Modulation of neural activity in response to dance training in Parkinson's: A case study

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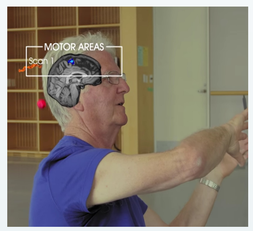
Introduction

Dance has been associated with short-term improvements in motor functioning as well as non-motor symptoms in people with Parkinson's (PwP).

Little is known about the effects of long-term dance training in PwP, although a recent 3-year longitudinal study found evidence that regular dance participation may delay progression of motor symptoms (Bearss & DeSouza, 2021).

Additionally, the specific neural mechanisms underlying improvements through dance are not understood.



Scan to see "Synapse Dance" film

Learned dance choreography

AIM OF THE STUDY:

- **To investigate long-term modulation of cortical activity in a case study of a PwP taking part in weekly dance training.**

Key References

Bar, R. J., & DeSouza, J. F. X. (2016). Tracking plasticity: Effects of long-term rehearsal in expert dancers encoding music to Movement. PLOS ONE. https://doi.org/10.1371/journal.pone.0147731.

Bearss, K. A., & DeSouza, J. F. X. (2021). Parkinson's disease motor symptom progression slowed with multisensory dance learning over 3-years: A preliminary longitudinal investigation. Brain Sciences. https://doi.org/10.3390/brainsci11070895.

Methodology

The participant was a **69-year-old male with mild idiopathic PD** (disease duration 4 years) learning dance over 29 weeks.

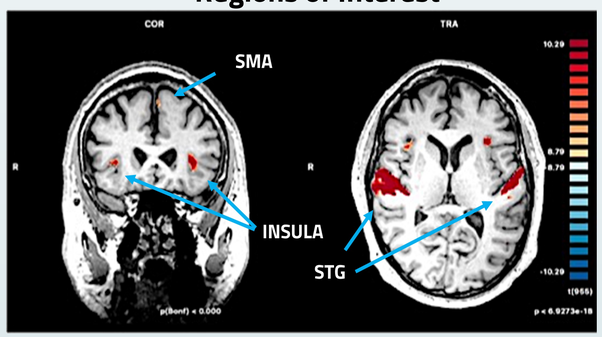
Weekly dance classes (75 minutes in duration) were taught by a certified Dance for PD® instructor at Canada's National Ballet School (NBS) in Toronto, Canada.

Functional Magnetic Resonance Imaging (fMRI) was performed at four timepoints and the data were analyzed to identify modulation of cortical activity in significantly activated brain regions.

While in the scanner, **the participant imagined the dance** learned during training (including both visual and kinesthetic elements), while listening to the music from the dance classes.

- **Blood-oxygen-level-dependent (BOLD) signal activation for blocks of dance-imagery vs. rest were compared.**
- **Regions of interest (ROI) were identified from the activation map.**
- **Modulation of BOLD signal in these regions was then analyzed across the four timepoints.**

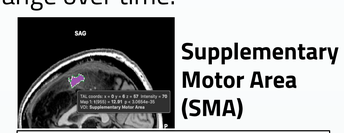
Regions of Interest



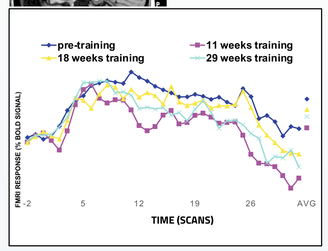
A multi-study GLM was performed by collapsing scans from all four timepoints. The activation map was thresholded with $p < .0001$ (Bonferroni-corrected) and a cluster threshold of 22. Regions of interest were selected from the resulting activation map. SMA = supplementary motor area; STG = superior temporal gyrus.

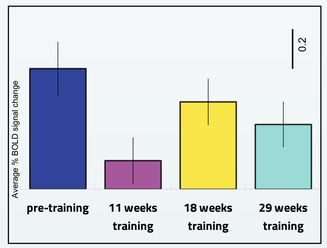
Results

After beginning dance training, the SMA and bilateral STG showed an increase followed by a decrease in activation. The right insula showed a steady decrease, while the left insula showed no significant change over time.

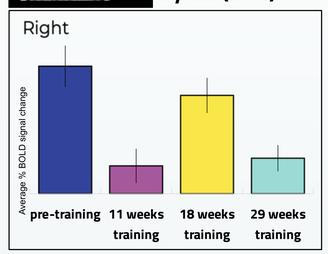


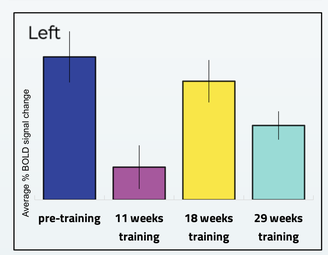
Supplementary Motor Area (SMA)

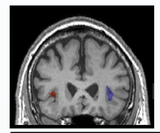




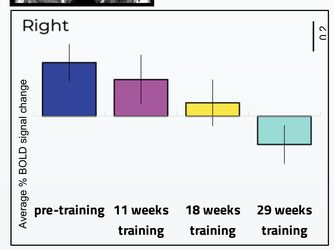
Superior Temporal Gyrus (STG)

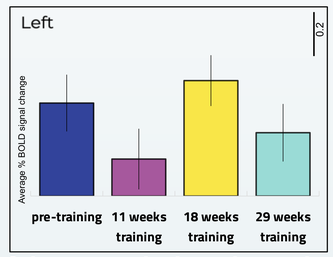






Insula





- **Scan images show BOLD signal activation of each region of interest during dance-imagery averaged across the 4 timepoints.**
- **Bar graphs show average percent BOLD signal change of each region between the 4 timepoints.**
- **Error bars represent SEM; scale bar represents 0.2 percent BOLD signal change.**

Conclusion

The present findings suggest that long-term dance participation can promote functional changes across several cortical regions in PwP, including the SMA, STG, and insula.

- **The SMA, thought to be involved in processes of motor planning, preparation and imagery, was significantly activated during all four timepoints. In previous work applying the same paradigm in expert dancers, activations were found in SMA and primary motor cortex (M1), indicating the role of motor processes during imagined dance (Bar & DeSouza 2016).**
- **The bilateral STG, which has a key role in auditory processing, showed a similar pattern of activity to the SMA across the four timepoints.**
- **The right insula showed a significant overall change across time. This region is associated with functions including emotion processing, rhythm, and multisensory integrations.**

In conclusion, dance may have neuroplastic effects for PwP, through activation of multiple brain networks associated with movement planning, imagery, auditory and emotional processing.