

## **Cognitive and motor function and the size of the cerebellum in adolescents born very pre-term**

Brain, Vol. 124, No. 1, 60-66, January 2001

Matthew Allin, Hideo Matsumoto, Alastair M. Santhouse, Chiara Nosarti, Mazin H. S. AlAsady, Ann L. Stewart, Larry Rifkin and Robin M. Murray

### FROM ABSTRACT

Individuals born before 33 weeks gestation are at risk of brain lesions, which have the potential to disrupt subsequent neurodevelopment.

As a result they manifest an increased incidence of neuromotor signs and cognitive deficits, which can still be detected in adolescence.

The cerebellum is known to be involved in both the co-ordination of movement and in cognitive processes.

We therefore set out to establish whether cognitive and motor impairments in adolescents born very pre-term are associated with abnormalities of the cerebellum as revealed by volumetric analysis of brain MRI scans.

The volume of the whole cerebellum was determined in 67 adolescents born very pre-term and 50 age-matched, full-term born controls.

Cognitive and neurological assessments were performed at 1, 4, 8 and 14–15 years of age in these subjects.

The pre-term-born subjects had significantly reduced cerebellar volume compared with term-born controls.

This difference was still present after controlling for potential confounders.

There was no association between cerebellar volume and motor neurological signs. However, there were significant associations between cerebellar volume and several cognitive test scores, in particular the Wechsler Intelligence Scale for Children—Revised, the Kaufman Assessment Battery for Children and the Schonell reading age. **[IMPORTANT]**

This provides further evidence implicating the cerebellum in cognition and suggests that cerebellar abnormalities may underlie some of the cognitive deficits found in individuals born very pre-term.

THESE AUTHORS ALSO NOTE:

## INTRODUCTION

The process of neurodevelopment starts soon after conception and continues into the second decade of life.

“The survivors of very pre-term births show an excess of neurological and cognitive impairments, reflecting the influence of early damage on their subsequent neurodevelopment.”

Once these individuals reach school age they are more likely to be clumsy than their term-born classmates and tend to do less well academically.

“In addition to cognitive impairments, such individuals manifest a constellation of neurological signs, including dysdiadochokinesis, poor co-ordination of fine movements and impaired motor sequencing which has been termed ‘developmental co-ordination disorder.’”

“Such motor signs are traditionally associated with dysfunction of the cerebellum, a brain structure known to be particularly vulnerable around the time of birth.”

The authors hypothesized that the cerebellum is damaged by very pre-term birth, and hypothesized that reduced cerebellar volume would be associated with impaired cognitive and motor function in this pre-term group.

## RESULTS

“Subjects born very pre-term had abnormal neurological examination results compared with term-born controls.”

The volume of the cerebellum was smaller in pre-term-born cases than controls.

There “were significant relationships between various cognitive variables measured at 4, 8 and 14–15 years and cerebellar volume in the cases of patients born very pre-term.”

## DISCUSSION

“We have demonstrated that individuals born very pre-term have significantly smaller cerebella than their term-born peers and that this difference remains statistically significant after controlling for whole brain volume and other potentially confounding variables.”

There are good grounds for suspecting that the cerebellum may be involved in the motor and cognitive problems associated with very pre-term birth.

“The mammalian cerebellum is known to be in a vulnerable state around the time of birth, since this is a period of active proliferation and migration of the cerebellar granule cells.”

Potentially harmful events around the time of birth or during a post-natal period may interfere with the development of the cerebellar cell population.

“Other cell populations of the cerebellum may then have their own development altered because of disordered, or absent, interactions with cerebellar granule cells.”

“The reduced size of the cerebellum that we demonstrate may thus reflect a relative loss of cell populations or abnormal ultrastructural development —such as dendritic branching or synaptogenesis —as a result of a neonatal insult.”

These findings may represent a lack of “developmental plasticity of the cerebellum or of cortico-cerebellar circuits.”

“Although there was no relationship to motor signs, we did find significant associations between a number of cognitive measures and cerebellar size.”

“Although our findings do not prove a causal relationship they do add to the accumulating body of evidence implicating the cerebellum in cognition, language, and attention in addition to its motor functions.”

“Focal cerebellar lesions in both adults and children produce a characteristic cognitive-affective syndrome consisting of deficits in executive function, visuospatial cognition and language and blunting of affect, or disinhibited or inappropriate behaviour.”

“The overall result of these deficits is an overall decline in cognitive performance.”

These results are consistent with reduced cerebellar volume being associated with deficits in executive and visuospatial function and language (reading age, riddle interpretation, etc).

“Our findings are therefore broadly consistent with the cerebellar cognitive-affective syndrome.”

"The cognitive deficits associated with pre-term birth may therefore be related to dysfunction in several neural systems, which include the cerebellum."

"There are anatomical connections from the cerebellum, via the thalamus, to sensorimotor cortex, dorsolateral and dorsomedial prefrontal cortex, Broca's area and limbic and parahippocampal areas." **[IMPORTANT]**

The "function of the cerebellum is to aid the performance of any area of the brain to which it has reciprocal connections." **[IMPORTANT]**

"Subtle cerebellar abnormality causing a degree of cerebellar hypofunction could thus underlie the reduced performance of pre-term-born individuals in a number of different cognitive domains."

## SUMMARY

The authors "conclude that the smaller cerebellar volume of adolescents born very pre-term reflects a disruption of the normal development of this structure."

The authors have "noted a relationship between cerebellar volume and performance on cognitive tests, including some tests of language function."

"This suggests that cerebellar pathology may, at least in part, underlie the cognitive impairments seen in those born very pre-term."

"In addition it provides further evidence in support of the general role of the cerebellum in cognition."

---

The cerebellum is very important to chiropractors. Spinal adjustments are mechanical, and fire to the cerebellum. This article supports the model that problems with early life cerebellar synaptogenesis results in cognitive impairments later in life. I believe that this supports our contention that infants, including newborns, should be assessed by a chiropractor for proper joint afferentation and subsequent cerebellar synaptogenesis. If a joint or postural problem is found in these children, it should be adjusted.

Dan Murphy