Evaluating predispositions for music training: White matter in infancy relates to music aptitude abilities in preschool

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INTRODUCTION

The study of musical training as a framework for structural plasticity has evolved dramatically over the past decade[1].

Characteristic structural alterations between musicians and non-musicians have been shown, with emerging longitudinal evidence depicting training-induced white matter plasticity in:

- Corpus callosum (CC)[2]
- Arcuate fasciculus (AF)[3]

Yet, neural predispositions for training have been proposed: white matter organization prior to training onset among adults has been linked with faster auditory-motor learning[4], specifically in:

- Bilateral corticospinal tract (CST)
- Right superior longitudinal fasciculus (SLF)

This raises an intriguing question of whether training effects may be influenced by variability in brain structure in early childhood.

PRESENT STUDY

The present study investigates how white matter in infancy relates to emerging music aptitude abilities. We hypothesize that putative neural predispositions for training will be evident from as early as infancy.

This study draws from a prospective longitudinal investigation that employed Diffusion Tensor Imaging (DTI) with infants utilizing a natural sleep technique[5].

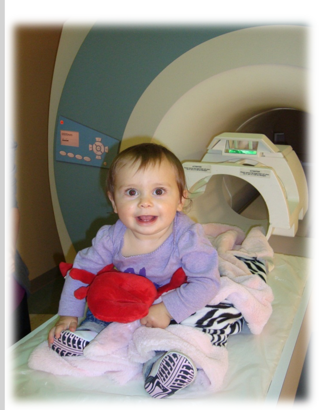
METHODS

Infancy *(4-24 mo.)* → Preschool *(4.5-6 yrs.)* → Kindergarten *(6-7 yrs.)*

Infants (to date):
145 infants
(2010 – Present)

Infant Measures:
- Structural MRI
- DTI tracts of interest:
  - CC
  - CST
  - AF*
  - SLF*

**Only n = 16 reconstructed, no effects observed*



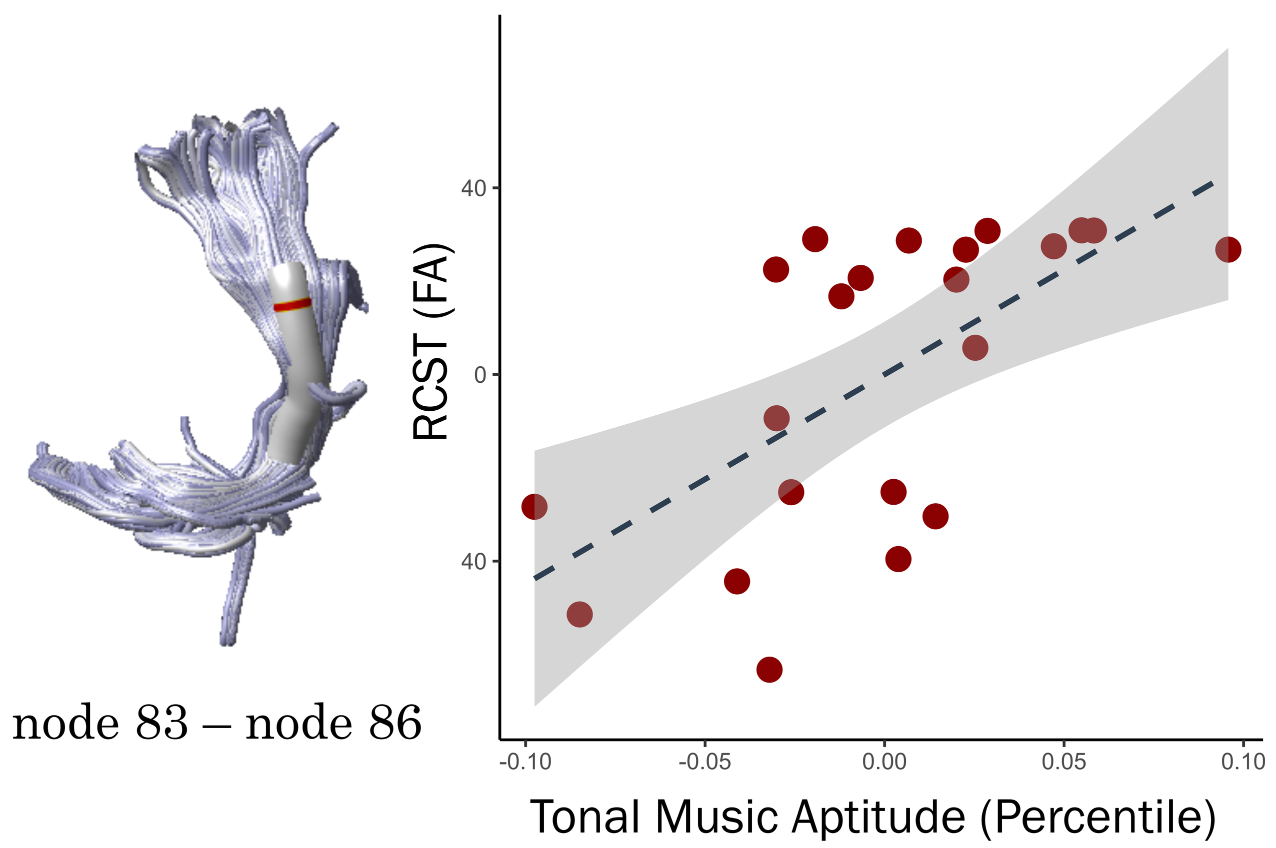
Follow-ups w/ key measures (to date):
25 children (17 preschoolers, 8 kindergarteners)
(2016 – Present)

Follow-up Measures of Interest:
- Gordon Primary Measures of Music Audiation
  - Tonal
  - Rhythm
- Phonological Awareness (standardized, WJ-OL)

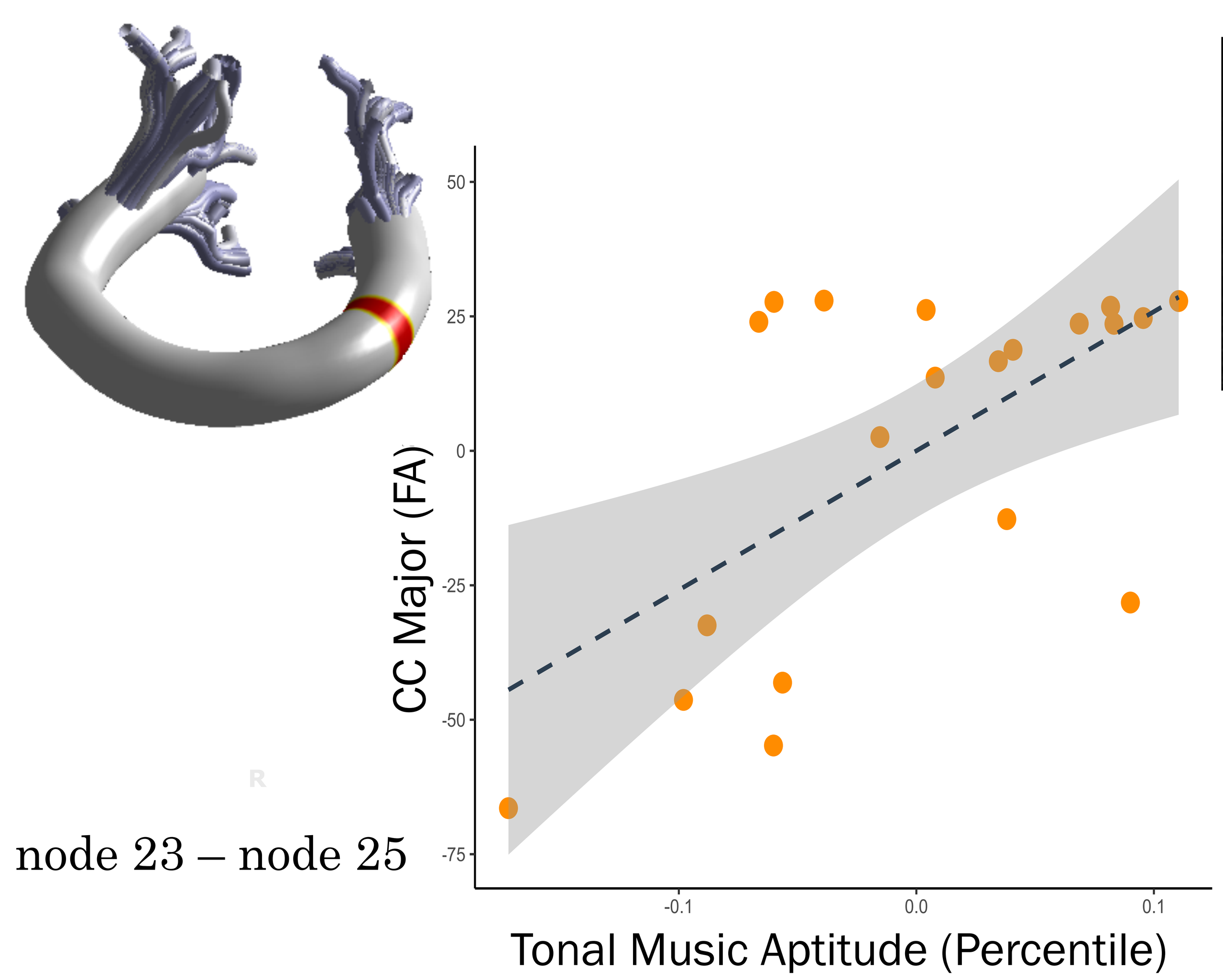
DTI Acquisition & Analysis:
- Siemens 3T MAGNETOM Trio
- Images reviewed for quality assurance
- Fractional Anisotropy (FA) estimated utilizing Automated Fiber Quantification (AFQ)[6]
- Significance determined by:
  - FWE correction for multiple comparisons
  - Parametric bootstrapping

RESULTS

Examining the relationship between white matter in infancy and subsequent tonal music aptitude abilities



The right corticospinal tract in infancy (as indicated by FA) is prospectively associated with subsequent tonal music aptitude abilities, accounting for age
(Sig. nodes displayed in red, $p < 0.0026$, FWE-Corrected)



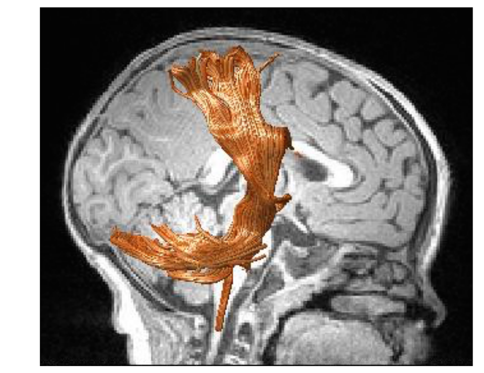
The CC Major (as indicated by FA) in infancy is prospectively associated with subsequent tonal music aptitude abilities, accounting for age
(Sig. nodes displayed in orange, $p < 0.0026$, FWE-Corrected)

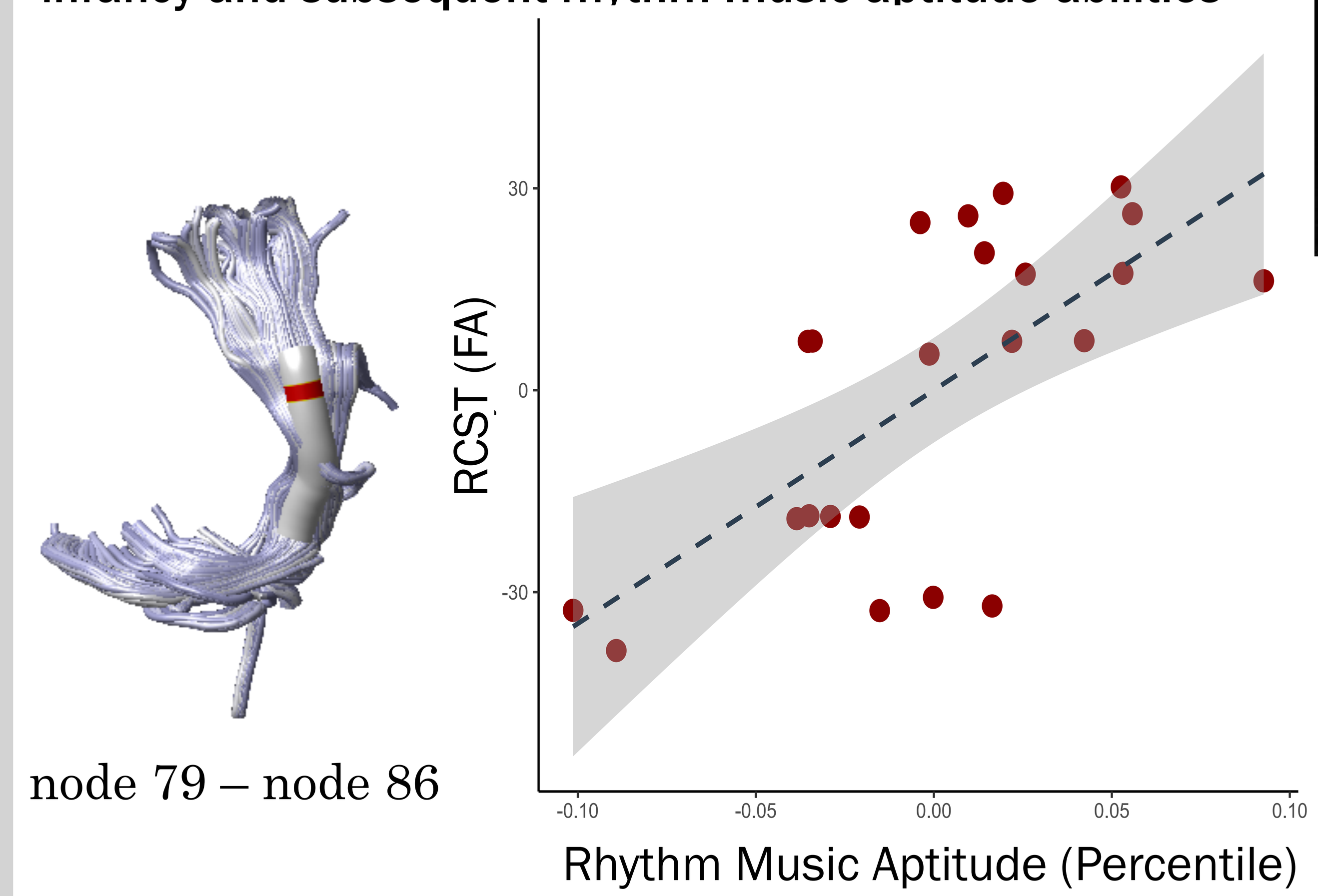
Are the observed effects explained by language?

42% of variance in tonal music aptitude is explained by:
Sig. nodes of RCST & CC Major, infant age, school-age phonological awareness
Only RCST significantly contributes to the prediction ($\beta = 0.545$, $p = 0.023$).

RESULTS (Cont.)

Examining the relationship between white matter in infancy and subsequent rhythm music aptitude abilities





The right corticospinal tract in infancy (as indicated by FA) is prospectively associated with subsequent rhythm music aptitude abilities, accounting for age
(Sig. nodes displayed in red, $p < 0.003$, FWE-Corrected)

Are the observed effects explained by language?

48% of variance in rhythm music aptitude is explained by:
Sig. nodes of RCST, infant age, school-age phonological awareness
Only RCST significantly contributes to the prediction ($\beta = 0.659$, $p = 0.004$).

CONCLUSIONS

Structural organization of the right corticospinal tract in infancy significantly contributes to the prediction of subsequent music aptitude abilities (tonal and rhythm), even when accounting for language (phonological awareness).

Structural organization of the corpus callosum major in infancy is prospectively associated with subsequent tonal discrimination abilities, but this effect does not explain unique variance in tonal music aptitude outcomes.

This research provides developmental evidence in early childhood to support the notion that white matter organization prior to the onset of formal training may serve as a scaffold upon which ongoing experience can build.

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