Dance for enhancing motor and cognitive skills in children with cerebellar developmental anomalies

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Introduction

- The cerebellum plays a crucial role in temporal cognition and sensorimotor synchronization (SMS, capacity to synchronize movement with external stimuli). Developmental cerebellar anomalies (DCA) are rare pathologies leading to a cerebellar syndrome with severe impact on motor and cognitive skills including SMS [1,2,3]. Although SMS is critical for development, no therapy exists for its remediation in this condition [2,4].
- Dance is a motivating and rhythmic activity that stimulates the sensorimotor neural circuitry (i.e., cerebellum, basal ganglia, motor and pre-motor cortices) and has already been used to improve rhythm and cognition in children and adults (e.g., ADHD, Parkinson’s disease.) [5,6,7,8].
- To test the efficacy of dance training as remediation tool in patients with rare DCA, we used a test-retread protocol with an original multiple baseline experimental design, which consists in testing the patients several times before the training with different start time of the treatment for each patient. This method is adapted to interventional studies including a small number of subjects [9], particularly suited for rare diseases.

**Goal:** to show that dance is an efficient way to reduce SMS, motor and cognitive deficits associated with DCA. A longitudinal study with multiple baselines was used to assess the effect of a 2-month dance training.

Method

**Participants:**
- 7 children: aged 7-11, 2 females, with clinical cerebellar syndrome, IQ > 70 (Wechsler scale)
- Neuro-imagery (MRI). Anomaly of the vermis: n = 2 (see Figure 1), Joubert syndrome: n = 1 (with Molar tooth sign, see Figure 2), Ventricular anomalies: n = 1, normal MRI: n = 3

**Experimental design:**
- Test-retread 4-month longitudinal study with multiple baselines
- Exclusion criteria: musical expertise (> 2 years), comorbidity or epileptic treatment

**Material:**
1. Temporal cognition testing - Perceptual and SMS tasks from the Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA) [10].
- Subjective time estimation (TKS questionnaire)

**Dance training protocol:**
- 7-week training, 14 sessions of 1.5h in total, delivered by a professional dance teacher. Drumming and synchronization, progressive movements, jumping in hoops, singing, choreographies, Body and space exploration

**Results**

**Main result 1:** Patients’ deficit in SMS before training (Mann-Whitney tests, p < 0.05)
- For all temporal cognition tasks: DCA patients (n=7) < age-matched control children (n=25)
- SMS: Patients are more variable when tapping to an external beat as shown by the coefficient of Variation (CV) of the produced sequence (Mean Controls = .10, Mean Patients = .35, p < 0.05)

**Main result 2:** Improvement of SMS (CV) after training (Wilcoxon rank test, p < 0.05)
- Metronome: Mean pre = .35 / post = .19; p < .05
- Music: Mean pre = .40 / post = .22; p < .05
- Results maintained at Follow-up. No change found in rhythm perception and subjective time.

**Main result 3:** Improvement of motor, cognitive and social skills after training (Wilcoxon rank test, p < 0.05)
- Balance - number of jumps. Mean Pre = 1.86 / Post = 3.57; p < .05
- Mental flexibility (Speed and quality of the responses); p < .05
- Flexibility at home (Parents’ questionnaire - Brief); p < .05
- Social cognition (Parents’ questionnaire)
- Results were maintained at Follow-up. No change found in inhibition and arithmetic.

**Conclusion and perspectives**

- Dance may improve motor (balance), sensorimotor (movement variability in tapping) and cognitive skills (flexibility, social cognition) in children with DCA, with positive influence on everyday life.
- The impaired sensorimotor network, including the cerebellum in relation with other cerebral structures (basal ganglia, motor cortex), is likely to be boosted by dance. This neural circuitry sustains also partially other motor and cognitive capacities. Therefore, improvement in these capacities may stem from a transfer effect from the sensorimotor training involved in dance.
- Children’s improvement in social cognition observed by the parents suggest that dance positively affect social interactions of children.

**References**