



Introduction

Music and math rely on different executive functions, yet both involve complex cognitive processing in the prefrontal cortex. This study uses functional near-infrared spectroscopy (fNIRS) to explore whether specialized training—such as musical experience—influences how the prefrontal cortex activates during music and math tasks.

Hypothesis: Math tasks produce greater frontal lobe activation than music tasks in both groups (musicians and non-musicians).

Methods

- Eight adults (ages 18-29) in Boston participated in this study. Participants were categorized as musicians or non-musicians based on their prior musical and mathematical knowledge.
- Using fNIRS, we recorded hemodynamic responses during music and math tasks.
- Using NIRSIT Quest software, we processed the raw hemodynamic response using the Modified Beer-Lambert Law transformation for four areas of the frontal lobe bilaterally—dorsolateral prefrontal cortex (DLPFC), ventrolateral prefrontal cortex, orbitofrontal cortex, and frontopolar cortex.
- Paired-samples t-tests were conducted to compare the mean oxyhemoglobin concentration [HbO] changes between the two task types within each group.

Results

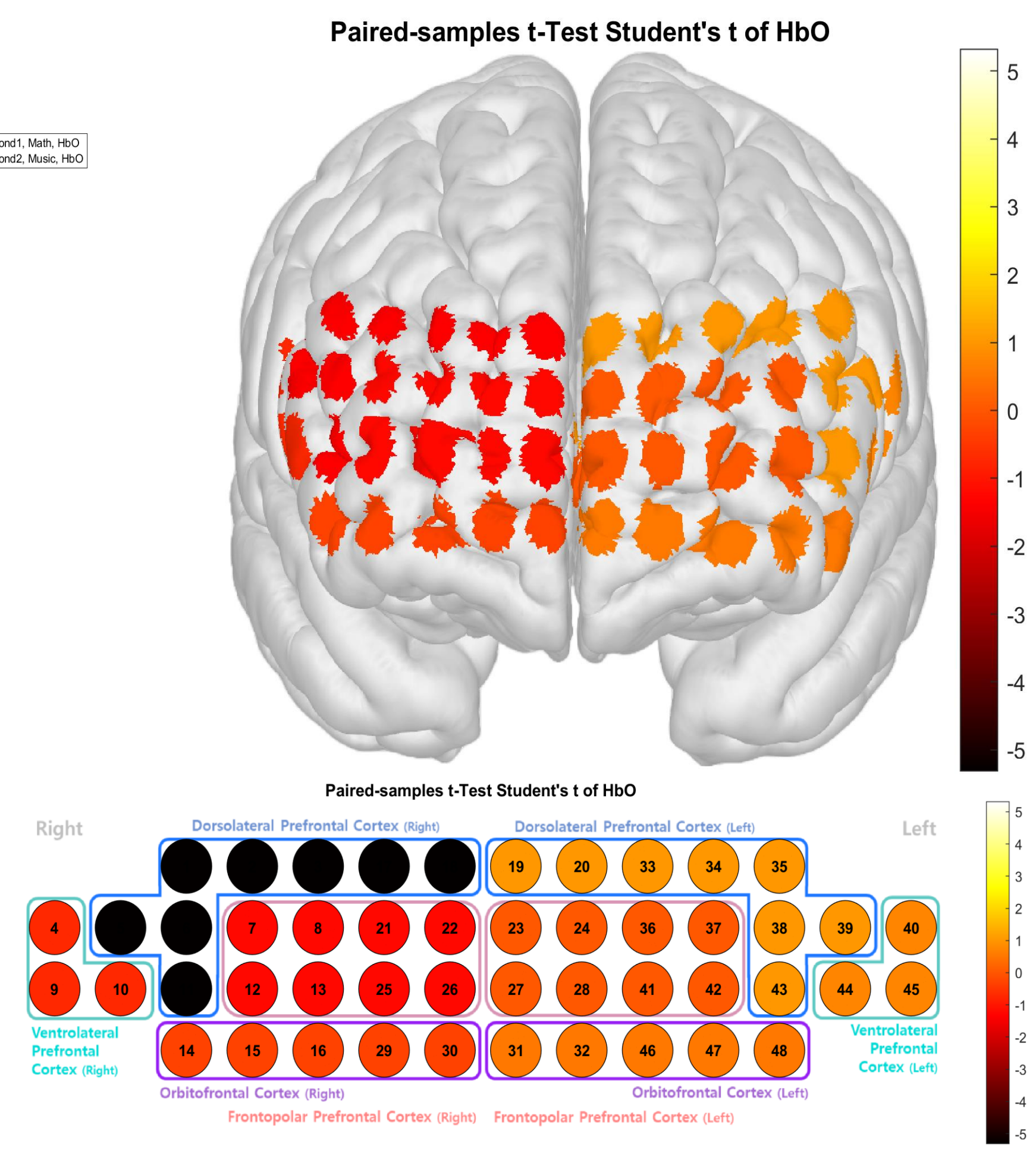
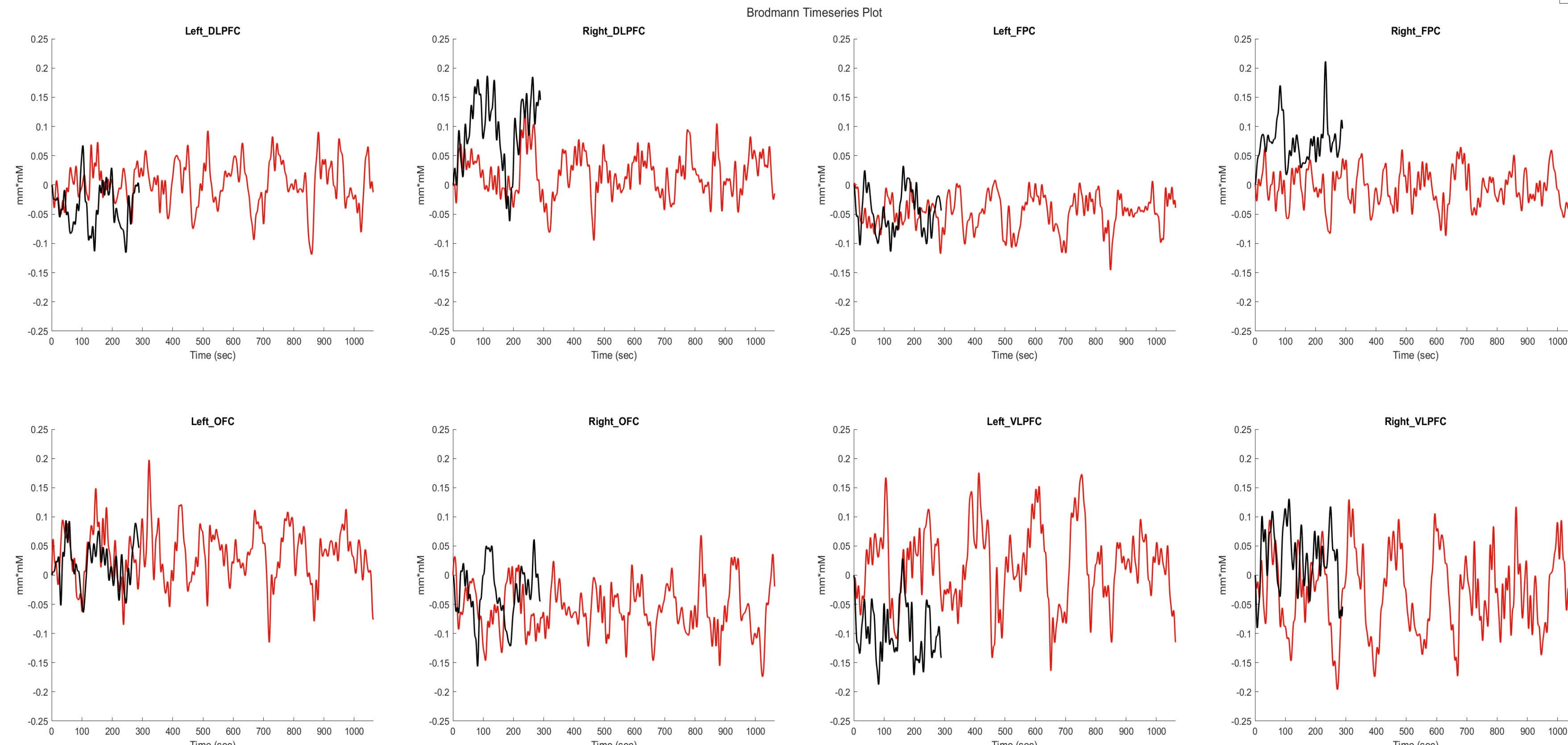
Musicians

Statistics : Paired-samples t-Test

	Test	Statistic	df	P _{uncorr}
Left_DLPFC	Student	1.002	2.000	0.422
	Wilcoxon	1.069		0.285
Right_DLPFC	Student	-5.316	2.000	0.034*
	Wilcoxon	-1.604		0.109
Left_FFC	Student	0.010	2.000	0.993
	Wilcoxon	0.000		1.000
Right_FFC	Student	-1.221	2.000	0.347
	Wilcoxon	-1.069		0.285
Left_OFC	Student	0.528	2.000	0.650
	Wilcoxon	0.535		0.593
Right_OFC	Student	-0.301	2.000	0.792
	Wilcoxon	0.000		1.000
Left_VLPFC	Student	0.712	1.000	0.606
	Wilcoxon	0.447		0.655
Right_VLPFC	Student	-0.722	2.000	0.545
	Wilcoxon	-0.535		0.593

Group Descriptives

Group-level	Condition	N	Mean	SD	SE
Left_DLPFC	Condition1	3	0.00276	0.0385	0.0222
	Condition2	3	-0.0416	0.0383	0.0221
Right_DLPFC	Condition1	3	0.0177	0.0432	0.0249
	Condition2	3	0.0866	0.0494	0.0285

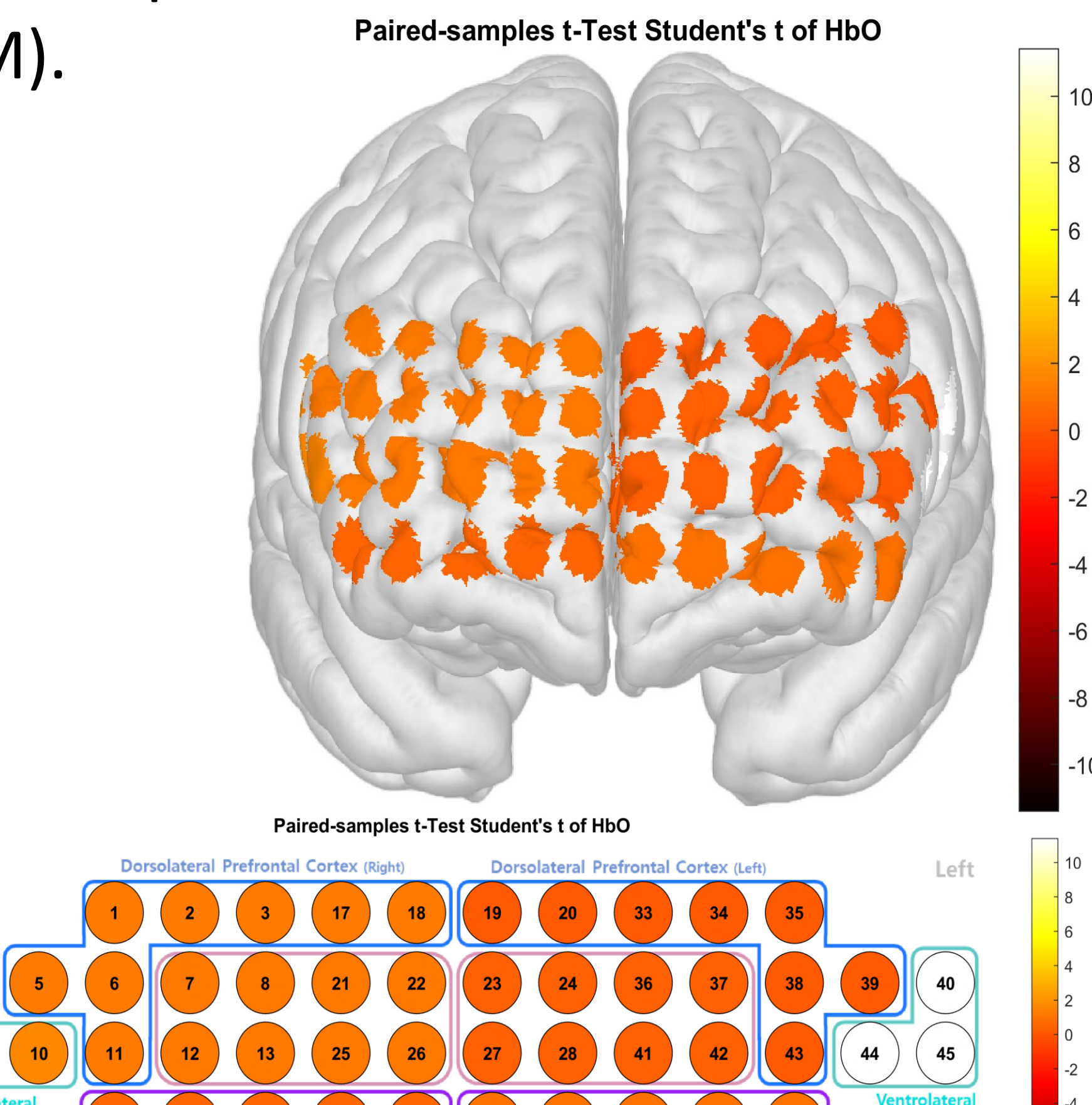
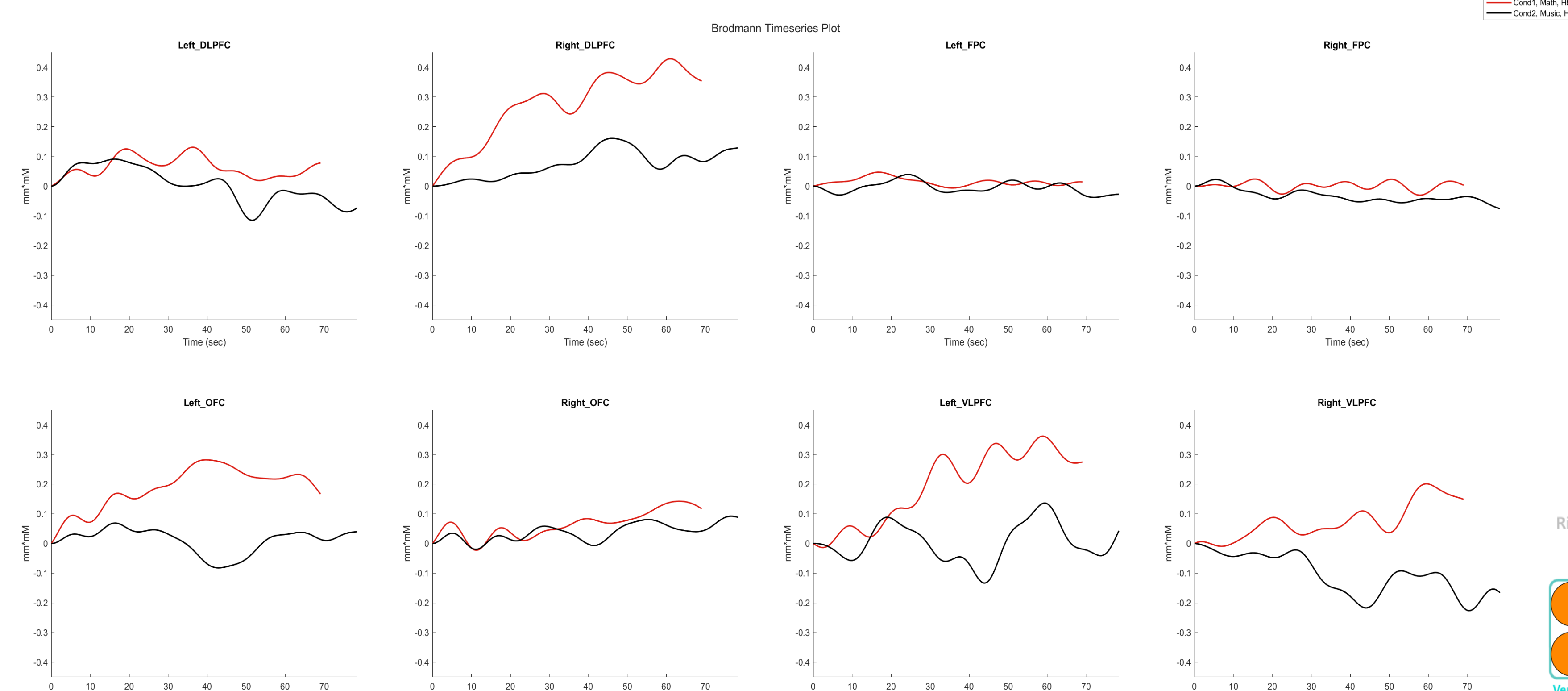


A significant difference of [HbO] in the musicians' right DLPFC between the music and math tasks, $t(2)=5.316$, $p=0.034$. The right DLPFC showed a greater mean [HbO] during music ($0.10 \pm 0.05 \mu\text{M}$) than math ($0.02 \pm 0.04 \mu\text{M}$).

Non-Musicians

Statistics : Paired-samples t-Test

	Test	Statistic	df	P _{uncorr}
Left_DLPFC	Student	0.172	2.000	0.879
	Wilcoxon	0.000		1.000
Right_DLPFC	Student	1.216	1.000	0.438
	Wilcoxon	1.342		0.180
Left_FFC	Student	0.338	1.000	0.793
	Wilcoxon	0.447		0.655
Right_FFC	Student	1.153	2.000	0.368
	Wilcoxon	1.069		0.285
Left_OFC	Student	0.984	2.000	0.429
	Wilcoxon	0.535		0.593
Right_OFC	Student	0.497	2.000	0.668
	Wilcoxon	0.535		0.593
Left_VLPFC	Student	11.405	1.000	0.056
	Wilcoxon	1.342		0.180
Right_VLPFC	Student	1.634	1.000	0.350
	Wilcoxon	1.342		0.180



No statistically significant differences were found in any regions.

Conclusion

- Contrary to our hypothesis, only musicians' right DLPFC showed higher [HbO] during music than math tasks.
- In non-musicians, although results were not statistically significant, math tasks generally elicited higher [HbO] levels than music across all prefrontal regions, implying greater cognitive effort due to unfamiliarity.
- Musical training leads to functional specialization rather than increased cognitive load.
- Given the right DLPFC's involvement in working memory, attention, and decision-making, musicians likely engage this region more during music tasks because of their training and familiarity, resulting in increased [HbO] localization to that area.

Acknowledgments

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