Music-based fine motor rehabilitation in Parkinson's patients: feasibility, efficacy and neural correlates

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Objective: To assess the feasibility, preliminary efficacy and underlying mechanisms of a structured Neurologic Music Therapy (NMT) fine motor intervention in patients with Parkinson's disease (PD).

Background: Besides notable gross motor symptoms (e.g. bradykinesia, postural instability, etc…), fine motor impairments cause patients with PD difficulties everyday tasks such as writing, self-care, fine object manipulation, and therefore negatively impact their quality of life. NMT is an evidence-based clinical model consisting of standardized interventions using music for restorative training in neurorehabilitation. While NMT has provided benefit for gait in PD, possibly by mobilizing motor networks that have been spared during disease progression, its applicability within fine motor rehabilitation has not been explored yet. We hypothesized that NMT holds rehabilitative potential to improve fine motor abilities by increasing auditory-motor connectivity in the beta and gamma frequency bands.

Methods: We enrolled patients with PD to undergo a structured 5-week course of NMT emphasized on fine motor training (Buard et al., 2021). Study participants were evaluated in person to collect assessments prior to starting NMT, and after cessation of therapy. Outcome measures included: (i) Unified Parkinson's Disease Rating Scale (UPDRS) (ii) Grooved Pegboard Test (GPT) scores and (iii) Magnetoencephalography (MEG).

Results: Sixty participants with PD (11 withdrawals) were enrolled in the study. Our control group included twenty-one patients with PD. From all those who completed the study, adherence and compliance to the NMT intervention was 100%. NMT improved PD motor symptoms, with a 13.4% and 22.4% respective reduction (greater scores are associated with greater motor symptoms) in dominant and non-dominant hand motor scores. Fine motor dexterity was also improved: ANOVA followed by pairwise comparisons indicated a significant increase in dominant hand dexterity ($p=0.026$) but not in the non-dominant hand ($p>0.05$) compared to those in the waitlist group. Last, MEG results on a sub cohort indicated an increased beta evoked power in the motor cortex after NMT, an increased functional connectivity between the auditory and motor regions and a distinct neurophysiological profile for the high vs. non responders to the NMT intervention.

Conclusions: We suggest that using music-based fine motor rehabilitation for patients with PD is not only feasible but also holds great promise for enhancing fine motor skills by influencing cortical patterns. Furthermore, the varying responses among individuals and the neurophysiological differences among them present an opportunity to customize music therapies specifically for PD patients. However, due to the limited number of participants in our study, we believe it is essential to conduct further research in this area. Last, using MEG could deepen our understanding of the neuropathophysiology associated with these diseases and shed light on the mechanisms behind successful NMT interventions for upper extremity rehabilitation.