



Trinity College Dublin

Coláiste na Tríonóide, Baile Átha Cliath

The University of Dublin

Network Changes in Polio Survivors- CorticoMuscular Coherence Study

Dr Amina Coffey

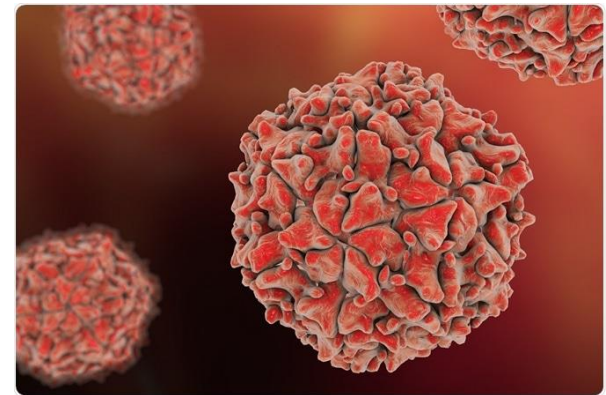
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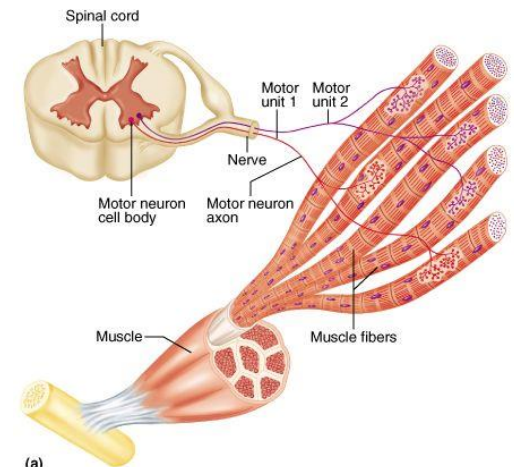
Post Polio Syndrome

- **Post-Polio Syndrome (PPS)**
 - New muscle weakness
 - Fatigability
 - Muscular atrophy
- **15- 80 % polio survivors go on to develop PPS**
- **15–20 million people worldwide continue to experience sequelae of polio**



PPS Background

- **Limited neurophysiological studies of brain changes and its effects on spinal cord (anterior horn cell) function**
 - Evolving evidence of central pathways affected in PPS
 - Directly as a result of the original illness
- Or
- Compensatory process following the loss of motor neurons



(a)
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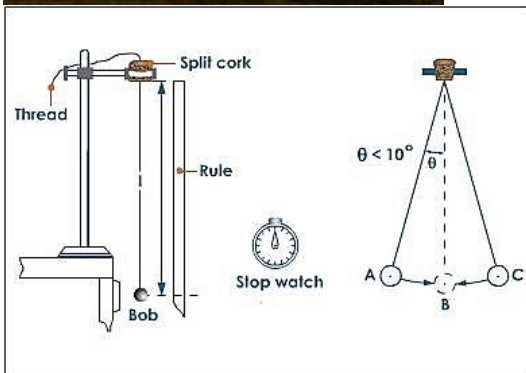
Hypothesis

Those who experience late effects of poliomyelitis exhibit wider changes in motor circuitry as a compensatory response to continuous remodelling of the motor unit (nerve muscle bundles).

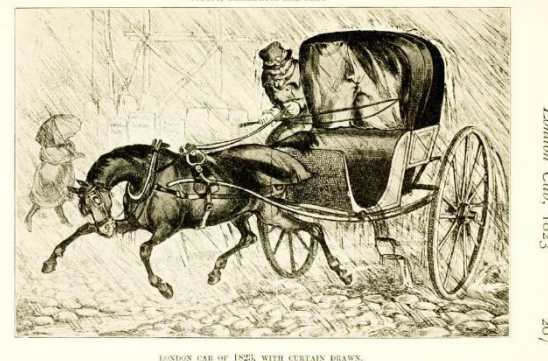
Coherence

Coherence

Introduction



Moore, Omnibuses and Cabs

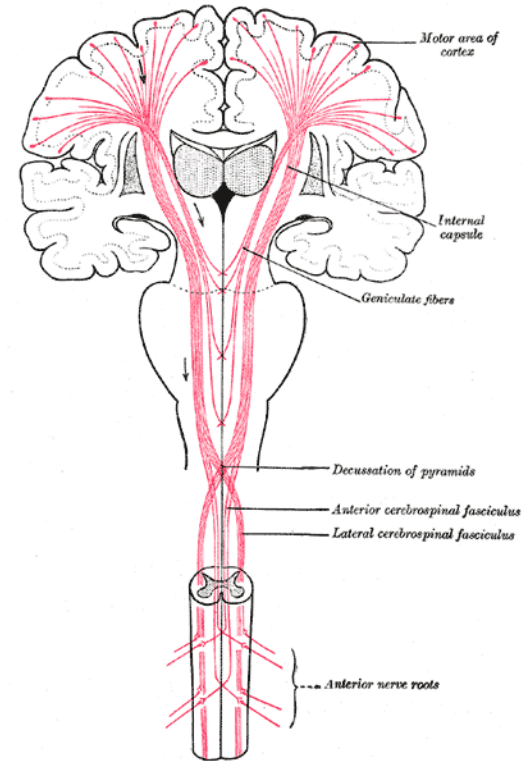


London Cab, 1825

Coherence

Coherence- mathematical approach to assessing real time messaging between nerve signals

- Involves: simultaneous recordings of multi-channel EEG and EMG for statistical analysis.
- Quantify the level of effective communication between all brain regions while quantifying the oscillatory motor drives to muscles during movement.



Frequency Bands in CMC

Band	Frequency	Physiological Correlates
Alpha band	8-12Hz	Physiological tremor
Beta band	15-30Hz	Present in sustained muscle contraction
Gamma band	30-60Hz	Present in dynamic force output

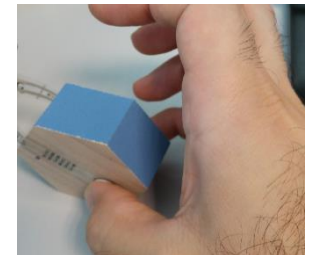
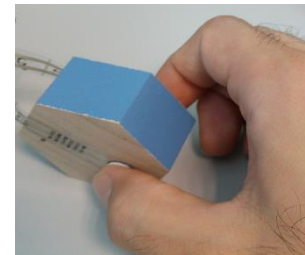
CMC Protocol (1/2)

Clinical Assessment

- MRC muscle strengths,
- Reflexes,
- Tone,
- Pathological signs noted- Wasting, fasciculations, clonus.

3 Isometric thumb-index pincer grips based on visual cues

- Maximum Voluntary Contraction
- Grip, hold, release (preferred speed)
- Sustained grip of an elastic object



CMC Protocol (2/2)

Simultaneous High-density 128-channel EEG + 3 bipolar surface EMG (Right arm)

- Abductor Pollicis Brevis (APB)
- First Dorsal interosseous (FDI)
- Flexor Pollicis Brevis (FPB)



Recruitment

Patients recruited between 2017-September 2019 (Polio clinic-Beaumont Hospital)

- All patients verified diagnosis of poliomyelitis in childhood
- All had clinical and EMG examination that support diagnosis

Exclusion Criteria :

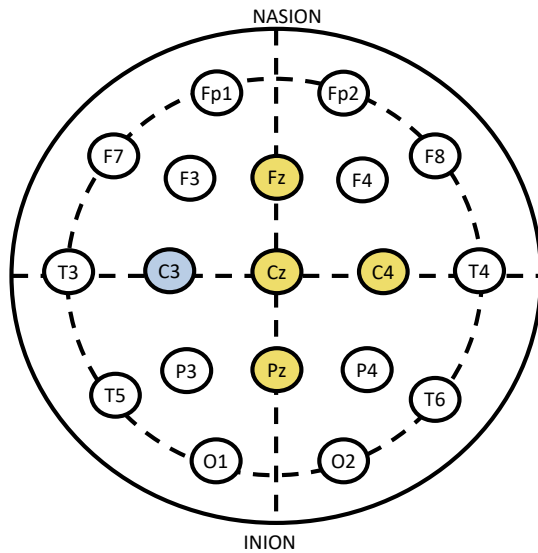
• Major head trauma	High dose psychoactive medication
• Neurological conditions that could affect cognition	Diabetes Mellitus
• Alcohol dependence syndrome	Cerebrovascular Disease
• Current use of neuroleptic medications	Neuropathy from other causes

Recruited Demographics

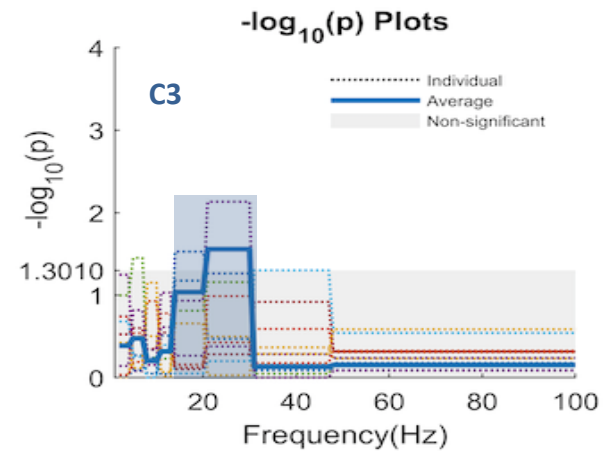
	Patient group	Controls
Gender (F/M)	15/6	4/7
Average Age at recording (F/M)	69.2/63.5	63.7/67
Onset < 24 months	11/10	-

CMC Results

Results- what you would expect to see

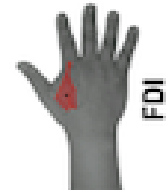
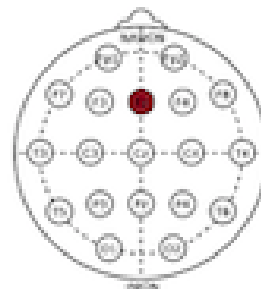
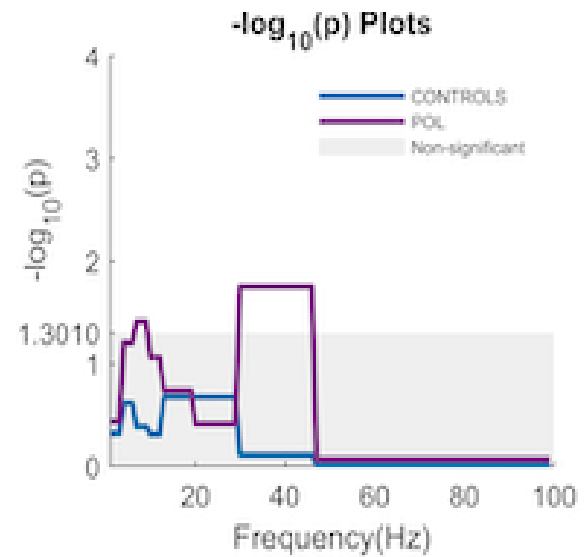
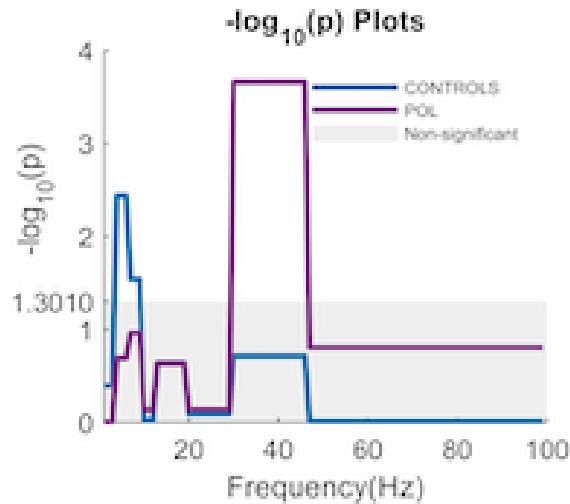


Typical Beta band frequency and location seen in healthy controls



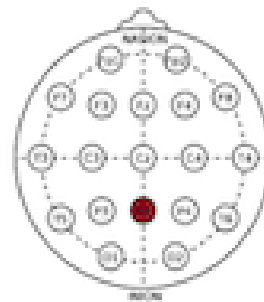
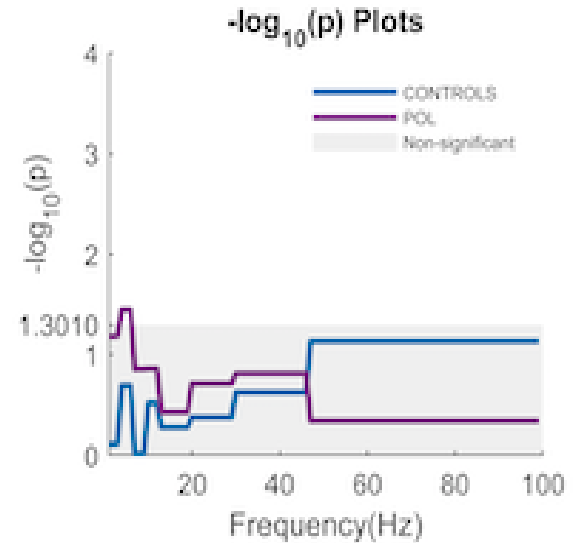
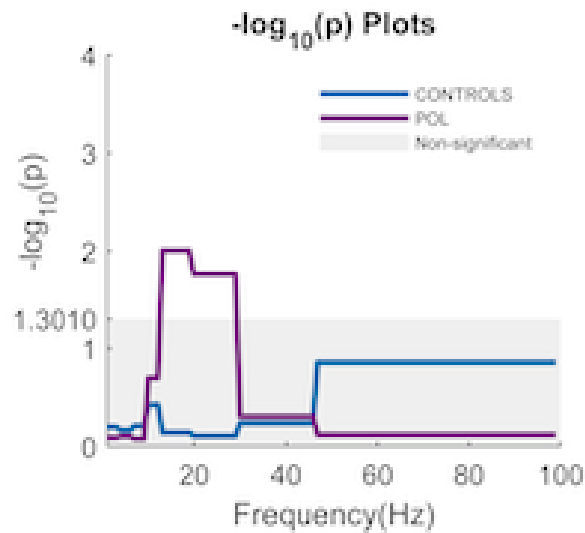
Group level results

CMC during low force levels-Fz



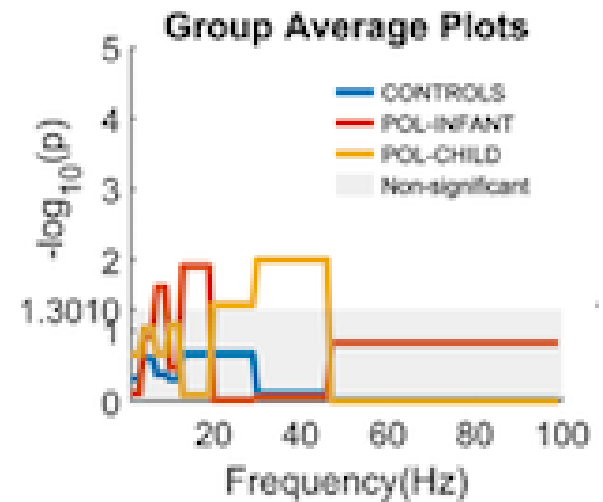
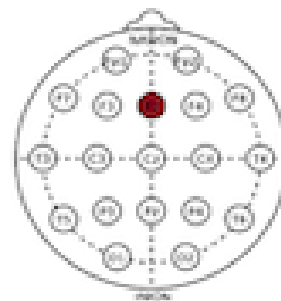
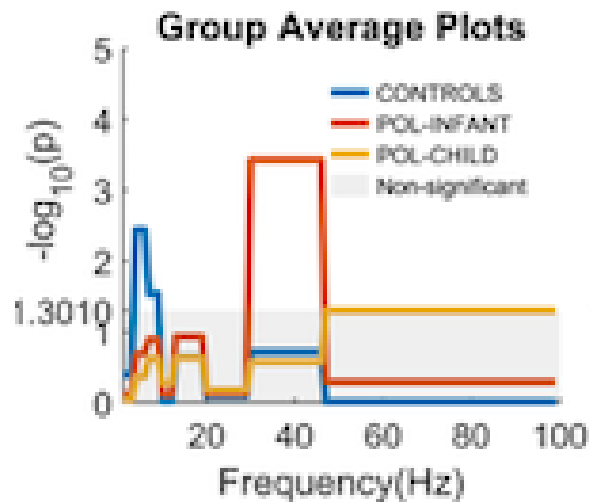
Group level results

CMC during low force levels-Pz



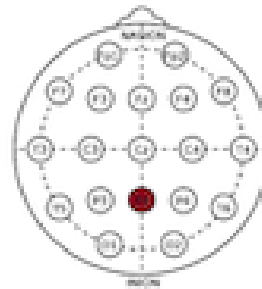
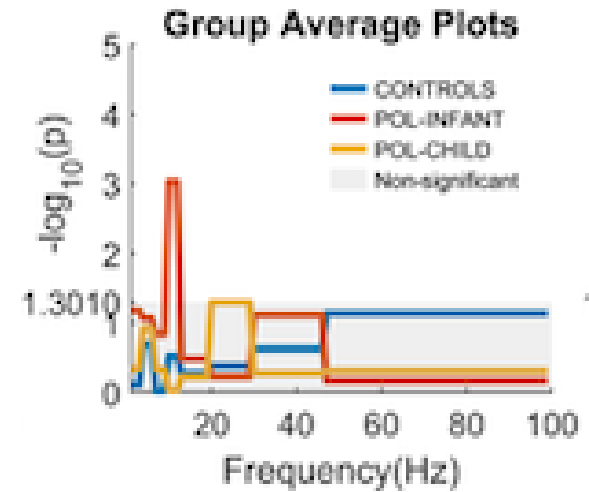
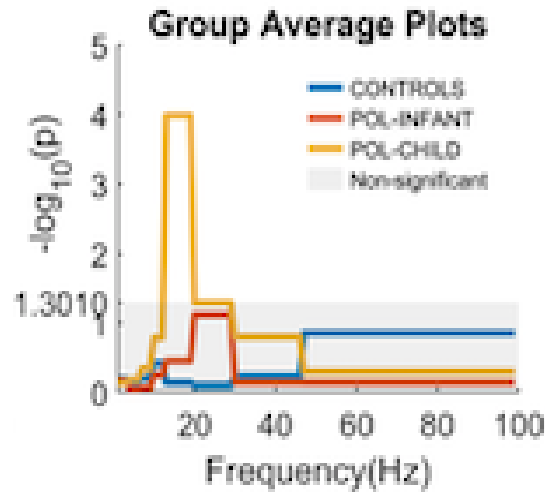
PPS Sub-groups

CMC during low force levels-Fz



PPS sub-Groups

CMC during low force levels-Pz



Discussion

Discussion

Other studies have shown evidence of brain networking changes

- Enlarged motor areas in patients who contracted polio prior to reaching 18 months of age
- Findings consistent with imaging data from other similar syndromes (SMA) → increased grey matter density in motor and extra-motor regions seen on MRI

Adaptive Reorganization

Our study suggest motor pathways in PPS undergo compensatory changes

- Indications of plasticity in the motor circuitry
 - Evidenced by presence of consistent altered frequency bands in PPS
- Changes likely reflect compensatory changes within the motor cortex

Changes in projecting nerves to motor nerve pools is most likely to happen in the first few years of life, when nerves are undergoing growth and pruning stage

Conclusions

“Growth and Pruning” stage → supports our findings of differing CMC patterns seen between the differing age of onset groups

CMC is a tool that can be used to evaluate motor networks as a whole

Source reconstruction can associate abnormal findings to more specific brain regions

Ongoing studies looking into harnessing CMC as a tool to measure changes /improvements in clinical trials where measuring objective physiological changes is sometimes difficult

Acknowledgements

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Thank You

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