V12: Understanding Neurologic Music Therapy through Diffusion Tensor Imaging as an intervention for Parkinson's disease

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INTRODUCTION

Music Cognition (MC)	Parkinson's disease (PD)
What we know	
Rhythmic (Lesiuk, Bugos & Murakami, 2018) or beat-based (Cochen de Cock et al. 2021) music therapy helps in developing compensating neuroplasticity in cerebellar thalamocortical network (CTC) for PD patients, which help them in better management of planning and sequencing movements and also in preventing overall cognitive decline in later stage of disease.	
What we do not know	
How different auditory features cognitively construct MC and what the associated neural correlates are in processing these auditory features.	Why musical therapeutic intervention works in PD, and specifically, the shared neural mechanisms between the processing auditory features and movement that help the PD patients develop neuroplasticity.

OBJECTIVES

To identify clinically relevant auditory features and understanding their shared mechanisms with movement planning as well as governing executive functions.

METHODOLOGY

Cognitive/Behavioural	Neurological
PROMS (Law & Zentner, 2012)	*Neuroimaging using functional MRI (fMRI)*
Profile of Music Perception Skills: Provides objective performance score based on discrimination ability between reference and target stimulus composed of eight different auditory features.	*Diffusion tensor imaging (DTI)*: helps to understand the integrity of the white matter tract.

Participant Details

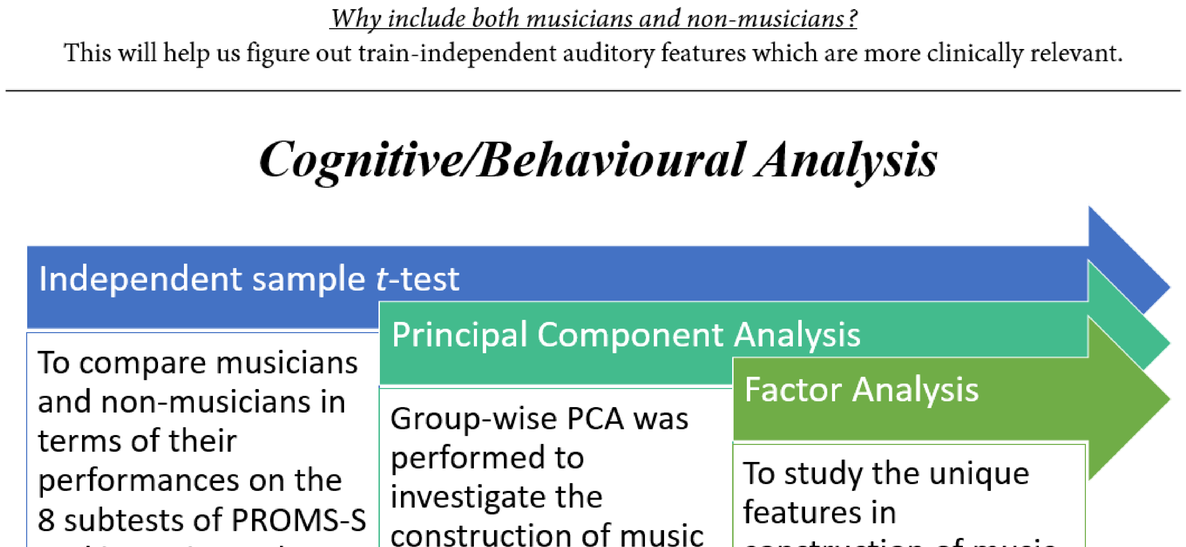
***Sample size*:** 80 (Musicians – 36, Non-musician – 44)
***Age range*:** 18-45 years

Why include both musicians and non-musicians?
This will help us figure out train-independent auditory features which are more clinically relevant.

Cognitive/Behavioural Analysis

- **Independent sample *t*-test** — To compare musicians and non-musicians in terms of their performances on the 8 subtests of PROMS-S and investigate the training effect
- **Principal Component Analysis** — Group-wise PCA was performed to investigate the construction of music perception through its features as a function of duration of training
- **Factor Analysis** — To study the unique features in construction of music perception for both musicians and non-musicians

Neuroimaging Analysis



RESULTS

Comparison between musicians and non-musicians

✓Through independent sample t-test, we found that musicians performed better on all subtests compared to non-musicians

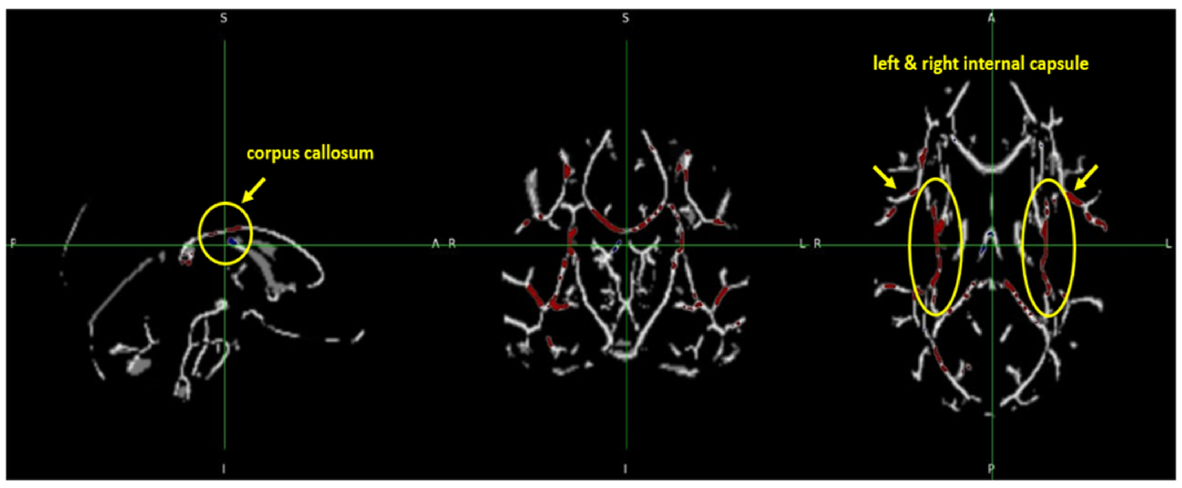
✓A strong training effect was observed on melody, tuning, timbre, and pitch. For the rest of the features, the training effect was moderate.

Effect Size			
Melody: 1	Rhythm: 0.40	Embedded Rhythm: 0.55	Tuning: 1
Tempo: 0.58	Accent: 0.44	Timbre: 0.72	Pitch: 0.80

Feature-based construction of Music Perception as a function of Duration of Training

1) Factor analysis reveals melody (0.725) and rhythm (0.722) to be a unique feature for musicians and tempo (0.476) and rhythm (0.496) for non-musicians in defining music perception.
2) This points to the cognitive understanding of why rhythmic and beat-based musical stimulation primarily works in various auditory intervention that is clinically implicated.

✓ Musicians show higher white matter integrity in corpus callosum and internal capsule compared to non-musicians in DTI.



Labelling template used: JHU-ICBM white matter tractography

1) In case of musicians, the fractional anisotropy in the genu of corpus callosum show higher correlation with their performance in auditory features like rhythm (0.43), melody (0.45) etc. while for non-musicians, fractional anisotropy in splenium shows higher association with tempo (0.60), rhythm (0.58) etc.
2) This points to the fact that musicians use genu for processing beat-based auditory features, while non-musicians use splenium for the same, thereby establishing a double dissociation for beat perception for genu and splenium across musicians and non-musicians.

DISCUSSION & CONCLUSION

✓Training effect on the performance of auditory features and higher white matter integrity in internal capsule of musicians prove that auditory or musical intervention is significantly effective in developing movement-oriented plasticity

✓Tempo and rhythm, i.e. beat-based auditory features are clinically significant and can be used for designing neurologically informed and more targeted auditory intervention

✓Since musicians use genu for beat perception, while non-musicians use splenium, a longer beat-based auditory intervention is required for developing plasticity in genu compared to splenium. A longer auditory intervention can help in movement control and planning and sequencing movements as well as learning sensory discrimination and memory by developing plasticity in genu, and a shorter intervention could help in developing plasticity in splenium, which is important for information transfer, language, calculation, IQ and behaviour.

✓Overall, beat-based auditory intervention can not only help in developing movement-oriented plasticity in compensatory networks in PD patients, but could slow down overall cognitive decline that comes at a later stage of the disease.

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