a similar fashion to control segment and whole-body motion.

ACKNOWLEDGEMENTS: Supported by NSERC.

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The influence of stride frequency and body-weight support on muscle coordination during weight-assisted treadmill locomotion

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INTRODUCTION: Partial body weight-supported treadmill training is a commonly used approach for the rehabilitation of patients with incomplete spinal cord injury. By providing repetitive rhythmic input to a patients legs, treadmill training provides the sensory feedback necessary to enhance neural output of a 'central pattern generator' for stepping movement. Treadmill training has also been shown to improve ambulatory capacity. Functional improvements have been associated with improved muscle activity patterns during gait.

METHODS: The purpose of this study was to identify the contribution of the level of body-weight support and stride frequency to the coordination patterns of the leg muscles. Eight healthy subjects were tested. They walked on a treadmill at a combination of weight-support (0, 20, 40, 60 and 100%), and stride frequencies (0.40, 0.49 and 0.57 Hz). Treadmill walking was performed with the assistance of the Lokomat robotic gait orthosis to constrain leg kinematics. Surface EMG was collected from the following nine muscles: tibialis anterior, medial and lateral gastrocnemius, soleus, vastus medialis and lateralis, rectus femoris, semitendinosus, and biceps femoris. Each condition was presented twice in randomized order, for a total of 30 trials (15 possible combinations of weight support and stride frequency). Data were recorded for 60 seconds for each condition. A foot-switch identified the time of foot-contact with the treadmill belt and was used to identify individual strides. The intensity of the EMG was calculated using wavelet analysis (that provides a measure of the power of the EMG signal) and formed into a 9 x 100 EMG grid for each stride (9 muscles x 100 time points within each stride). The principal components (PCs) were calculated for the EMG grids (a total of 5250 grids across all 8 subjects). The EMG grids describe the patterns of activity between the muscles, and their PCs identify the major features and differences in these patterns.

RESULTS: The results showed a general increase in the level of muscle activity with reductions in body-weight support coupled to greater quadriceps activity during stance. The stride frequency primarily influenced the pattern of coordination between the muscles: walking at the lower frequency resulted in greater activity in the ankle extensors and hamstrings during the stance phase.

CONCLUSIONS: The results indicate that both the selection of stride frequency as well as body weight support can influence the coordination patterns within the leg and may thus be an important determinant when selecting the appropriate training parameters during gait rehabilitation.

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The effect of visual perception on coordination of posture and arm movement during standing

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INTRODUCTION: Arm reaching during standing is limited by subjective perception of body stability. This perception is developed taking into account the visual perspective in which the environment is observed. This suggests that manipulation of visual perspective can alter subjective estimation of stability restraints and influence motor performance. To test this hypothesis we compared reaching for an object in a virtually generated environment that was presented using different visual perspectives with reaching while standing in a real-world environment.

METHODS: Eleven young healthy individuals performed forward and lateral reaches in the physical world and in the virtually generated environment. In the physical world, they were instructed to reach as far as possible with no specific target. In the virtual world, participants stood in front of a screen in which they saw a computer-generated model of their body in a courtyard surrounded by a semi-circular hedge topped with flowers (Fig.1). The image was presented randomly in one of five different perspectives ranging from looking from directly behind (0º), to looking down from almost straight overhead (90º). Participants were instructed to reach for the furthest flower without a loss of balance or taking a step. Movement kinematics were recorded and analyzed in terms of the end-point displacement, arm-postural coordination and displacement of the center of mass.

RESULTS: The results showed that participants reached a greater distance in the virtual world, particularly with visual perspectives of approximately 45 to 77.5º. Greater distance was achieved by increased involvement of the leg and trunk body segments, and decreased inter-segmental delay at the moment of movement initiation and termination.

CONCLUSIONS: Thus these visual perspectives can be recommended as optimal for designing virtual rehabilitation programs for balance and functional movement re-training, for virtual reality game development, in ergonomic design, and teleoperation training.

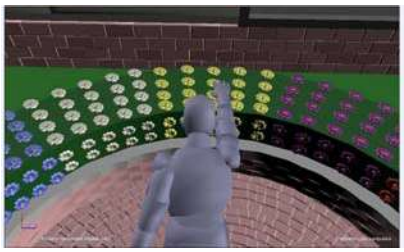

Fig. 1 Image of participant's avatar presented on the screen

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Ground reaction force coordination during split-belt treadmill walking

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INTRODUCTION: Few studies have investigated how the gait pattern of healthy adults is modified by walking on a split-belt treadmill at different asymmetry ratios (AR) (i.e. [fast belt speed - slow belt speed] / fast belt speed). In fact, most of them have studied the spatial-temporal gait modifications [1,2] using or not the ground reaction forces (GRF) [3] and only one investigated lower limb muscular activity modifications [4]. No studies have reported on the GRF modifications during split-belt walking despite its relevance when analysing postural control during gait using inverse dynamics methods. The purpose of this study was thus to analyse the variation of GRF at different AR and at different reference speeds (RS).

METHODS: Seventeen (N=17) healthy adults were asked to walk on a split-belt treadmill and completed 18 conditions. The ipsilateral leg (i.e. the dominant leg) corresponded to the fast belt working which was fixed at three RS (0.5m/s, 1m/s, and self-comfortable speed (SCS): 1.42 m/s). For each RS value, the speed of the slow belt which corresponds to the controlateral leg was varied at six RS coefficients: RS, RS*0.9, RS*0.8, RS*0.7, RS*0.6, and RS*0.5. The RS as well as the slow belt coefficient orders were randomized. The GRF data were collected using two Kistler force platforms. Five parameters were selected as dependant parameters. The medial, posterior and anterior GRF peaks, as well as the first and second vertical peaks. The ten most repeatable gait cycles were kept for statistical analysis.

RESULTS: For SCS condition, all the parameters decreased significantly ($p<0.001$) for the controlateral leg when AR increased except the first vertical peak. For the ipsilateral limb even if the speed belt was kept constant, all the parameters decreased significantly ($p<0.007$) except the anterior force peak. This behaviour was identical when the imposed speed RS =1 m/s were analysed with the exception of the low RS =0.5 m/s. The timing of the controlateral (fast leg) was affected by the asymmetric conditions. In fact, the timing of the anterior, the posterior, and the second vertical peaks occurred significantly earlier during the gait cycle than during the symmetric condition.

CONCLUSION: Walking in an asymmetric environment modifies the GRF pattern in the slow leg. In fact, the anterior posterior and vertical forces in the controlateral limb are the most affected by AR. In the other hand, the fast leg reacts by generating anterior, posterior, and second vertical peaks earlier in gait cycle and reducing slightly the force magnitude. In our point of view these are new results which could explain the fact that the fast leg reduces significantly the occurrence of the second vertical force peaks and lesser the percentage of stance duration, and the opposite for the slow leg. This could have an implication for the development of therapeutic programs for deficient leg such as in hemiplegia.

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Foot dynamics and posture change during walking on inclines

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