand in chronic stroke survivors. The positive effects may be explained by the intensity and specificity of the intervention that also provided online multi-sensory feedback.