Two types of exercise-induced neuroplasticity in congenital hemiparesis: a transcranial magnetic stimulation, functional MRI, and magnetoencephalography study.

Abstract:

Early unilateral brain lesions can lead to a persistence of ipsilateral corticospinal projections from the contralesional hemisphere, which can enable the contralesional hemisphere to exert motor control over the paretic hand. In contrast to the primary motor representation (M1), the primary somatosensory representation (S1) of the paretic hand always remains in the lesioned hemisphere. Here, we report on differences in exercise-induced neuroplasticity between individuals with such ipsilateral motor projections (ipsi) and individuals with early unilateral lesions but 'healthy' contralateral motor projections (contra). Sixteen children and young adults with congenital hemiparesis participated in the study (contralateral [Contra] group: n=7, four females, three males; age range 10-30y, median age 16y; ipsilateral [Ipsi] group: n=9, four females, five males; age range 11-31y, median age 12y; Manual Ability Classification System levels I to II in all individuals in both groups). The participants underwent a 12-day intervention of constraint-induced movement therapy (CIMT), consisting of individual training (2h/d) and group training (8h/d). Before and after CIMT, hand function was tested using the Wolf Motor Function Test (WMFT) and
diverging neuroplastic effects were observed by transcranial magnetic stimulation (TMS), functional magnetic resonance imaging (fMRI), and magnetoencephalography (MEG). Statistical analysis of TMS data was performed using the non-parametric Wilcoxon signed-rank test for pair-wise comparison; for fMRI standard statistical parametric and non-parametric mapping (SPM5, SnPM3) procedures (first level/second level) were carried out. Statistical analyses of MEG data involved analyses of variance (ANOVA) and t-tests. While MEG demonstrated a significant increase in S1 activation in both groups (p=0.012), TMS showed a decrease in M1 excitability in the Ipsi group (p=0.036), but an increase in M1 excitability in the Contra group (p=0.043). Similarly, fMRI showed a decrease in M1 activation in the Ipsi group, but an increase in activation in the M1-S1 region in the Contra group (for both groups p<0.001 [SnPM3 within the search volume]). Different patterns of sensorimotor (re)organization in individuals with early unilateral lesions show, on a cortical level, different patterns of exercise-induced neuroplasticity. The findings help to improve the understanding of the general principles of sensorimotor learning and will help to develop more specific therapies for different pathologies in congenital hemiparesis.

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