Music aids gait rehabilitation in Parkinson’s disease

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Introduction

The presentation of temporally regular auditory stimuli as a cue to facilitate movement execution is a widespread tool in the gait rehabilitation of Parkinson's Disease (PD). This disorder is characterized by the malfunctioning of basal ganglia – cortical brain circuitry, leading to a failure to automatically maintain an appropriate amplitude and timing of sequential movements. Synchronizing steps with auditory cues improves patients’ gait kinematics. In spite of a great deal of clinical evidence on the benefits of auditory cueing (Lim et al. 2005), little is known about changes in sensorimotor synchronization (SMS) skills or brain plasticity underlying this form of training. Here we summarize some evidence in the literature in line with the idea that cueing effects are underpinned by tight coupling of perception and action. Our final aim is to better understand the benefits of extensive therapy via auditory cueing PD.

PD therapies

1. Pharmacologic:
   • Dopamine replacement (L-Dopa, MAO-B inhibitors)
   • Serotonin re-uptake inhibitors
   • Central cholinesterase inhibitors
   • α - adrenergic blockers

2. Surgical options:
   • Removal of the ventrolateral nucleus of the thalamus improves contralateral tremor. Also, ablation of the ventral and posterior globus pallidus interna reduces contralateral dyskinesia.
   • Chronic electrical stimulation within the basal ganglia structure. Electrical stimulation of the subthalamic nucleus substantially improves the Parkinsonian symptoms.

3. Physical and exercise therapies:
   Listening to regular auditory stimuli while walking facilitates movement execution. Widespread tool in the gait rehabilitation. The neural mechanisms underlying cueing are still unclear.

Neural mechanisms

Beat perception:
• Isochronous rhythms generate higher activation of the putamen than a complex metrum (within the basal ganglia, BG, the supplementary motor area – SMA - and pre-supplementary area - preSMA).

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Auditory-motor action coupling:
• Sensorimotor synchronization studies with MEG show that task execution is associated with activations of the cerebellum, thalamus, primary motor cortex (M1), posterior parietal cortex, premotor cortex, SMA contralateral to the moving hand and the auditory cortex.
• Neuroimaging studies pre/post therapy show increased activity in the cerebellar anterior lobule and dentate nucleus as well as in the temporoparietal junction.

Current project

Objective: Clinical work on the positive effects of auditory cueing on gait, SMS skills and the underlying changes in brain plasticity in PD following a cueing rehabilitation programme.

Hypothesis: Evaluation of auditory-motor coupling via auditory cueing positively affect gait kinematics, foster brain plasticity and general sensorimotor processing.

Methods: A group of idiopathic PD patients (planned n = 40) are being submitted to the following tasks before and after 1 month of therapy:
1. Auditory perception and tapping tasks to assess time perception and SMS abilities.
2. EEG to measure resting-state activity and deviance detection as a function of temporal predictability in an oddball task.
3. Source localization analyses to uncover changes in plasticity underlying this form of training.
4. Motion capture experiments to assess gait kinematics.

Status: First ongoing rehabilitation
• Aged controls all tested (n=20)
• PD patients tested (n=6)

Patients show pre-therapy impairments in SMS and gait

Main symptoms of PD:
• Tremor at rest
• Rigidity
• Freezing of gait (slowness in initiation and continuation)
• Bradykinesia (slow movements)
• Akinesia (poor balance)

PD is mainly idiopathic with no final cure. It affects 1% in people over 60 years old. Every year, 8-18 out of 100 000 people risk to develop the pathology.

Dopaminergic neurons depletion leads to striatal deficiency. Symptoms appear when 80% of striatal and 50% of the nigra compacta cells have neurodegenerated

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