Moving to the beat: Examining the role of auditory perception in motor coordination abilities among children using a multimodal neuroimaging approach

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Background

Developmental coordination disorder (DCD)

- Difficulties in learning and execution of motor skills + **sensorimotor timing** [1]
- The precise perceptual timing is a prerequisite for motor coordination [2]
- Unclear whether these difficulties arise from auditory perceptual or motor timing differences, or both [3]

Music-based interventions

- Even passive listening to rhythmic auditory stimuli activates motor regions of the brain and leads to enhanced motor performance in adults with movement difficulties [4]

References

[1] American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

[2] Debrabant, J., Gheysen, F., Caeyenberghs, K., Van Waelvelde, H., & Vingerhoets, G. (2013). Neural underpinnings of impaired predictive motor timing in children with developmental coordination disorder. *Research in developmental disabilities, 34*(5), 1478-1487.

[3] Trainor, L. J., Chang, A., Cairney, J., & Li, Y. C. (2018). Is auditory perceptual timing a core deficit of developmental coordination disorder?. *Annals of the New York Academy of Sciences, 1423(1)*, 30-39.

Chen, J. L., Penhune, V. B., & Zatorre, R. J. (2008). Moving on time: brain network for auditory-motor synchronization is modulated by rhythm complexity and musical training. *Journal of Cognitive Neuroscience, 20(2)*, 226-239.

Research Questions:

1. Do children with DCD have auditory perceptual timing difficulties in addition to motor difficulties?
2. Can rhythmic auditory cues enhance motor coordination accuracy in children?
3. Are there differences in neural patterns between children with DCD compared to TD children?

Methods

Session #1

- **Child:** Standardized assessment of motor and cognitive abilities (MABC, KBIT, Digit Span)
- **Caregiver:** Questionnaires

Session #2

1. Auditory perceptual tasks
   - Duration vs. rhythm discrimination

2. Motor tasks with/without auditory cues **(EEG-fNIRS)**
   - Paced vs. unpaced tapping (500/1000 ms)

3. Conscious and subconscious auditory-motor synchronization **(EEG-fNIRS)**
   - Continuous time-modulated intervals at 3%, 7%, and 20% of baseline interval (1250 ms)

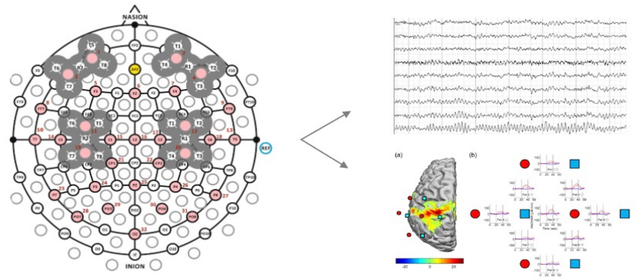
Participants

- **Children 7 – 11 y. o.**
  - Children with DCD (N=15), TD without music training (N=15), and TD children with extensive music training (> 2 years; N=15)

- **Data collection is ongoing! #0509**

Future steps: Data analysis

- Perceptual thresholds: An adaptive 2-up-1-down transformed-response procedure
- Tapping: Synchronization error (SE) and inter-response interval (IRI)



g.Nautilus Research Headset: 32 channel EEG montage with 8 fNIRS channels

- EEG-fNIRS preprocessing pipeline
- EEG: Induced oscillatory neural activity, inter-trial phase coherence
- fNIRS: Hemodynamic changes in the prefrontal / motor cortex

Predicted results & clinical relevance

Should the results support the hypotheses that

(a) children with DCD have auditory perceptual differences

(b) rhythmic auditory cues can enhance children's ability to coordinate and synchronize their movements

these findings will imply that **auditory-motor interventions may confer additional benefit over motor training alone.**

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