Inter-hemispheric communication is altered during learning of a new bimanual coordination in teenagers with developmental coordination disorder

**Background**

- Developmental Coordination Disorder (DCD) leads to possible motor learning deficit (GheySEN et al. 2011).
- Bimanual coordination paradigm allows investigating possible dysfunction in brain communication because it relies on the coupling between brain regions of both cerebral hemispheres (Serrien, 2008).
- Learning a new bimanual coordination results in the increase of accuracy and stability of the coordination (Tallet et al. 2008) and is associated with changes in intra- and inter-hemispheric coherence between electroencephalographic (EEG) signals (Gerloff and Andres, 2002).

**Protocol**

**Participants**

10 typically developing (TD) and 10 DCD teenagers right-handed aged 12 to 16 years

**Experimental task**

Teenagers had to tap with their thumbs on two required joystick buttons in synchrony with a visual stimulus following 3 bimanual coordination: Inphase, Antiphase and New (Fig. 1).

**Procedure**

- **Control Task** (Perception + EEG)
  - Inphase
  - Antiphase
  - New
- **Pre-test** (Tapping + EEG)
  - Inphase
  - Antiphase
  - New
- **Practice** (Tapping)
  - 25 trials
- **Post-test** (Tapping + EEG)
  - Inphase
  - Antiphase
  - New

**Analysis, Results & Discussion**

**Behavioral variables:**

- **Absolute Error** (AE) of relative phase (RP) is the absolute difference between the required and the produced RP and reflects accuracy.
- **Standard Deviation** (SD) of RP reflects stability.
- **Number of additional taps** (N) are defined as two consecutive taps of the same thumb.

**EEG variable:**

- The EEG-EEG coherence is calculated in the time-frequency domain for FC3-FC4 (fronto-central cortex), FC3-C3 and FC4-C4 (left and right fronto-central regions, respectively) pairs of electrodes using wavelet coherence analysis (Bigot et al., 2011).
- **Task-Related Coherence** (TRCoh) is specifically associated to the bimanual tapping in each condition by subtracting the magnitude of beta (13-30 Hz) EEG-EEG coherence of the Control task from that of the Pre-test or the Post-test.

**ANOVA Test** (2) x Coordination (3) on:

SD, N, AE and TRCoh in the 13-30 Hz over the fronto-central cortex (FC3-FC4, FC3-C3 and FC4-C4 pairs) (p<.05)

**Behavioral results: SD, N and AE**

- Higher AE, SD and N for DCD than TD group
- SD and N were higher in DCD group despite practice

**Neural results: TRCoh FC3-FC4 and TRCoh FC4-C4**

- TRCoh over FC3-FC4 regions was lower for DCD compared to TD
- TRCoh over right FC4-C4 regions increased between Pre- and Post-Tests for the new coordination for both groups.

In both groups, practicing a new motor coordination leads to the improvement of accuracy, associated with the increase of intra-hemispheric (right) fronto-central communication. However, in DCD group, practice did not increase stability and additional taps. This last finding could be related to lower inter-hemispheric communication in DCD group. Taken together, our results could suggest a lack of motor inhibition in DCD.

For the first time, our findings provide neuroimaging evidence of a dysfunction in inter-hemispheric transfer related to motor learning difficulties in DCD.