

Introduction

- Musical training has a profound effect on the development of the brain and enhancement of language and reading skills¹⁻³.
- Music experience/training engages various neural circuits and employs several cognitive capabilities, amongst them are executive functions⁴.
- While music training has been related to improvement in cognitive and language abilities both underlie reading, the relationship between music training, reading and executive functions is still scarce.

Aim

To examine the involvement of executive functions networks in children with and without music experience in relation to their reading abilities using resting state functional connectivity analyses.

Methods

Participants

- Children with (N=30, mean age: 9.9 ± 1.24 years) and without (N=25, mean age: 9.72 ± 1.56 years) music experience.
- Music experience range: 48-864 hours total.

Behavioral measures

General abilities

- Nonverbal intelligence (TONI)
- General verbal ability (PPVT)

Reading Measures

- Reading accuracy (TOWRE)
- Automatic Decoding Reading Efficiency (TOWRE)
- Orthography (Woodcock Johnson)
- Decoding (Woodcock Johnson)
- Phonemic awareness (CTOPP)
- Reading comprehension (Woodcock Johnson)

Executive functions (EF) Measures

- Sustained attention (CPT3)
- Speed of processing (WISC)
- Switching abilities (D-KEFS)
- Inhibition abilities (D-KEFS)

Methods, continued:

Neuroimaging measures

All participants were scanned during a 10-min resting state condition using a 3T Philips Achieva MRI scanner. A gradient echo planar sequence was used for T2*-weighted BOLD fMRI scans with the following parameters: TR/TE = 700/30 ms; BW = 125 kHz; FOV = 200 x 144 mm; matrix = 68 x 67; slice thickness = 3 mm.

- Data preprocessing and post-processing was conducted using the CONN toolbox⁵.
- Functional connectivity within executive functions networks was compared between the groups and in relations to their reading ability.
- Analysis included region of interest (ROI_ROI) and graph theory focusing on two main measures: average path length (APL) and clustering coefficient (CC)⁶.
- Networks: eight networks selected based on their involvement in reading^{7,8} (Figure 1):
- Default Mode Network (DMN), Visual, Auditory, Salience, Dorsal Attention Network (DAN), Ventral Attention Network (VAN), Fronto-parietal Network (FPN) and Cingulo-opercular (CO) Network.

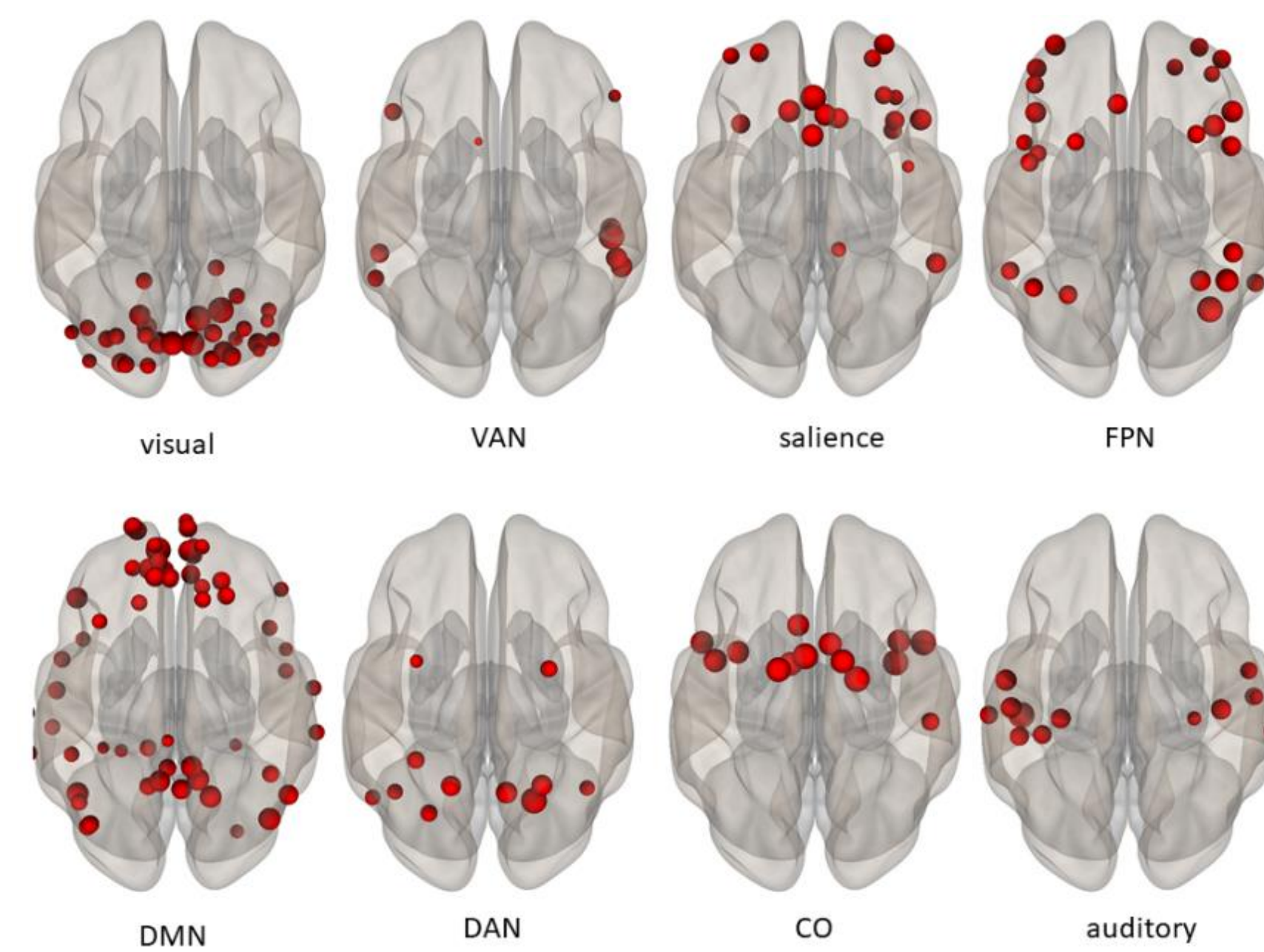


Fig. 1: networks included in the analysis

Results

Behavioral results:

- No significant difference between the groups in verbal and non-verbal abilities.
- Lower reading and EF abilities in children without music experience compared to children with music experience (Figure 2)

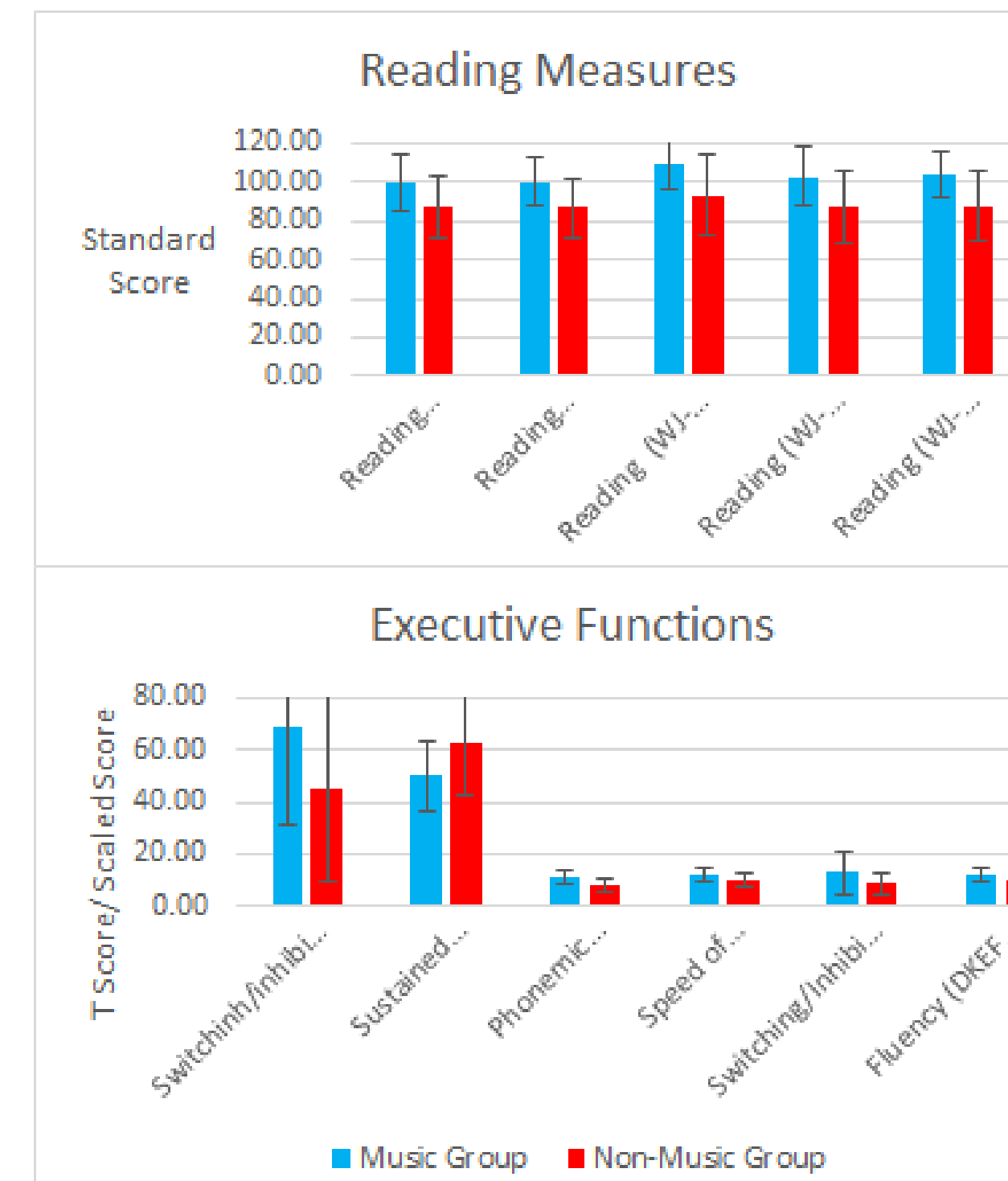


Figure 2. Mean reading and EF scores of children with and without music experience. Children in both groups were tested for reading ability, inhibition, switching and shifting, and attention. ** P<0.01, * P<0.05.

Graph theory results

- Children with music experience and better reading ability demonstrated increased average path length (APL) (Figure 3-left) and decreased clustering coefficient (CC) (Figure 3-right) of the fronto-parietal network (FPN).



Figure 3: increased APL and decreased CC of the FPN in children with music experience and better reading ability p< 0.05 FDR corrected

ROI-ROI results

- Decreased functional connectivity between seeds of the FPN (Figure 4) and the CO (Figure 5) and seeds of the visual, salience and auditory networks

Results, continued:

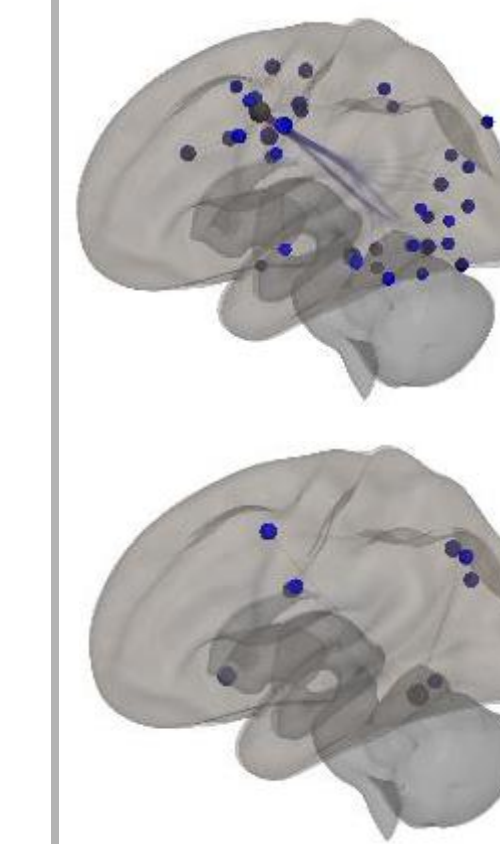


Figure 4. decreased functional connectivity between left cingulate gyrus (CO) and seeds in the visual, auditory, DMN and FPN (P<0.05- FDR corrected).

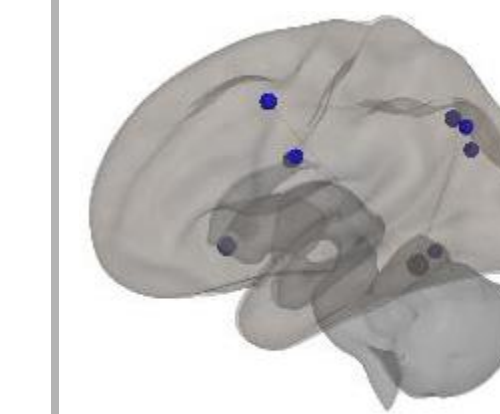


Figure 5. decreased functional connectivity between the right middle temporal gyrus (FP) and seeds in the salience, DMN and VAN (P<0.05- FDR corrected).

Discussion

Children without music experience utilize neural circuits supporting executive functions more than children with music experience.

The importance lies in providing a neurobiological account for the relative challenges in reading and executive functions in these children.

Music training could potentially be associated with modulation of cognitive control networks, which might be related to better reading.

References

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