Brain Activation in Short-Term Musical Learning

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Background: Numerous studies suggest that musical training enhances various brain domains and influence brain plasticity, e.g., leading to increased gray matter volume in the temporal and frontal regions. However, the specific mechanisms by which musical training influences brain function remain underexplored. Learning to play a piece on the piano involves complex motor sequence learning - the process of mastering sequences of movements into well-executed behaviors. According to the skill acquisition model proposed by Fitts and Posner (1967), this learning process progresses through three stages: cognitive-verbal-motor (cognitive and conscious control), associative (fluency in executing sequences), and autonomous (automated performance). Each stage engages different brain regions and involves neurological processes. The aim of this study is to develop a comprehensive neurophysiological framework that explains these learning stages in the context of piano performance.

Methods: The experiment involves 40 piano students of the HMTM Hannover learning two sequences on a MIDI keyboard, while brain activity is recorded using a 64-channel EEG. Participants complete 20 trials of each sequence, with one sequence being guided by a metronome to provide a temporal goal, potentially facilitating the transition to an automated learning stage. Additionally, a comprehensive test-battery, including neuropsychological and psychomotor tests, will be administered to measure cognitive and motor functions.

Results: Preliminary data indicate that behavioral performance improves across the 20 trials, with participants reaching automated performance by the conclusion of the metronome-guided sequence. We expect to observe high activation in sensorimotor and prefrontal regions during the early trials, followed by a shift towards increased activation in motor and parietal cortical regions as performance becomes more automated.

Implications and Potentials: Identifying neurophysiolocial mechanisms underlying each stage of musical motor learning offers insights into the neuroplasticity induced by instrumental playing. It could help clarify conflicting results regarding the efficacy of musical interventions and inform optimized practice strategies.