bilateral coordination with increasing onset delays between arms (median values: healthy: 6.4% (55 ms); Stroke: 9.4% (89 ms)). The delays were reversed and differed from baseline at the beginning of the post-adaptation period (post-effects). The large between-subject variability prevented the detection of a difference between groups although the delays were greater overall in post-stroke participants during the adaptation period.
Conclusion Preliminary findings suggest that the EA protocol could modify the timing between movements of the two arms during a bimanual task. Additional data is currently analysed to further understand the potential benefits of training patients with the bimanual exerciser on inter-limb coordination.
Keywords Upper limb; Inter-limb coordination; Stroke
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Upper limb rehabilitation with movement-sound coupling after brain lesions

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Introduction/Background Recent studies showed that auditory feedback, sound and music can improve upper limb motor-recovery after stroke or Traumatic Brain Injury. However, the specific influence of different sound features and musical parameters has never been explored in this context. This study designed and tested different patterns of movement-sound coupling (sonification) that could stimulate arm movement during rehabilitation.
Material and method Five sonification patterns were developed through a participative design process. These included two basic sound parameters, two musical extracts and environmental sounds. Upper limb movement was recorded using three Inertial Measurements Units placed on each upper limb. Movement analysis, sound-movement coupling and sound synthesis were performed using Max/MSP software (Ircam). The experimental protocol included three steps. (1) An interview to evaluate the sound universe of individuals (French Psychomusical Appraisal) and Evaluation of Amusia (Montreal Battery). (2) Sonification of two tasks: functional gestures and elbow extension, compared with the same tasks without sound. The two sides were examined, the less affected first. The IMU data were used to quantify the kinematics of arm movement. (3) A semi-directive interview to provide detail on the participant's subjective experience.
Results At this stage, data has been obtained for 9 patients (stroke and TBI) and 7 healthy subjects. The subjective responses were positive, most of patients judged the sonification as interesting and stimulating. Most participants had a preference for environmental sound coupling. The observation of kinematic data showed large inter-individual differences and variable effects of sonification on movement amplitude, smoothness and velocity that varied between sides.
Conclusion This study has established a novel sonification protocol which may be used to enhance and vary motor rehabilitation tasks. However, further analyses are needed, particularly on symmetry, before concluding on a quantitative effect of sonification. In addition, we need to examine the relationships between quantitative data and participants' subjective experience.
Keywords Rehabilitation; Gesture sound coupling; Stroke/TBI
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Adaptation of upper limb movement using exoskeleton-based training and transfer of cinematic patterns to unconstrained movement: A preliminary study

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Introduction/Background Robotic technologies offer the possibility for highly specific training of upper limb movements. How exactly the motor coordination imposed during an intervention carries over into unconstrained upper limb activity, however, remains poorly understood. This preliminary study sought to examine the after effects of robotic training on upper limb joint kinematics during reaching.
Material and method Using a four-degree of freedom upper limb exoskeleton, healthy adult subjects trained on a series of reaching tasks. Shoulder and elbow joint coordination was modified using a viscous corrective force field. Kinematic variables during the different reaching tasks without the robotic device were evaluated using a motion capture system prior to and following the intervention. Movement adaptation was evaluated with respect to subject performance on reaching toward experimental targets as well as untrained targets.
Results Shoulder abduction profiles and terminal elbow position appeared modified two hours following the training. These changes reflected the joint kinematics forced during the robotic intervention. Furthermore, distance metrics based upon principal components analysis indicated that exposure to the corrective force field had durable effects upon shared coordination between the shoulder and elbow. This shift in movement patterns was observed for both the experimental and untrained targets.
Conclusion These preliminary results suggest that certain features of upper limb movement, trained using corrective force fields in an exoskeleton, may be retained following the intervention and potentially generalised to prehensile movements in the peripersonal workspace.
Keywords Exoskeleton; Upper limb; Motor learning
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User-oriented novel electric upper limb prosthesis with flexible sensors for detecting skin deformation

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