Die erhobenen Daten zeigen, dass behaviorale und stimulationsbasierte Interventionsparadigmen in der Lage sind, kortikale Reorganisationsprozesse zu induzieren und zu modulieren und somit gezielt sensomotorisches Verhalten verändern.

10. Summary

Brain plasticity is an intrinsic property of the human nervous system, covering all mechanisms of the brain to adapt itself in response to environmental changes, physiologic modifications, experiences, and new challenges like brain lesions. Given the fact that cortical reorganization takes place in response to changes in afferent input and efferent demand, behavioral and stimulation-based interventions have been shown to evoke reorganizations and associated behavioral improvements.

The present study assessed the impact of two intervention paradigms, which aim to induce neuroplasticity processes and cortical reorganization, thereby driving behavioral improvements in two different groups. In group 1, elderly individuals were exposed to a multisensory dance intervention for 1 hour / week over 6 months. It was hypothesized, that the aging process, which is characterized by a decline in the overall sensorimotor and cognitive performance, would benefit from modulating afferent input and efferent demand, thereby ameliorating age-related changes. In group 2, subacute stroke patients with sensorimotor impairments of the upper extremity were exposed to a stimulation-based intervention, i.e. repetitive electrical stimulation (rES) of the paretic hand for 45 minutes / day for 10 days, in addition to a daily standard rehabilitation program. In general, the rehabilitation outcome is characterized by a large interindividual variability, conceivably mediated by neurotrophins, such as brain-derived-neurotrophic factor (BDNF), which is known to control and modulate plasticity, synaptic efficacy and brain repair.

To unveil possible effects of the intervention both groups were divided into an intervention subgroup and a control subgroup, which received no intervention. In group 1 the multisensory dance intervention was investigated using a broad assessment covering cognition, fluid intelligence, attention, reaction times, motor, tactile, postural and proprioceptive as well as cardio-respiratory performance. In addition, cortical reorganization was assessed using electrophysiological measures. In face of the sensorimotor limitations in group 2 a broad assessment covering grip strength, tactile, motor, haptic and proprioceptive abilities was performed. Additionally, the presence of the
BDNF-val<sup>66</sup>met-polymorphism was determined to assess the possible impact on sensorimotor improvement following rehabilitation. Besides the broad assessment employed in the present study, two new tests were developed to allow the rapid assessment of standing balance (group 1) and proprioceptive performance (group 2).

While after a 6 months period retesting in group 1 revealed no change in the control group, individuals in the intervention group showed improved performance in all tasks, except fluid intelligence. Importantly, the cardio-respiratory performance remained unaltered in both groups, indicating that even low levels of physical activity, not able to drive changes in cardio-respiratory performance, can - in combination with multisensory training procedures - induce behavioral improvement. Moreover, reorganization of the somatosensory cortical hand representation was found after the intervention within the IG, consisting of a normalization of the age-related expansion, indicating that a multisensory dance intervention in elderly can drive neuroplasticity reorganizations.

In group 2 the intervention group revealed significant improvements after the intervention for tactile, motor, haptic and proprioceptive abilities as well as grip strength. The control group showed significant improvements for sensory and motor abilities. However, the improvements within the two subgroups differ in magnitude and range, showing significant advantages for the intervention group. Beyond additional rES-driven improvements in sensorimotor performance, the analysis of genetic determinants, i.e. the presence of the BDNF val<sup>66</sup>met polymorphism, revealed an interference with rehabilitation outcome mainly for motor abilities. In comparison to the CG the reduced rehabilitation effectiveness was less distinct, suggesting that rES stimulation to some extend can compensate polymorphism-induced impairments in sensory rehabilitation. However, further investigations are necessary to unveil underling mechanisms.

The results show that behavioral and stimulation-based intervention paradigms, utilizing neuroplasticity principles that modulate afferent input and efferent demand, can drive behavioral gain in healthy and diseased subpopulations.