Structural Correlates of Sensorimotor Integration: Evidence from Musicians

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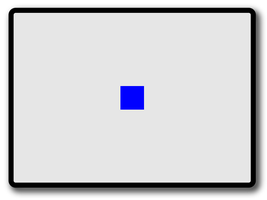
Background & Rationale

- Highly skilled musicians have the ability to keep precise time and synchronise their performance with other musicians.
- While there is evidence that the sensorimotor integration skills necessary for synchronised playing can be improved with practice[1-4], the age of onset of musical training may also be important.
- Previous work has shown that early trained musicians (ET; before age 7) outperform late trained musicians (LT; after age 7) on auditory-motor synchronisation[5], and structural work indicates that the CC may be linked to these enhanced abilities[6].
- The current study compares visuomotor synchronisation performance of ET and LT musicians, assesses the white-matter differences between them, and examines possible white-matter correlates of skilled synchronisation performance.

- **Musicians:** 18 **ET**; 19 **LT**
  - Equated for - Years of Formal Training
    - Years of Experience
  - Differ by - Age (22.7 : 27.4)
    - Age of onset (5.7 : 10.8)
- **Controls:** 12 **NM**
  - Age: (27.1)
  - < 3 yrs musical training/experience

Procedure

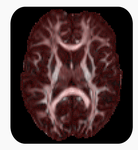
Training sequences
↓
Trials to criterion (**LRN**)
↓
Control (**SMP**)
Learning (**LRN**)
↓
3 blocks of 16 trials each for 2 days
↓



Synchronisation (PSYN)

$$100 - \left[\frac{\text{abs(stimON - keyON)} + \text{abs(stimOFF - keyOFF)}}{\text{stimulus duration}}\right]$$

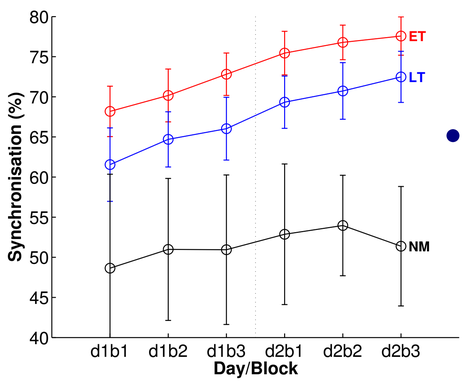
Siemens Trio 3T whole body MRI scanner
32 channel head coil



DTI: 99 directions
2x2x2mm^3; b=1000
FSL FDT (2 fibre model)

MTR: 1x1x3mm^3

Behavioural Findings

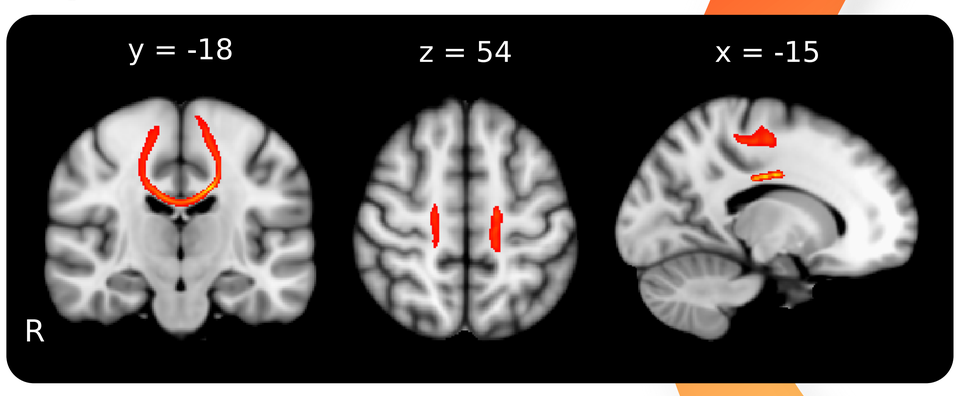


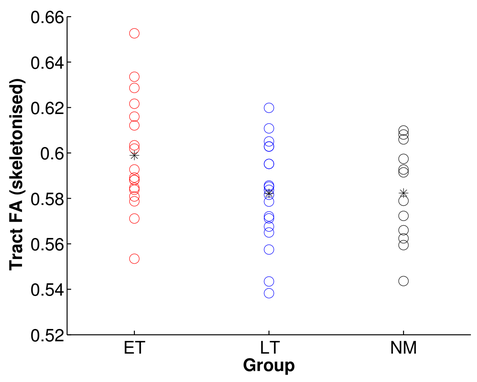
- Synchronisation Measures (**LRN**)
  - Final PSYN (final block avg.)
  - PSYN Slope (best fit linear regression)

- ET performed better than LT musicians on all blocks of training while ET & LT showed equivalent rates of improvement
- NM performed significantly worse and did not improve across training (error bars: 95% CI)

Fibre Tractography

This region of the CC connects bilateral S1/M1/PMC

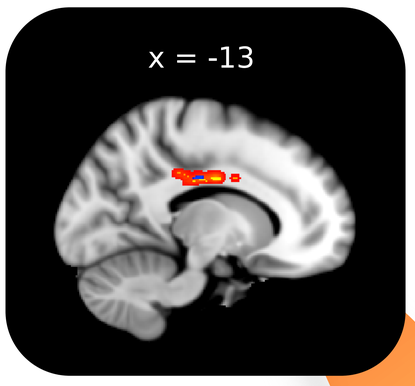


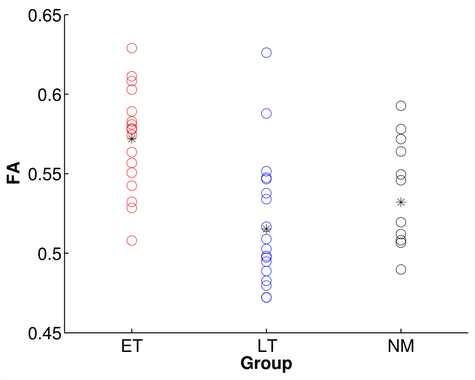


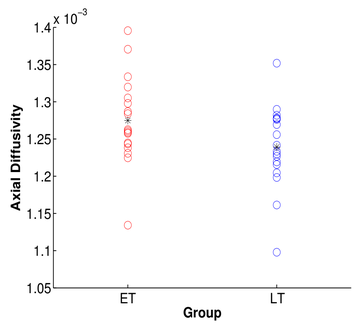
- FA extractions from the tract region show the same pattern of results as the seed region (ET>(LT=NM), p<.05)
- No differences in tract-based MTR extractions

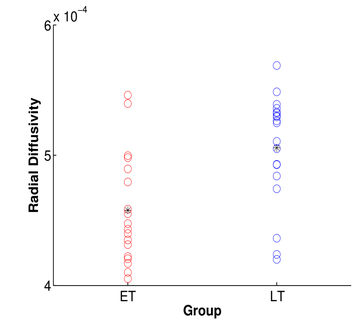
Group Differences (ET > LT)

FA in sensorimotor region of CC greater in ET than LT







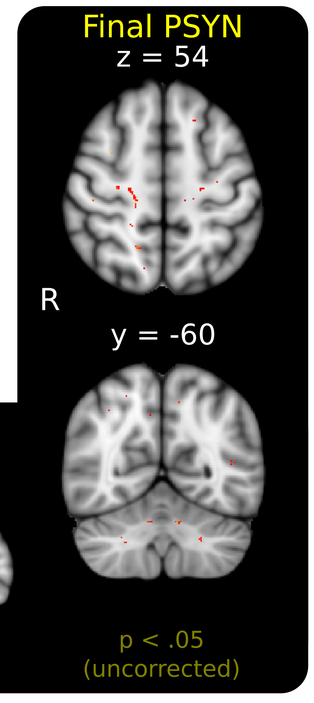


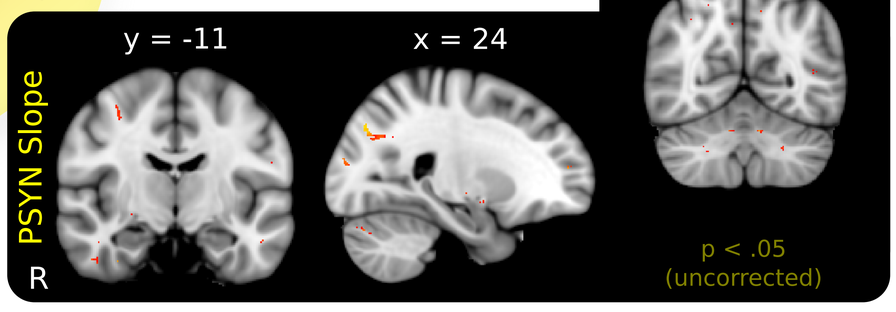
- Sensorimotor region of L CC showed greater FA in ET vs LT (red); driven by significantly higher axial and lower radial diffusivity
- NM controls equivalent to LT and show sigificantly lower FA values than ET
- Subset of this region showed greater correlation with Final PSYN in ET vs LT (blue)
- MD also significantly lower in LT vs ET in this region (not shown)
- No significant between-group differences in MTR, though at p<.05, uncorrected, ET>LT in L IPS and MTG

Brain-Behaviour Correlations

No significant positive or negative correlations with FA/MTR

- Final PSYN related to FA underlying R S1/M1/PMC and cerebellar motor regions L V/VI/VIIIA (p<.05, uncorrected)
- PSYN Slope related to FA underlying R PMC, PLs, and bilateral Crus I/II of the cerebellum (p<.05, uncorrected)
- No significant correlations between performance and MTR





Summary

- Replicates previous behavioral findings for ET and LT musicians[4]
- Extends the observation that CC is larger in those commencing musical training prior to age 7[6]
- Greater fibre integrity in the sensorimotor region of the CC and the delineated tract indicates a possible advantage in interhemispheric communication conveyed by early musical training
- Our results are consistent with the hypothesis for a sensitive period in musical training that, in this case, conveys a specific advantage for visuomotor integration
- Future analyses will look for structural differences between musicians and controls and more fully assess differences in MTR

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5) Bailey & Penhune, Rhythm synchronization performance and auditory working memory in early- and late-trained musicians. Exp Brain Res (2010).
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