# High Frequency Coherence in Pediatric Primary Motor Cortices

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**Target audience:** Those interested in studying functional connectivity of brain networks.

**Purpose:** fMRI measurements of signal coherence are used to detect regional communication in brain. It is known that coherence varies with frequency. fMRI often uses frequencies of less than 0.2Hz to measure coherence. In this project we use fNIRS to study a wider range of frequencies than it is possible to do with fMRI, in order to better understand the relationship between frequency and magnitude of coherence.

**Methods:** Eight pediatric controls (age 14.5±0.6) completed a 5 minute resting state and a 5 minute tapping task (30s rest, 15s tapping). The head cap was placed over motor cortex based on anatomical area. The CW5 NIRS system records the absorption of near infrared light wavelength of deoxy-hemoglobin (Hb) at 690nm and oxy-Hb at 830nm. Coherence is based on Oxy-Hb concentrations as measured with fNIRS. Coherence analysis used a reference seed from the left hemisphere from the fiber pair showing the maximum response to finger tapping with the right hand. Intrahemispheric coherence was measured in 3 source-detector pairs in close anatomical approximation to reference seed. Intrahemispheric coherence was calculated[1] in 0.04-0.1 Hz, 0.1-1 Hz, 1-2 Hz, 2-3 Hz, 3-4 Hz, 4-8 Hz, 8-10 Hz and 10-50Hz frequency ranges within the motor cortex. A two way analysis of variance (ANOVA) and bonferroni multiple comparisons were completed for coherence values in frequencies ranges during resting state and task activation in comparison to the 0.04-0.1Hz frequency band.

**Results:** In comparison to 0.04-0.1Hz frequencies, in resting state there was a significant reduction in coherence at 2-3 ($p<0.001$), 3-4 ($p<0.001$), 4-8 ($p<0.001$) and 8-10Hz ($p<0.001$). Coherence was similar in 0.1-1, 1-2 and 10-50Hz frequency ranges. During task activation, there was a significant difference from 0.04-0.1Hz coherence to 3-4Hz ($p=0.01$), 4-8Hz ($p<0.001$) and 8-10Hz ($p<0.001$). There was a significant increase in intra-hemispheric coherence between resting state and task activation in at 0.1-1Hz ($p<0.05$) and 10-50Hz ($p<0.01$) frequency bands.

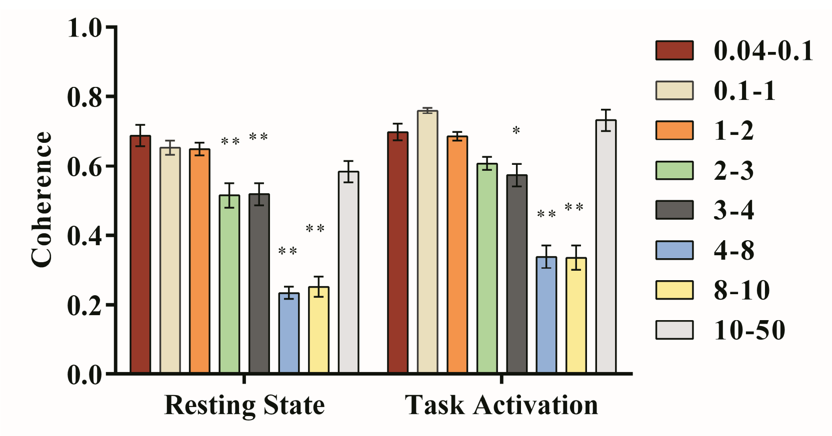


**Fig 1. Coherence between motor cortices displayed by frequency band.** Average coherence values are illustrated during resting state and task activation in left primary motor cortex. Each band is compared to 0.04-0.1Hz during resting state and task activation. There is an evident decrease in coherence up to 10Hz followed by an increase similar to 0.04-0.1Hz.
(* $p<0.05$; ** $p<0.001$)

**Discussion:** These data are collected at high frequency (50Hz) allowing for accurate description of the frequency response of coherence. We confirm that low frequencies, as can be described by fMRI [4], are suitable for coherence analysis in pediatric populations. We reported similar results previously for adults [1]. There is an increase in coherence due to tapping at the higher frequencies (10-50Hz) but the underlying cause is not known. These responses are too fast for hemodynamic changes. It has been suggested that neuronal activation causes high frequency changes in scattering due to cellular conformational changes [2,3,4]. Further work needs to be completed to understand the increase in coherence during task activation at 10-50Hz.

**Conclusion:** This study uses fNIRS to obtain high frequency data and is the first to study coherence in a pediatric population. We confirm that low frequencies are suitable for fMRI coherence analysis and show that there is a high frequency signal, which also may relate to regional communication.

**References:**

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