EEG study of a synchronisation-syncopation task in DCD children

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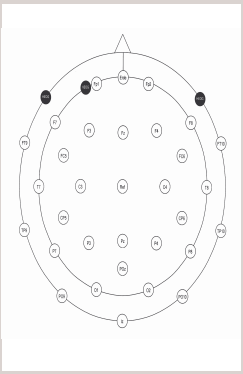
OBJECTIVE

Children with Developmental Coordination Disorder (DCD) have deep and persistent troubles in daily life activities requiring motor coordination. This disorder is specific and not due to a general medical condition, and its aetiology is still unknown. According to a central tenet of a dynamical perspective to motor coordination positing that behavioural stability stems from the self-organized synchronisation of the subcomponents (for a revue, see Kelso, 1995), the present study investigates the hypothesis that the lack of motor coordination in DCD pertains to a disorder in synchronisation. A main goal is to unravel the neurophysiological correlates of such a synchronisation

METHODS

We recorded EEG activity (Neuroscan system) with 32 electrodes in 24 children with DCD (aged eight to thirteen years) and 60 control children, while performing sensorimotor coordination task. None child is affected by ADHD. Following a paradigm pioneered by Engström et al.(1996), children were required to flex one finger with a visual periodic beep either in synchrony (each tapping should occur in strict simultaneity with visual stimulus) or in syncopation (halfway between stimuli). The stimulus frequency is progressively increased (0,5 Hz-1,3 Hz) in small steps (0,2 Hz) every 20 cycles. In parallel to stability measures in terms of the variability of performance over time, we performed a movement-related brain macropotentials (MRBMs) EEG analysis.



MEASURES

For synchronisation task, we have measured relative phase, i.e. ratio between stimulus and tapping onset (CT) and the time separating two successive visual stimuli, by 360°. A synchronisation or syncope perfectly performed have got a relative phase of 180°.

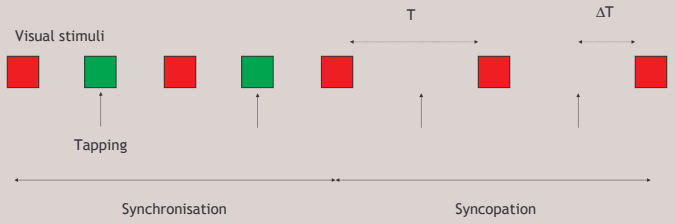


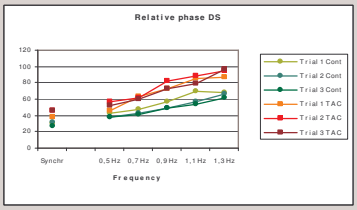
Fig. 1 : Graphic representation of experimental task, upright arrow show the time at when the children must press on keyboard, sound depicted in yellow disappear in syncope task.

Along with stability measures of performance, for EEG task we analysed three movement-related potentials (MRP) components: "*Bereitschaftspotential*" (BP), N100, and P200. BP is a negative potential reflecting cerebral process related to the preparation of movement; N100 is a negative peak following the onset of EMG and belonging to the "motor sensory period"; P200, a positive peak with a latency about 200 ms, corresponds to a "motor completion period".

BEHAVIORAL RESULTS

Synchronisation

They are no significative difference in relative phase achievement but a significative interaction between factor Trial and Group ($F(2,78) = 4,4$; $p < .05$): TAC children adopt different strategy through trial (reaction-versus anticipation) even though controls adopt the same strategy. TAC children are more variable than controls ($F(1,78) = 23$; $p < .0001$) and, unlike controls, their performance deteriorated significantly with repetition ($F(2,154) = 3$; $p < .05$) (fig. 2 and fig. 3).



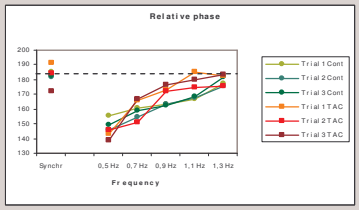


Fig. 2 (left) Frequency progressions of relative phase during synchronisation and syncope phase for DCD group (red) and controls (green) through tree trials. Fig. 3 (right) Progressions of DS of relative phase.

Syncope (fig2 et 3)

TAC are not different from control for relative phase achievement but contrary to controls whose adjust (flex) regularly to frequency increase, TAC have an very irregular adjustment ($F(4,312) = 2.7$; $p < .05$). Results shows that TAC (DS=73) are more variable than controls (DS=52) ($F(1,78) = 48,6$; $p < .0001$). Variability decrease significantly with age ($F(2,78) = 16.3$, $p < .0001$). The performance deteriorated significantly with repetition ($F(2,156) = 8.4$; $p < .0001$) and TAC performance are much sensible to frequency increase ($F(4,312) = 4.1$; $p < .01$) (fig. 2 and fig. 3).

EEG RESULTS

BP

The two groups was very different at 8 years : TAC children have got a preparation of 608 despite control children of 428. There was an interaction group-age [$F(2,75) = 4.6$; $p < .05$].

N100

Latency was different between the groups, lower for the subjects of the control group (mean latency of 117,2 ms) that for those of TAC group (123,6 ms on average) with an effect of the factor Group [($F(1,74) = 6.6$; $p<.05$)]. There was no group effect for amplitude.

P200

P200 was not different between groups.

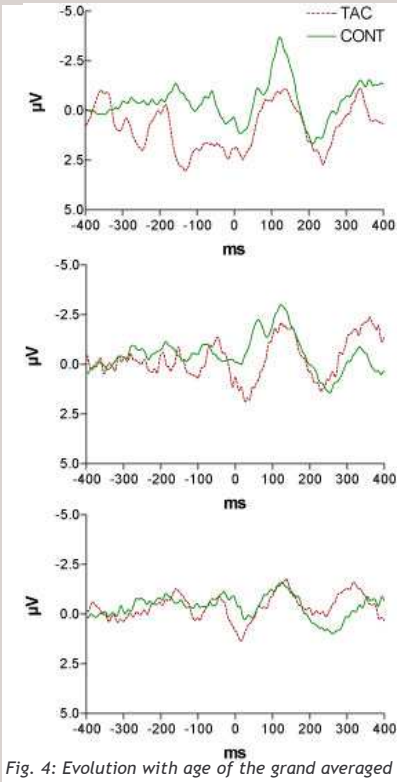


Fig. 4: Evolution with age of the grand averaged ERPS from the group of DCD children (red) and the group of control children (green) from CP5 electrode

CONCLUSION

In one part, behavioural results show that DCD children are significantly more variable than controls in all conditions and that they are not improved with repetition. The performance of DCD is more impaired than controls with frequency increase. These results suggesting that more the task is difficult in terms of synchronisation, more performance deteriorate.

Similar conclusions were found in a study of bimanual performance (Albaret et al., 2000, Volman & Geuze, 1998). In other part, EEG findings suggest, that abnormalities in latency and amplitude of those components were found in preparation and execution phases. Regarding prepara-tion, eight-years-old DCD children showed a much larger motor preparation component. Similar results are observed in other neurological diseases like Parkinson syndrome (Fattapposta, 2000) or neuro-developemental disorders, such as Gilles de la Tourette syndrome (Rothenberger, 1998). Regarding execution, all DCD children exhibited a N100 latency longer than control children, suggesting that the processing of the reafferent activity generated by the muscles as a result of movement is achieved more slowly (Hill & Raab, 2005). This slowness might contribute a basic inability to produce movements with spatial and temporal accuracy, such as synchronised movement. N200 was not different between groups. In sum, children with DCD show abnormalities in MRP during a motor coordination task, indicating a peculiar pattern of cortical processing.

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Acknowledgements

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