Relationship between amateur musical practice and white matter connectivity in the attention system

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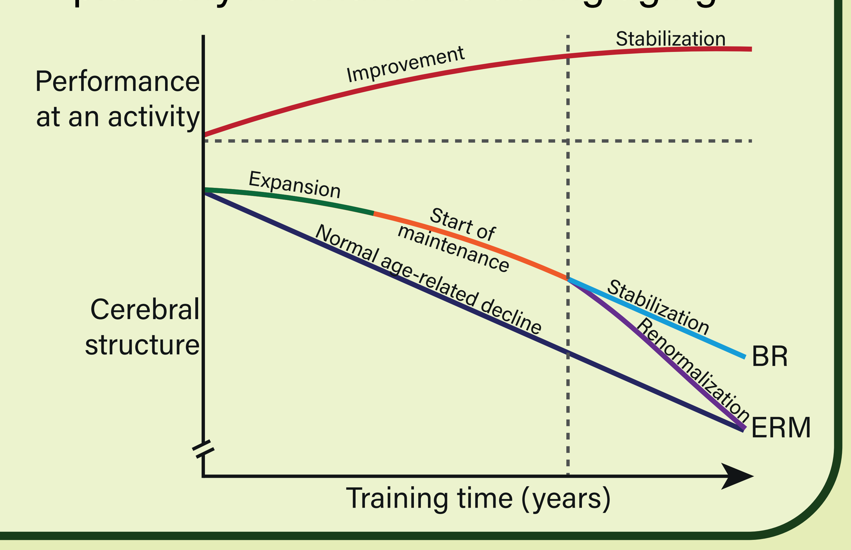
Introduction

The brain's attentional control system consists of a network of cortical and subcortical regions interconnected by white matter tracts[1,2]. Age-related changes in brain structural connectivity reduce the integrity of this system.[3]. According to the Scaffolding Theory of Aging and Cognition (STAC-r), participation in a leisure activity, such as music practice, could induce compensatory neuroplasticity, which would slow this decline[4,5].

The potential mechanisms of plasticity are (**Figure 1**):

- Brain reserve (BR)[6]
- Expansion and renormalization (ERM)[7]

Figure 1 : Schematic diagram of plasticity mechanisms during aging



Objectives & hypothesis

1 - Examine age-related differences in attention in amateur singers, instrumentalists and non-musicians.
2 - Investigate the relationships between aging, musical practice, and structural connectivity in the attentional system.
3 - Explore whether structural connectivity mediates the relationship between aging, attention and musical practice.

Hypothesis: Musicians would show reduced age-related decline in connectivity, and this would be associated with better attentionnal performance.

Method

Sample

105 healthy adults, engaged in a cognitivo-motor activity for at least 3h/week for at least 5 years, from the PICCOLO project[8,9,10,11,12]

- 31 **singers** (65% ♀) Age = 61 ± 16 (23-88)
- 37 **instrumentalists** (32% ♀) Age = 53 ± 19 (20-88)
- 37 **non-musicians** (49% ♀) Age = 56 ± 19 (20-87)

Cognitive tasks

Test of Attention in Listening (TAiL)[13]

Task	Bip! Bip!	Bip! Bip!	Bip! Bip!	Bip! Bip!
Frequency	Same	Different	Same	Different
Localisation	Same	Same	Different	Different
	Congruent	Non congruent	Non congruent	Congruent

The two TAiL scores are expressed as a cost of reaction time (RT) and errors (ER) (total 4 scores);

- Conflict resolution (Non congruent – Congruent)
- Distractibility (Different – Same of the distractive modality)

Colour Word Interference Test (Stroop)[14]

Task	Stimuli		
Word Reading	Red	Blue	Green
Colour Naming			
Inhibition	Red	Blue	Green
Inhibition/Switching	Red	Blue	Green

Two scores are calculated for the Stroop: time of completion for each of the 4 tasks and number of errors, resulting in 8 scores.

Connectometry analysis

Figure 2. MRI images processing steps

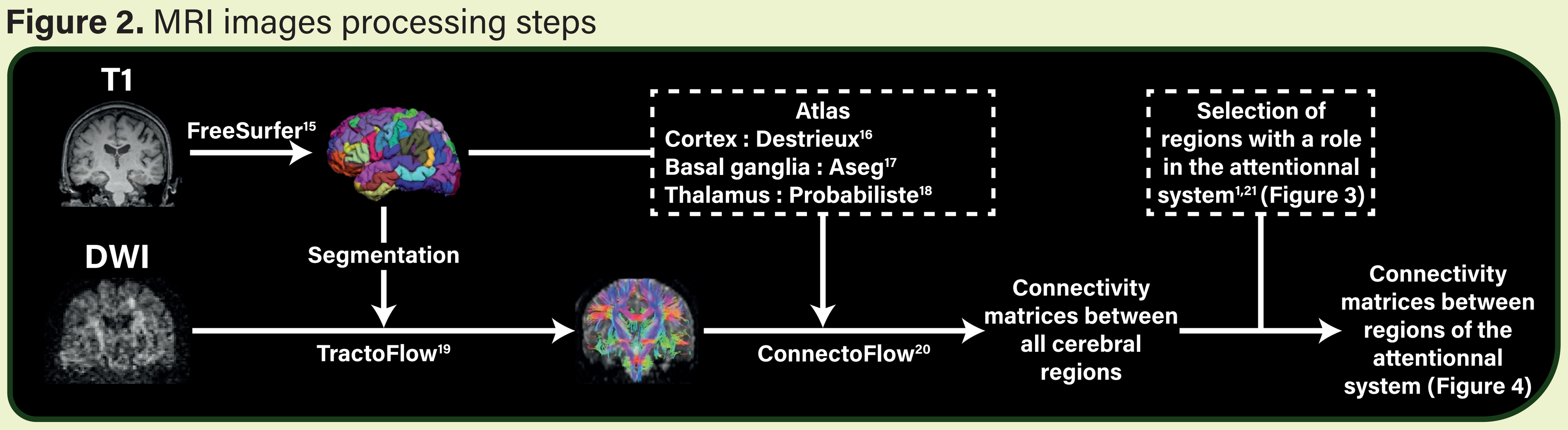


Figure 3. Attentional system

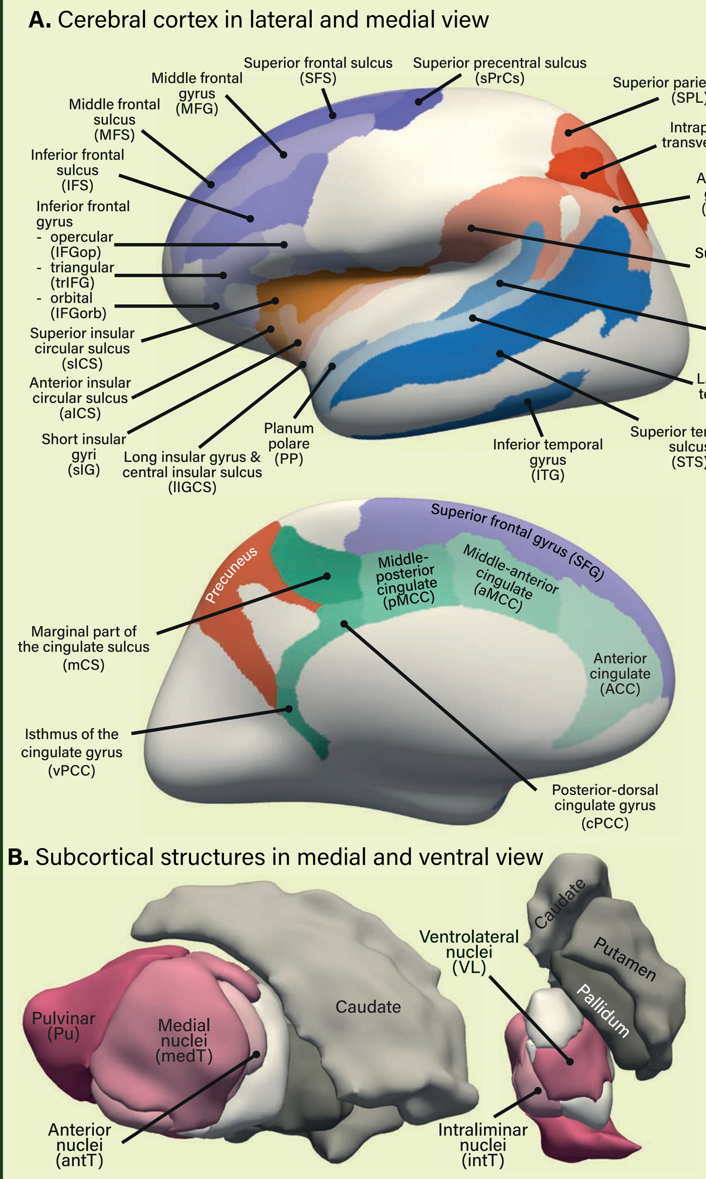
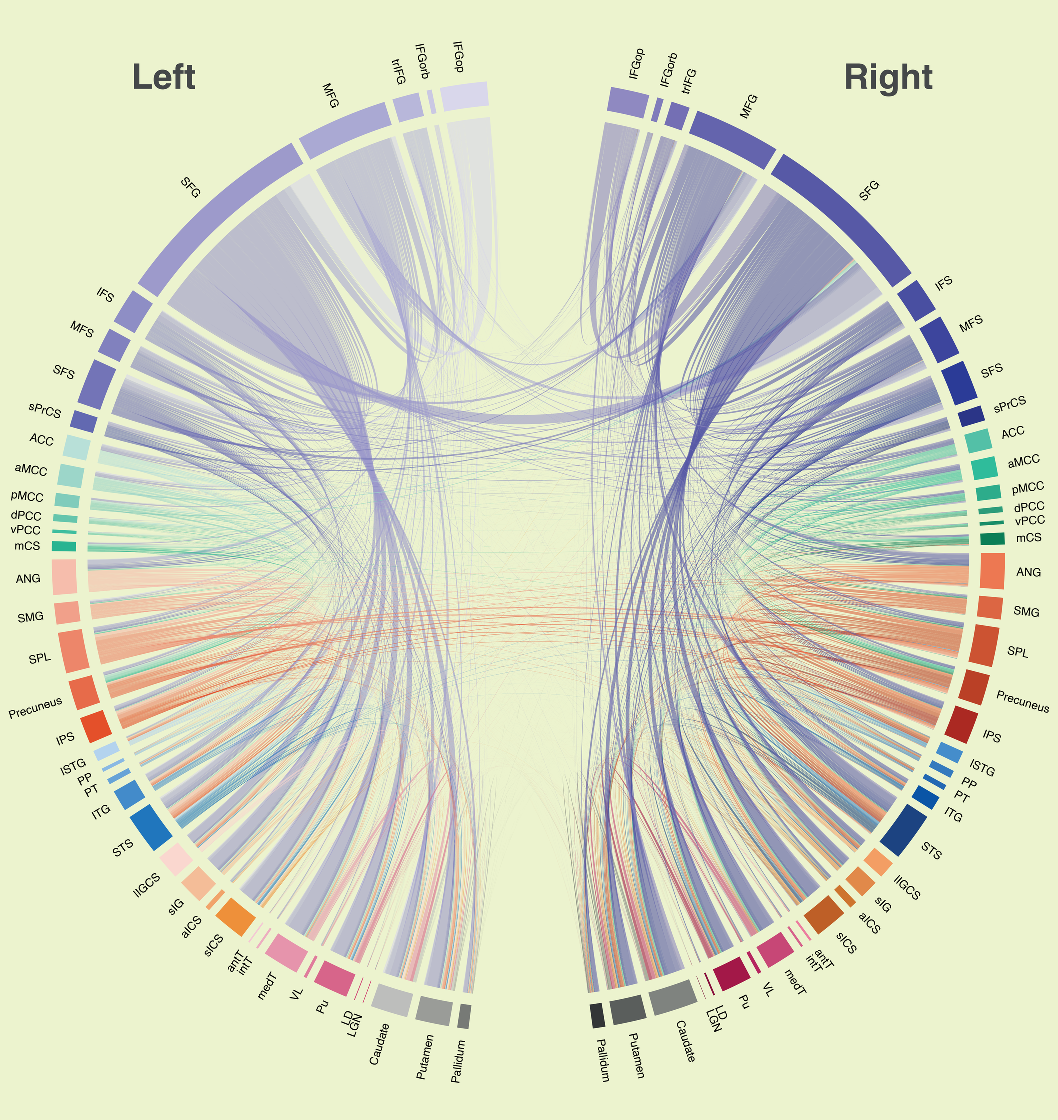


Figure 4. Average connectivity matrices with SC



Connectometry metrics

Streamline count (SC): total for the whole system, per region (ROI), and per connection (Conn)

Statistical analysis

Linear mixed model, controlled for 9 dementia risk factors (combined score; DRF)

Model 1 (Obj 2): For the whole system: log(SC) ~ Age x Group + Sex + DRF + 1|Participant;
For ROI/Conn: log(SC) ~ Age x Group + Sex + DRF + 1|Participant + Age|ROI/Conn
Post-hoc for each ROI and Conn if random effect or random slope

FDR correction by ROI and connection

Model 2 (Obj 3): For the whole system : Attention ~ Age x Group x log(SC) + Sex + 1|Participant

Results

Figure 5. Results of cognitive tasks[8]

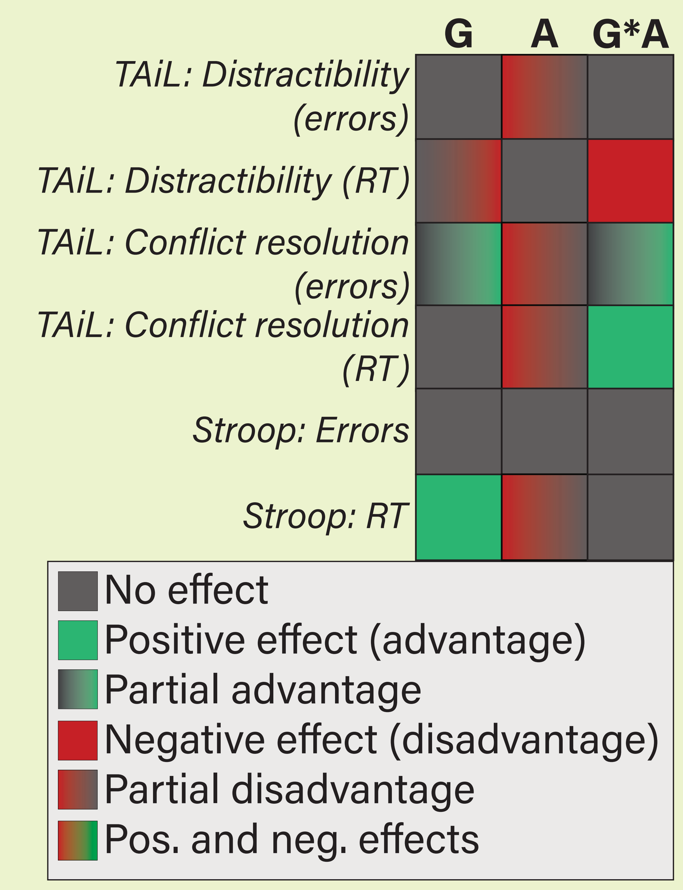


Figure 6. Results at the whole system level

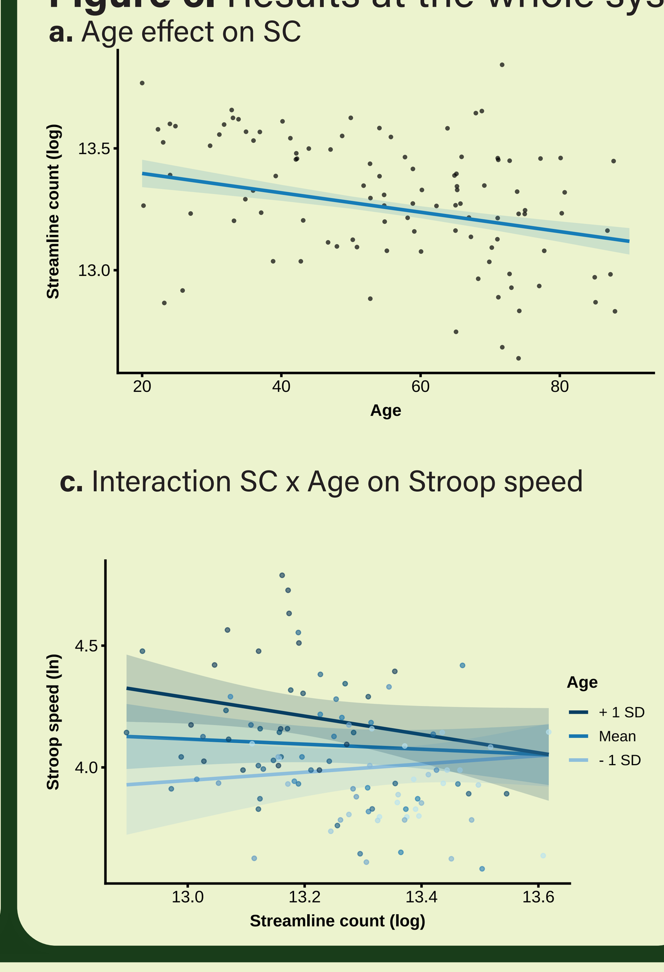


Figure 7. Results at the regions of interest level — Age effect on SC

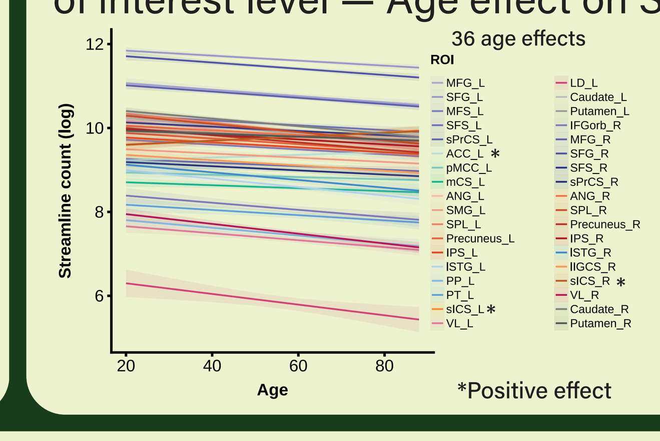
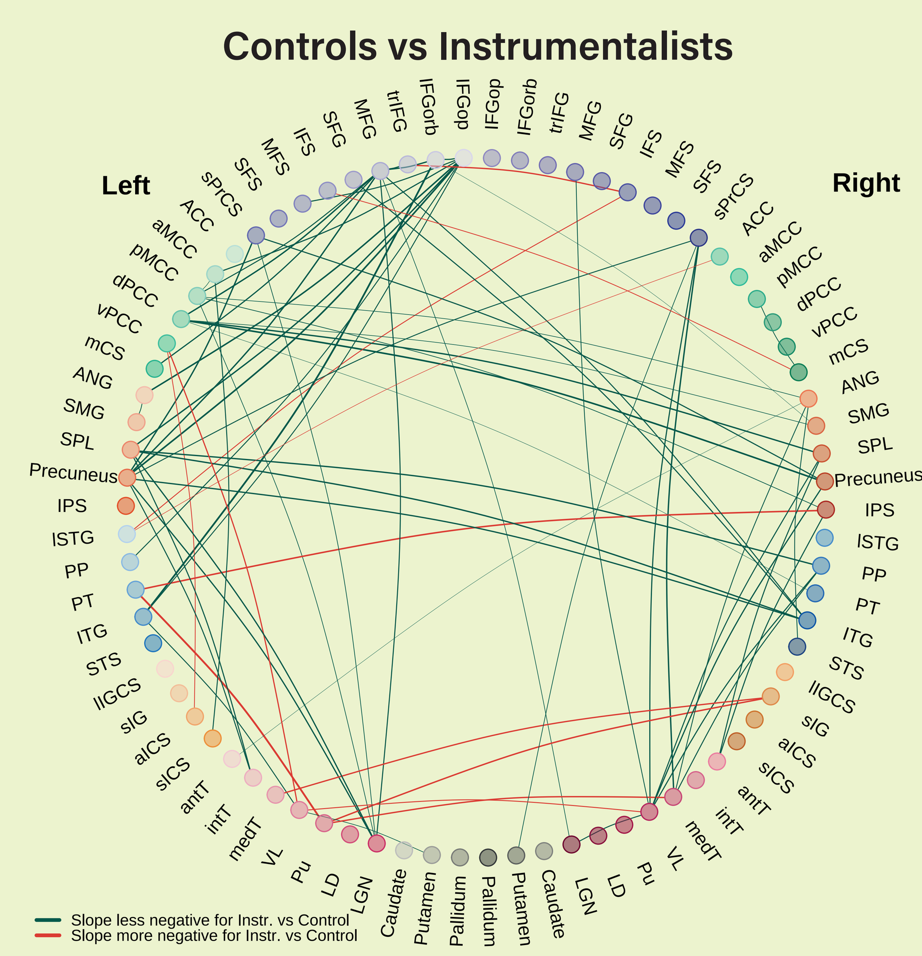
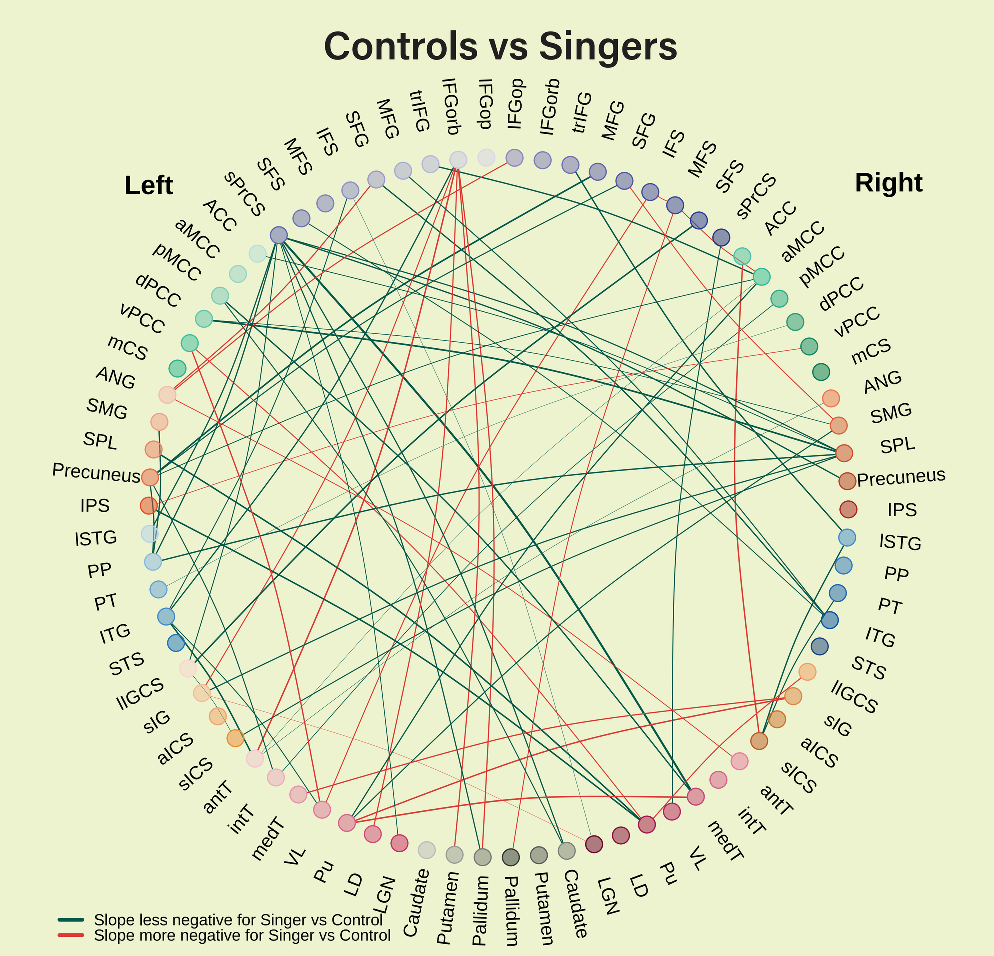


Figure 8. Results at the connections level — Interaction Age x Group on SC





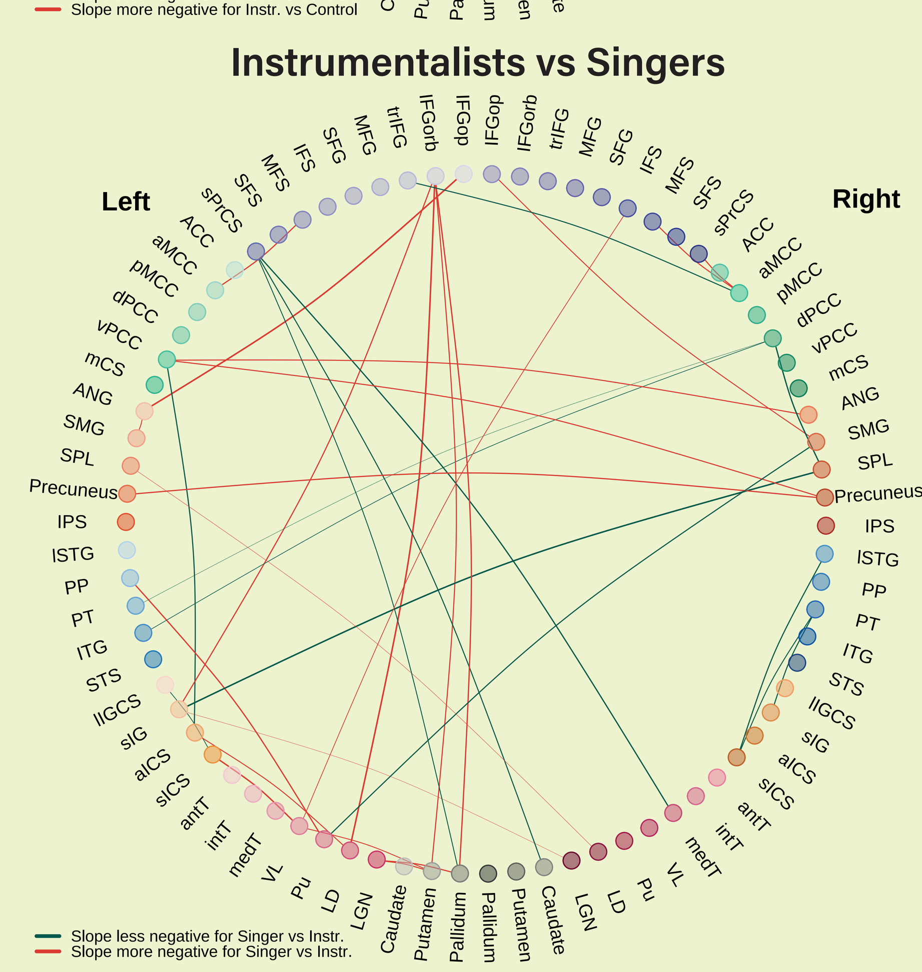


Table 1. Contrast for Age x Group on SC at the connection level

Contrast A vs B	Slope between Age and SC of: A is less negative than B				A is more negative than B			
	Total	L — L	L — R	R — R	Total	L — L	L — R	R — R
Instr. vs Controls	58	28	16	14	12	3	9	0
Singers vs Controls	46	13	29	4	22	7	9	6
Singers vs Instr.	14	3	7	4	22	13	6	3

Note : L — L = Connection within left hemisphere; L — R = Interhemispheric connection; R — R = Connection within the right hemisphere

Discussion

Results showed different age effects at different levels of the attentional system. At the system level, a general negative age effect was observed, which was also reflected at the region level, where nearly half of the regions showed declining connectivity with age. Age effects differed across groups for 138 connections (4.60%), with instrumentalists and singers showing an attenuated negative age effect compared to controls.

The effect of streamline count on attentional control was investigated at the system level only; significant effects were observed only for the Stroop task. Ongoing analyses will examine this relationship at the region and connection levels, and will incorporate additional connectometry metrics such as FA and AFD.

In summary, these results provide evidence for a limited benefit of musical practice on the structural connectivity of the attentional system.

References

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