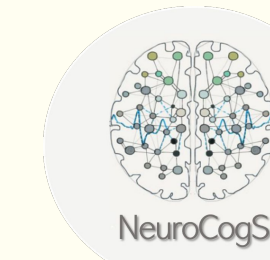


Music's Impact on Neural entrainment, Working Memory, and Reading Skills in Young Children

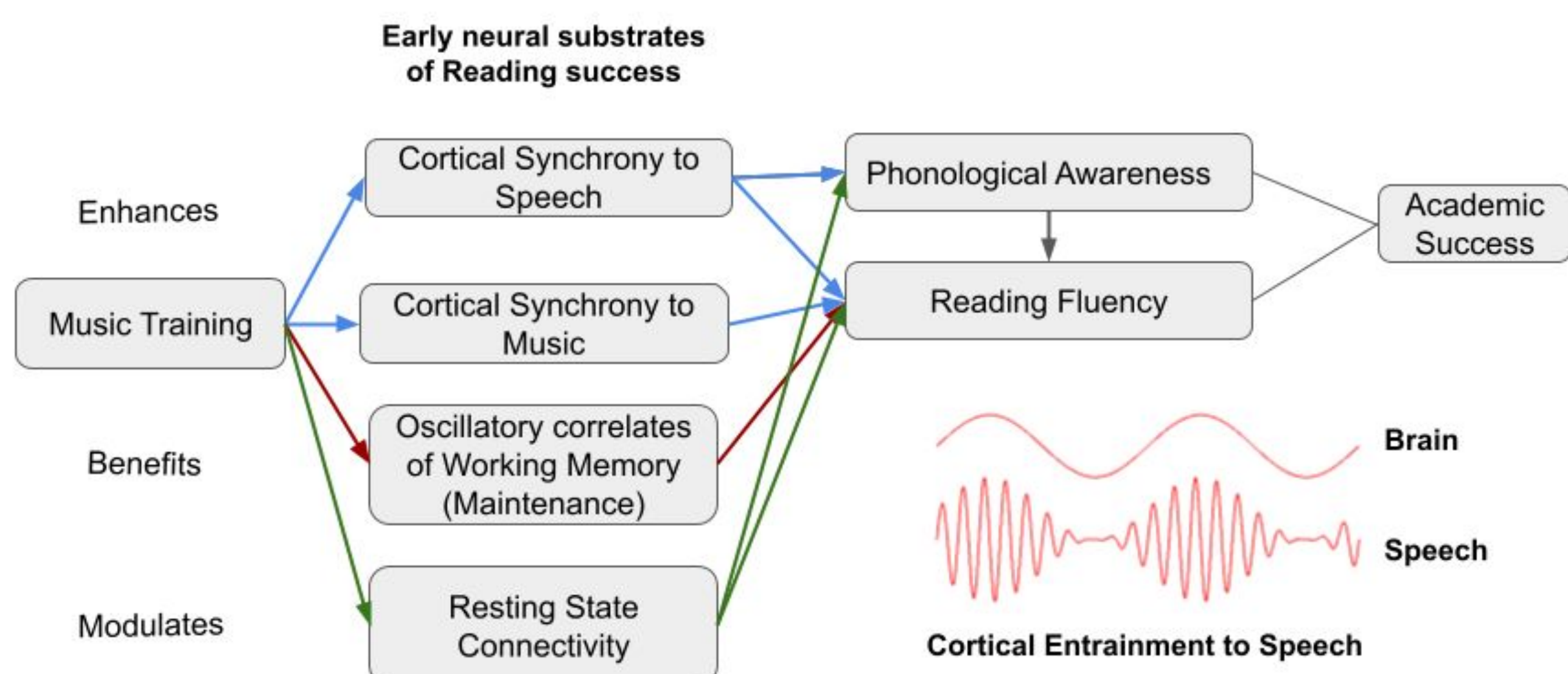
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Aims

Working memory and phonological awareness are key components in child's reading fluency and academic success. Both components can be facilitated by **musical training**, yet the cognitive mechanisms of such facilitation are unclear. We propose that neural entrainment plays the key role. We aim to uncover the relationship between musical training and neural entrainment in shaping cognitive abilities facilitating memory and phonological skills relevant for reading in young children.



General Methods

Participants

N = 80, children between 6-8 years old

- Music Learners.** Playing instruments or singing, music classes.
- Non-Music Learners.** Enrolled in an alternative sports-related extracurricular activity (e.g. football, swimming).

Exclusion criteria: bilinguals, diagnosis of developmental disorder, auditory impairments.

ONLINE QUESTIONNAIRES

- **Demographics** (SES, parent's educational level)
- **Music@Home** (Music Experience at home) [1]
- **BRIEF** (Executive Functions) [2]
- **Familial Risk of Dyslexia** (Adult Reading History Questionnaire -ARHQ-, Lefly and Pennington, 2000) [3]

FOLLOW-UP SESSION - 1 year after

- Have they received any **Dyslexia** or other **SEN** diagnoses?
- **Rapid Online Assessment of Reading task (ROAR)** [7]
 - Single Word Recognition, Phonological Awareness, Sentence Reading Efficiency, Receptive Vocabulary tasks.

Experiment 1:

Music training, Working Memory and Reading

Hypotheses: We expect sustained alpha phase synchrony with successful performance. Better performance in WM would correlated with higher scores in reading fluency. Parent-reported measures of WM would correlate with children's WM maintenance scores.

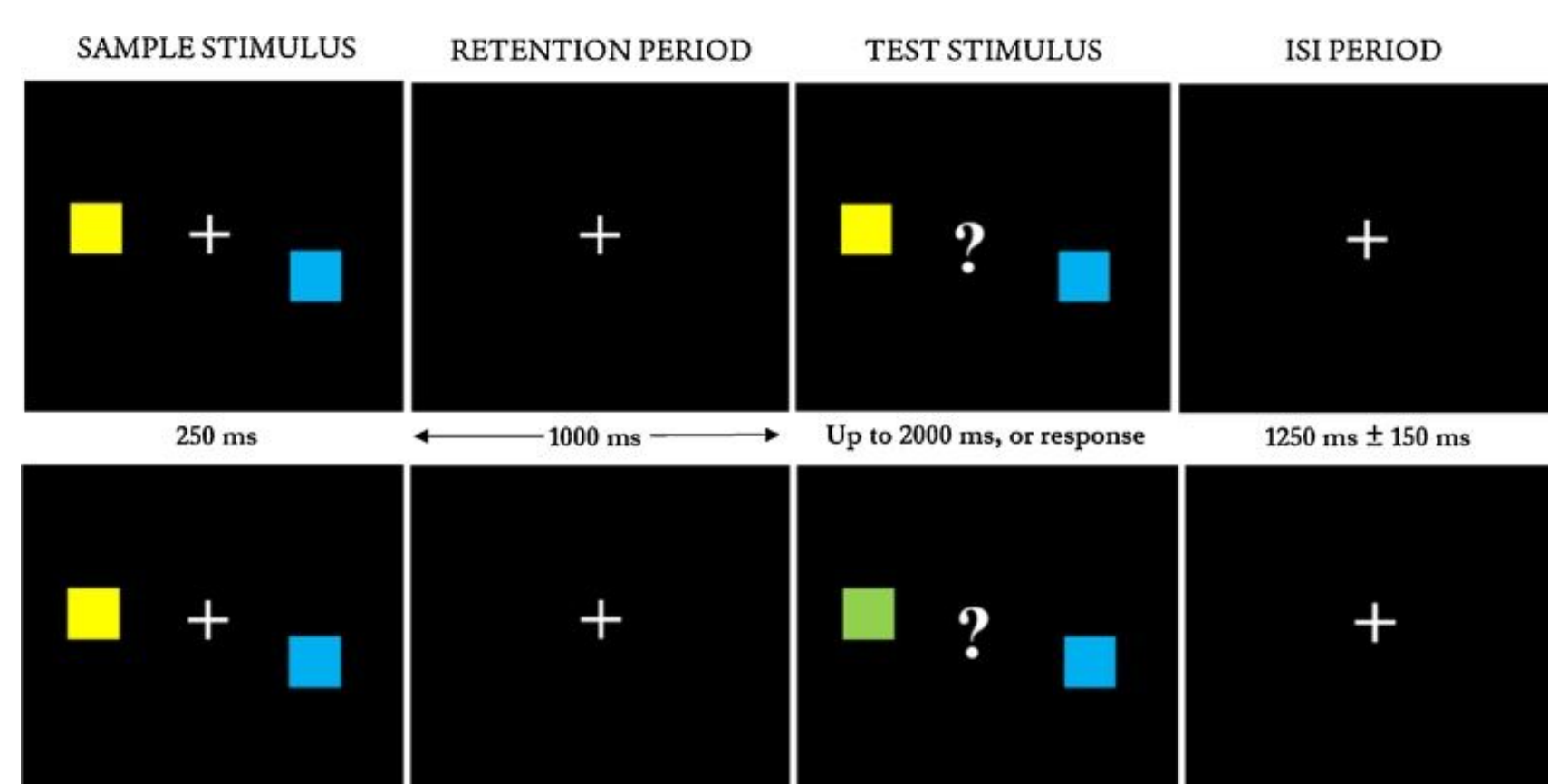
Tasks

READING FLUENCY (RF)

- Word Identification Fluency Task [4]

WORKING MEMORY TASK - Delayed Match-to-sample task [6]

EEG+Behavioural Task



Data Analysis

RF Task: accuracy, reaction time.

Working Memory Task: accuracy, reaction time. Other analyses:

- **Time Frequency** local power changes in alpha
- **Functional connectivity (FC).** Inter-regional phase synchronization over retention periods, weighted phase lag index (wPLI)
- **Correlations,** behavioural, RF and WM accuracy with FC, questionnaires
- **Maintenance-related Network** in left dorsolateral prefrontal cortex.

Experiment 2:

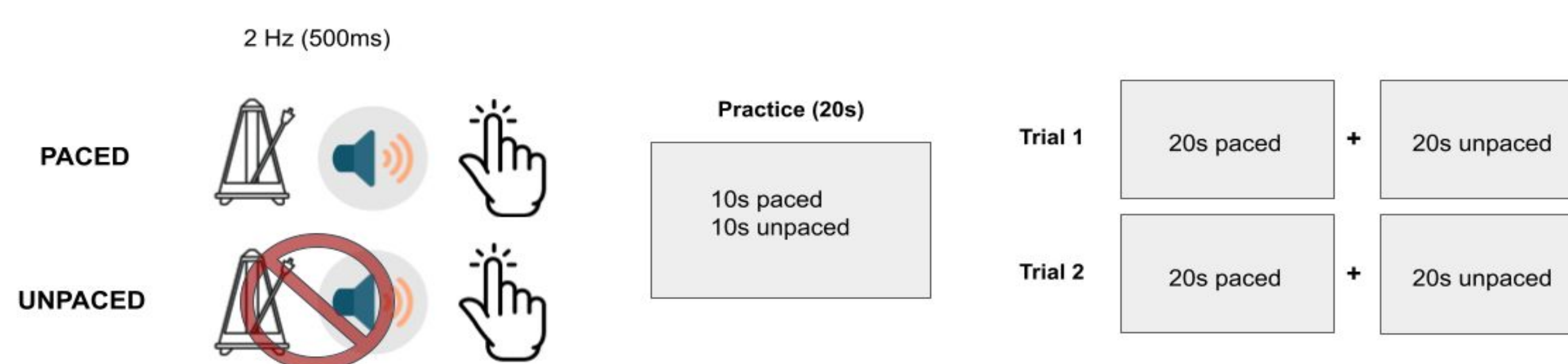
Music training, Entrainment and Reading

Hypotheses: We hypothesize that individuals who exhibit better entrainment to speech and music, specifically in the delta (1-4 Hz) and theta (4-8 Hz) frequency bands, will demonstrate higher scores in rhythm abilities and reading fluency tasks.

Tasks

READING FLUENCY WIF scores from Experiment 1.

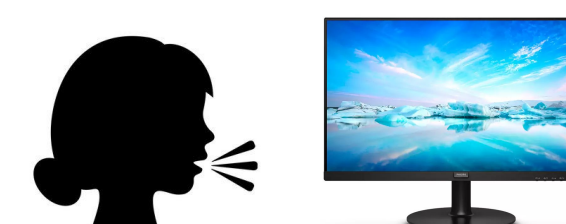
MUSIC ABILITY - Tap-to-metronome task [5]



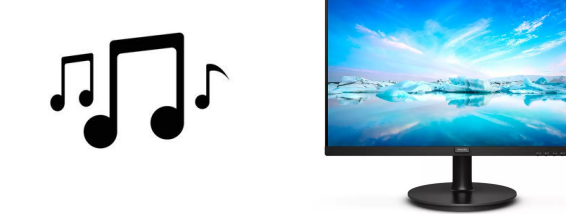
ENTRAINMENT

5 min/condition

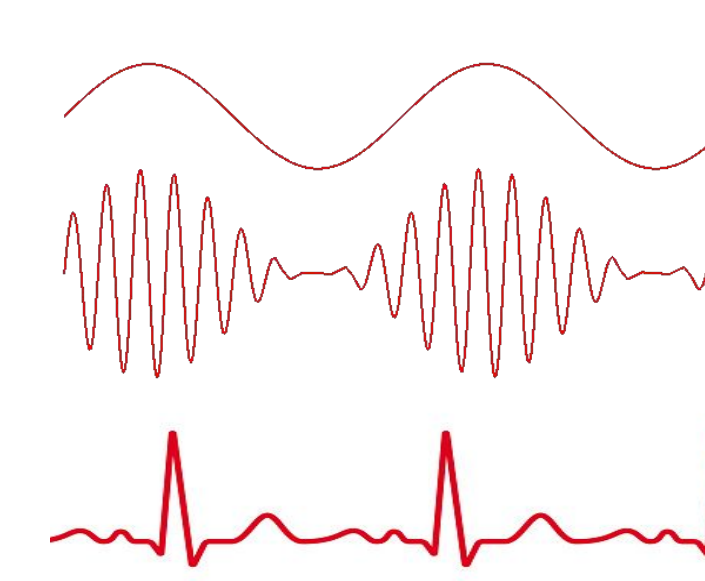
Speech
Audiobook



Music
Viola solo



EEG + ECG



Data Analysis

Music ability task.

- Inter-tap intervals, response count

Entrainment:

- **Time-Frequency** for speech and music (in delta and theta bands)
- **Oscillatory entrainment index** (phase-locking, power, and phase consistency)
- **Connectivity Analyses,** how brain regions communicate and coordinate
- **Synchronisation & Heart-Rate Variability** for EEG+ECG (cross-correlation & coherence)
- **Machine Learning.** Predict entrainment patterns, individual differences
- **Correlations** of rhythm ability and RF scores with Entrainment to music and speech + Music@Home, Familial Risk of Dyslexia questionnaires

Experiment 3:

Music Training and RS Neural Connectivity

Hypotheses: we expect higher power in theta and gamma and lower power in beta and delta will correlate with better rhythm ability

Tasks

MUSIC ABILITY - Tap-to-metronome task scores from Experiment 2

RESTING STATE EEG

- 5 min RS EEG activity while looking at a landscape image



Data Analysis

- **Power Spectrum,** for frequency bands delta, theta, beta, gamma.
- **Functional Connectivity,** to identify patterns of synchrony
- **Network,** small-worldness, modularity, and node centrality
- **Graph Theory,** degree, centrality, and efficiency and **Clustering**

General Discussion

Through this series of studies, I aim to uncover complex neural mechanisms that link music training, working memory, speech processing, and neural entrainment in young children.

These findings may contribute to:

- Identifying **individual differences in entrainment** and **potential biomarkers for speech-related disorders**
- The development of new and more effective **early interventions and educational strategies**, enriching the lives of young learners and promoting academic success