as young as 6 years old are capable of modifying limb kinematics in response to visually perceived movement errors. This may open up new opportunities to correct abnormal, asymmetric walking patterns in children and adults with neurological damage (e.g., stroke, cerebral palsy).

P2-M-66 Adaptation of multi-joint balance coordination to whole body force fields

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Background and aim: The ankles and the hips play an important role in standing balance. Multi-joint coordination adapts with task, the magnitude and type of disturbance [1]. Arm studies show that postural responses are highly dependent on externally applied force fields [2]. Our aim is to study how multi-joint postural responses in standing depend on such force fields, using closed loop system identification techniques (CLSIT) where two disturbances are applied [3]. This offers knowledge about the plasticity of the neuromuscular controller; e.g. the adaptive capacity to maintain standing balance. We hypothesize that application of a stabilizing force field will lead to downscaling of postural responses. Methods: Ten healthy subjects maintained standing balance while whole-body force fields were applied in three conditions 1) no force field 2) stiffness at the hip and 3) stiffness at the shoulder. In addition, unpredictable continuous pushing and pulling forces (0.05-5Hz) were applied at hip and shoulder level (Figure 1). Leg and trunk segment angles were recorded and the ankle and hip torques were obtained from ground reaction forces and torques by inverse dynamics. With CLSIT, the Frequency Response Function (FRF) of the neuromuscular controller was estimated. The FRF describes for each frequency in the disturbance signal the magnitude and relative timing (gain and phase) of corrective joint torques evoked by motions of the leg and trunk segment. Results: Figure 2 shows that the ankle provides relatively more torque at low frequencies and the hip is dominant at higher frequencies. Hip torque compensates for both trunk and leg movement, whereas ankle torque only compensates for movement in the legs. The phases of all neuromuscular controller FRFs decreased with frequency, indicating a delayed response. Addition of force fields decreased FRF magnitude mainly at the low frequencies, where stiffness dominates. Stiffness at the hip or shoulder both reduce the corrective ankle torque to maintain standing balance. Hip torque is only slightly reduced by additional shoulder stiffness. Conclusion: By adding force fields (i.e. stiffness) in standing balance, subjects adapt by lowering their control action mainly in the ankle torque. The gain of the neuromuscular controller is reduced, as subjects are externally stabilized and balance maintenance becomes easier. Downscaling of postural responses indeed occurs. In future studies, our methods allow to study pathological changes in multi-joint coordination as well as its adaptive capacity. References: [1] Kim et al, J Biomech, 2012 [2] Franklin et al, Exp Brain Res, 2003 [3] Boonstra et al, JNER, 2013

P2-M-67 The Effects of Transcranial Transcutaneous Electrical Nerve Stimulation on Primary Motor Cortex Enhance Implicit Motor Learning Process and Cortical Excitability

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