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# The child with acquired disorders of speech and language: Cerebellar Mutism Syndrome

EPNS Training Course

Budapest

10-11 March 2016

Philippe F. Paquier, Brussels, Belgium
Femke K. Aarsen, Rotterdam, The Netherlands

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## Acquired mutism in children

Possible surgical causes of neurological mutism:

- Thalamotomy for parkinsonism
- Callosotomy
- Surgery to SMA of dominant hemisphere
- Posterior fossa surgery

Aguiar PH et al. Transient mutism following a posterior fossa approach to cerebellar tumors in children: a critical review of the literature. Child's Nerv Syst 1995: 11: 306-310.

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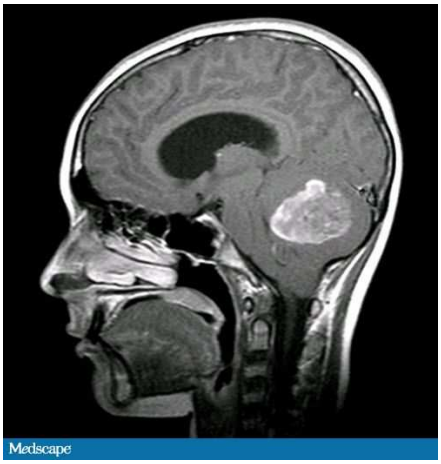
## Acquired mutism in children

Posterior fossa surgery:

"*A transient mutism occurring after a posterior fossa tumor approach in children with unimpaired consciousness, unimpaired symbolic functions, no detectable deficit of cranial nerves or peripheral organs of speech, and no lesions of long pathways in the course of the cranial nerves at the level of the brainstem*." [p. 306]

Aguiar PH et al. Child's Nerv Syst 1995: 11: 306-310.

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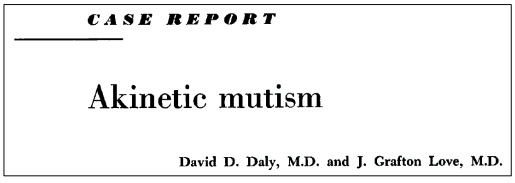
## Acquired cerebellar mutism in children



CASE REPORT

Akinetic mutism

David D. Daly, M.D. and J. Grafton Love, M.D.

Neurology 1958: 8: 238-242.

- First detailed observation of mutism after removal of a posterior fossa grade I astrocytoma in a 14-yr-old boy.
- Bilateral suboccipital craniectomy through a midline incision, vermis splitting (August 2, 1957).
- Patient displayed additional cognitive, behavioral, and affective symptoms.
- 3 weeks post-surgery, 40 mg methylphenidate hydrochloride IV.

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## Acquired cerebellar mutism in children

- *"The next day, the patient slept almost continuously but could be aroused by being spoken to. On command, he would grasp his father's hand."*
- *"He responded to aspiration by coughing and gagging, but he did not speak or utter any sounds."*
- *"By the third postoperative day the patient moved all extremities without signs of weakness. He would grasp objects firmly with both hands and protrude his tongue on request, but he remained mute."*
- *"One week after operation the patient appeared aware of his environment and cooperated slowly (…) yet he continued mute."*

Neurology 1958: 8: 238-242.

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## Acquired cerebellar mutism in children

- *"Although he seemingly recognized his parents, he showed no emotional response to them. His features were expressionless, and he had no interests in the activities about him."*
- *"At the end of two weeks he had yet to utter a sound (…) he obeyed simple commands and communicated with his parents by sign language."*

At this point: administration of analeptics up to daily doses of 100 mg.

- *"One month after operation the patient was able to follow moderately complicated commands (…) yet he had still made no effort to speak."*

Neurology 1958: 8: 238-242.

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## Acquired cerebellar mutism in children

- *"On September 5* the patient spoke for the first time when he called his parents by name (…) later that day he mentioned his sister's name."*
- *"The complexity of his speech rapidly increased the next few days. Within one week he spoke lucidly, but with a scanning measured speech of cerebellar type."*
- *"At the time of dismissal on September 27 he had mild cerebellar speech and moderate ataxia."*

* 34 days post-surgery

Neurology 1958: 8: 238-242.

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## Acquired cerebellar mutism in children

Further anecdotal observations:

- Hirsch JF et al. Medulloblastoma in childhood: survival and functional results. Acta Neurochir 1979: 48: 1-15.
- Pierre-Kahn A et al. Mutisme après chirurgie de la fosse postérieure chez l'enfant. Rev Neurol 1980: 136: 92.
- Sakai H et al. Three cases of "cerebellar mutism". Shinkeinaika 1980: 12: 302-304.

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## Acquired cerebellar mutism in children

First elaborated study published in 1985.

- 6 children, aged 2-11 yrs:
  - 4 medulloblastomas
  - 1 ependymoma
  - 1 cystic astrocytoma
- 2 detailed case descriptions:
  - acute lesions involving:
    - the cerebellar vermis
    - both cerebellar hemispheres
    - deep nuclei of the cerebellum
  - resolution of muteness over a period of 1 to 3 mths
  - during recovery process: dysarthria

**Muteness of Cerebellar Origin**

Harold L. Rekate, MD; Robert L. Grubb, MD; Dorothy M. Aram, PhD; Joseph F. Hahn, MD; Robert A. Ratcheson, MD

Clinical Aspects

| Patient No./ Age, yr | Duration of Muteness, mo | Diagnosis |
|---|---|---|
| 1/8 | 3 | Medulloblastoma |
| 2/6 | 3 | Cystic astrocytoma |
| 3/2 | 2 | Ependymoma |
| 4/10 | 2 | Medulloblastoma |
| 5/9 | 3 | Medulloblastoma |
| 6/11 | 3 wk | Medulloblastoma |

Arch Neurol 1985: 42: 697-698.

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## Acquired cerebellar mutism in children

"Purely cerebellar origin" because:

- lack of long-tract findings
- lack of cranial nerve dysfunction
- reversibility of muteness with period of cerebellar dysarthria
- preservation of higher cognitive functions

**Muteness of Cerebellar Origin**

Harold L. Rekate, MD; Robert L. Grubb, MD; Dorothy M. Aram, PhD; Joseph F. Hahn, MD; Robert A. Ratcheson, MD

Arch Neurol 1985: 42: 697-698.

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## Acquired cerebellar mutism in children

**Terminology since 1985:**

- ***Muteness*** of cerebellar origin (Rekate et al., 1985; Volcan et al., 1986).
- ***Mutism*** after posterior fossa tumor surgery (Humphreys, 1989; Ferrante et al., 1990), after removal of a vermian medullo-blastoma (Nagatani et al., 1991), following posterior fossa surgery (Balasubramaniam et al., 1993).
- ***Transient mutism*** following removal of a cerebellar tumor (Ammirati et al., 1989).
- ***Cerebellar mutism*** after posterior fossa surgery (Dietze & Mickle, 1990-91).
- ***Transient loss of speech followed by dysarthria*** after removal of posterior fossa tumor (Catsman-Berrevoets et al., 1992).
- ***Mutism and subsequent dysarthria*** (Van Dongen et al., 1994).

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## Acquired cerebellar mutism in children

Core features of Cerebellar Mutism:

(1) mutism occurs after resection of a cerebellar mass lesion;

(2) there is generally a delayed onset of speech loss after an interval of a few hours up to 11 days of normal speech post-surgery;

(3) mutism is transient and usually lasts from 1 day to 6 months, but exceptions up to 2½ years of postoperative speechlessness have been documented;

(4) mutism is followed by a severe disorder of motor speech production –i.e., dysarthria– which usually recovers in 1 to 7 months, but in some instances a residual dysarthria has also been recorded > 7 years after surgery;

(5) there are frequent associations with other neurological disturbances, such as long tract signs, language impairments, cognitive abnormalities, behavioral and affective deficits.

De Smet HJ et al. Eur J Paediat Neurol 2007: 11: 193-207.

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## Acquired cerebellar mutism in children

- Cerebellar mutism reported in few adults (e.g., Salvati et al., 1991; Van Mourik et al., 1997; Coplin et al., 1997; Ildan et al., 2002; Akil et al., 2006).
- However, cerebellar mutism is typically viewed as a pediatric syndrome.
- Frequency estimations:

  5/63 (7.9%) (Van Calenbergh F et al. Neurosurgery 1995: 37: 894-898)

  9/110 (8.2%) (Dailey AT et al. J Neurosurg 1995: 83: 467-475)

  12/142 (8.5%) (Pollack IF et al. Neurosurgery 1995: 37: 885-893)

  12/44 (27%) (Van Mourik M et al. Pediatr Neurol 1998: 18: 411-414)

  12/42 (29%) (Catsman-Berrevoets C et al. JNNP 1999: 67: 755-757)

  17/55 (31%) (Catsman-Berrevoets C et al. Pediatr Neurosurg 2003: 38: 122-127)

  41/148 (28%) (Catsman-Berrevoets C, Aarsen FK. Cortex 2010: 46: 933-946)

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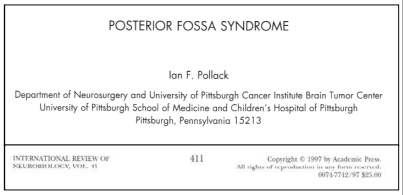
## Acquired cerebellar mutism in children

- Cerebellar-induced mutism may be associated with various neuro-behavioral abnormalities:
  - Eating dysfunction and poor oral intake
  - Emotional instability and irritability
  - Infantile and regressive behavior
  - Whining
  - Apathy and depressed affect
  - Impaired eye opening or eyelid apraxia
  - Lack of bowel and bladder control
  - Decreased spontaneous initiation of a wide range of voluntary activities
  - Impulsive reactions



POSTERIOR FOSSA SYNDROME

Ian F. Pollack

Department of Neurosurgery and University of Pittsburgh Cancer Institute Brain Tumor Center
University of Pittsburgh School of Medicine and Children's Hospital of Pittsburgh
Pittsburgh, Pennsylvania 15213

INTERNATIONAL REVIEW OF NEUROBIOLOGY, VOL. 41 411


0074-7742/97 $25.00

These symptoms led to the introduction of the broader term

**Posterior Fossa Syndrome (PFS)**

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## Acquired cerebellar mutism in children

At the emotional and affective level, adynamia and symptoms indicating inhibition of frontal lobe functions are often recorded, e.g.:

- Lack of initiative and aspontaneity
- Apathy and disinterest
- Emotional unsteadiness
- Flattened affect
- Inadequate emotional coping
- Diminished eye contact
- Withdrawal
- Symptoms consistent with Cerebellar Cognitive Affective Syndrome (CCAS)

ELSEVIER

Clinical Neurology and Neurosurgery

Review

Cerebellar neurocognition: Insights into the bottom of the brain

Hanne Baillieux, Hyo Jung De Smet, Philippe F. Paquier, Peter P. De Deyn, Peter Mariën

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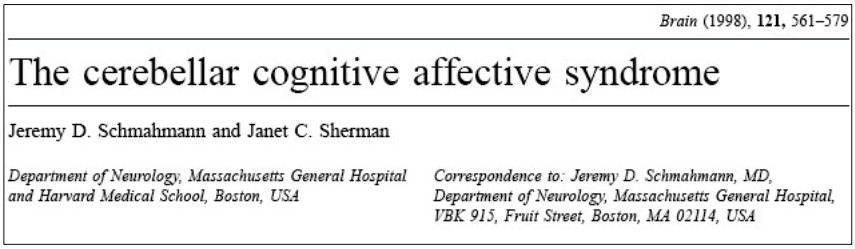
## Acquired cerebellar mutism in children



*Brain* (1998), **121**, 561–579

The cerebellar cognitive affective syndrome

Jeremy D. Schmahmann and Janet C. Sherman

*Department of Neurology, Massachusetts General Hospital and Harvard Medical School, Boston, USA*

*Correspondence to: Jeremy D. Schmahmann, MD, Department of Neurology, Massachusetts General Hospital, VBK 915, Fruit Street, Boston, MA 02114, USA*

- Impairment of executive functions such as planning, set-shifting, verbal fluency, abstract reasoning, working memory;
- Difficulties with spatial cognition, including visual-spatial organization and memory;
- Personality change with blunting of affect or disinhibited and inappropriate behavior;
- Language deficits including agrammatism and dysprosodia.

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## Acquired cerebellar mutism in children

*Brain* (2000), **123,** 1041–1050

Neuropsychological consequences of cerebellar tumour resection in children

Cerebellar cognitive affective syndrome in a paediatric population

Lisi Levisohn,[1] Alice Cronin-Golomb[1] and Jeremy D. Schmahmann[2]

Language impairments in 7/19 children (37%):

- Word-finding difficulties in conversation.
- Spontaneous vocabulary below age level.
- Impaired comprehension and repetition of sentences.
- Semantic paraphasias during confrontation naming.
- Difficulties with language initiation.

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## Acquired cerebellar mutism in children

Mutism occasionally does not materialize at all, and a wide range of postoperative neurobehavioral symptoms have been found instead, e.g.:

- Executive dysfunction
- Poor problem-solving
- Mnestic disorders
- Reduced attention-span
- Visual-constructive deficits

*The Cerebellum.* 2006; 5: 289–295

Taylor & Francis

ORIGINAL ARTICLE

**Neurobehavioral alterations in an adolescent following posterior fossa tumor resection**

HANNE BAILLIEUX[1], HYO JUNG DE SMET[1], GEOFFREY LESAGE[2], PHILIPPE PAQUIER[1,3], PETER P. DE DEYN[4] & PETER MARIËN[1,4]

[1]*Department of Linguistics, Vrije Universiteit Brussel, Brussels,* [2]*Department of Neurosurgery, ZNA Middelheim, Antwerp,* [3]*Hôpital Universitaire Erasme ULB, Brussels and Unit of Neurosciences, Universiteit Antwerpen, and* [4]*Department of Neurology, ZNA Middelheim, Antwerp and Laboratory of Neurochemistry and Behaviour, Institute Born-Bunge, Universiteit Antwerpen, Belgium*

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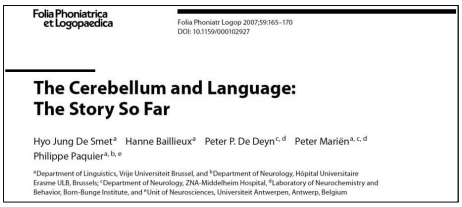
## Acquired cerebellar mutism in children

Various, concomitant non-motor language disturbances have also been identified, e.g.:

- Word finding difficulties
- Agrammatism
- Disrupted language dynamics and lack of verbal initiative
- Reading and/or writing problems
- Comprehension deficits

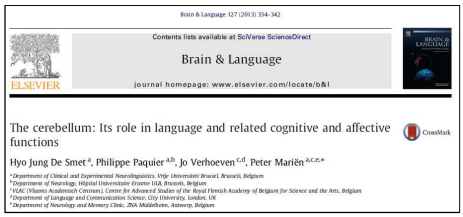

Folia Phoniatrica et Logopaedica

Folia Phoniatr Logop 2007;59:165–170
DOI: 10.1159/000102927

**The Cerebellum and Language: The Story So Far**

Hyo Jung De Smet[a] Hanne Baillieux[a] Peter P. De Deyn[c, d] Peter Mariën[a, c, d] Philippe Paquier[a, b, e]

[a]Department of Linguistics, Vrije Universiteit Brussel, and [b]Department of Neurology, Hôpital Universitaire Erasme ULB, Brussels; [c]Department of Neurology, ZNA-Middelheim Hospital, [d]Laboratory of Neurochemistry and Behavior, Born-Bunge Institute, and [e]Unit of Neurosciences, Universiteit Antwerpen, Antwerp, Belgium


Brain & Language 127 (2013) 334–342

Contents lists available at SciVerse ScienceDirect

Brain & Language

journal homepage: www.elsevier.com/locate/b&l

**The cerebellum: Its role in language and related cognitive and affective functions**

Hyo Jung De Smet [a], Philippe Paquier [a,b], Jo Verhoeven [c,d], Peter Mariën [a,c,e,*]

[a]Department of Clinical and Experimental Neurolinguistics, Vrije Universiteit Brussel, Brussels, Belgium
[b]Department of Neurology, Hôpital Universitaire Erasme ULB, Brussels, Belgium
[c]UGC (Vlaams Academisch Centrum), Centre for Advanced Studies of the Royal Flemish Academy of Belgium for Science and the Arts, Belgium
[d]Department of Language and Communication Science, City University, London, UK
[e]Department of Neurology and Memory Clinic, ZNA Middelheim, Antwerp, Belgium

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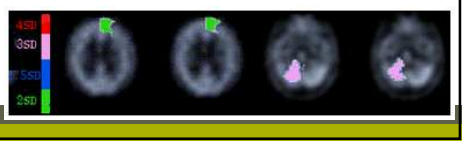
## Acquired cerebellar mutism in children

**Pathophysiology:**

- Postoperative spasm of the vessels supplying the cerebellum and the brainstem may cause ischemia and subsequent edema (cf. delayed postoperative onset of mutism after a period of normal speech).
- Transient dysfunction of A9 and A10 mesencephalic dopaminergic cell groups and ascending activating reticular system.
- Transient dysregulation of neurotransmitter release originating from the tumor removal and the alleviation of long-lasting compression of the brainstem by the tumor.
- Bilateral damage to dentate and interpositus nuclei or the afferent and/or efferent pathways passing through these nuclei.
- Crossed cerebello-cerebral diaschisis reflecting the metabolic impact of a cerebellar lesion on a distant yet anatomically and functionally connected supratentorial region.



Quantified ECD-SPECT study showing hypoperfusion in the right cerebellar hemisphere and the left medial frontal area (Baillieux et al., 2008).

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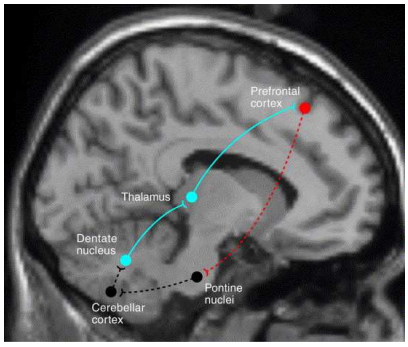
## Acquired cerebellar mutism in children

- Neuroanatomical studies in the 1970s, 1980s, and 1990s showed reciprocal neuronal pathways linking the cerebellum with autonomic, limbic, and associative regions of the cerebrum.

  $\Rightarrow$ the cerebellum can communicate in a bi-directional way with supra-tentorial area's concerned with cognitive functioning.




http://www.cell.com/cms/attachment/551142/3918657/gr1.jpg

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## Acquired cerebellar mutism in children

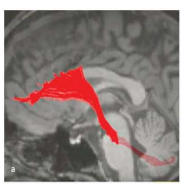
**Anatomical Evidence for Cerebellar and Basal Ganglia Involvement in Higher Cognitive Function**

Frank A. Middleton and Peter L. Strick*

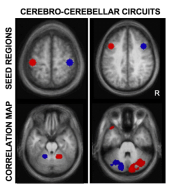
Middleton FA, Strick PL. Science 1994: 266: 458-461.

The concept of cerebellar contribution in nonmotor cognitive processes is based on the discovery of major reciprocal neuronal pathways between the phylogenetically new parts of the lateral cerebellum and the contralateral premotor areas of the cerebral hemisphere (Broca's area [BA 44-45] and SMA [BA 6]).

http://www.frontiersin.org/files/Articles/88676/fnsys-08-00163-HTML/image_m/fnsys-08-00163-g002.jpg



http://jn.physiology.org/content/jn/103/1/297/F15.medium.gif



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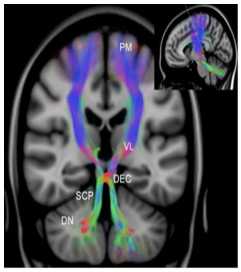
## Acquired cerebellar mutism in children

Recent diffusion tensor imaging (DTI) studies in patients with PFS confirm the crosswise organization of the reciprocal cerebello-cerebral connections, as demonstrated by functional neuroimaging studies.





Childs Nerv Syst (2013) 29:597–607
DOI 10.1007/s00381-012-1973-8

ORIGINAL PAPER

**Fronto-cerebellar fiber tractography in pediatric patients following posterior fossa tumor surgery**

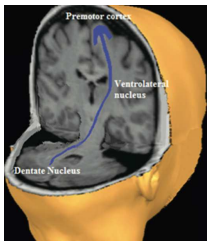
Verena Soelva · Pablo Hernáiz Driever · Alexander Abbushi · Stefan Rueckriegel · Harald Bruhn · Wilhelm Eisner · Ulrich-Wilhelm Thomale


doi:10.1093/brain/awp241 Brain 2009: 132; 3087–3095 | 3087

BRAIN
A JOURNAL OF NEUROLOGY

**Proximal dentatothalamocortical tract involvement in posterior fossa syndrome**

E. Brannon Morris,[1,2] Nicholas S. Phillips,[3] Fred H. Laningham,[3] Zoltan Patay,[3] Amar Gajjar,[1] Dana Wallace,[4] Frederick Boop,[5] Robert Sanford,[5] Kirsten K. Ness[6] and Robert J. Ogg[2]




From: Keating RF. Consensus meeting on the Posterior Fossa Syndrome and Cerebellar Mutism. Reykjavik, 2015.

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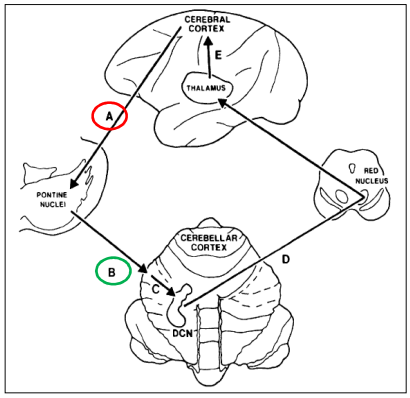
## Acquired cerebellar mutism in children

- *The **feedforward loop** of the cortico-ponto-cerebellar system:*

  **A.** Cortico-pontine projection (higher-order and sensorimotor information).

  **B.** Ponto-cerebellar pathway (to cerebellar cortex).




Schmahmann JD, Pandya DN. The cerebrocerebellar system. In: Schmahmann JD (ed). The cerebellum and cognition. San Diego: Academic Press, 1997.

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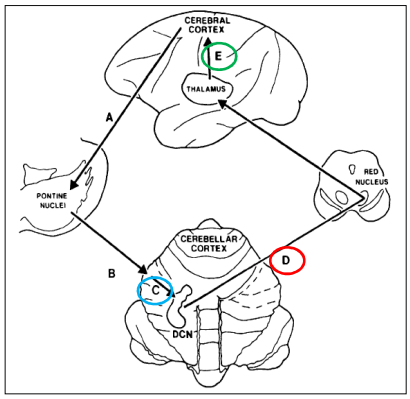
## Acquired cerebellar mutism in children

- *The **feedback loop** of the cerebello-thalamo-cortical system:*

  **C.** Cerebellar cortico-nuclear projection (to deep cerebellar nuclei).

  **D.** Cerebello-thalamic projection (via red nucleus).

  **E.** Thalamo-cortical projection.




Schmahmann JD, Pandya DN. The cerebrocerebellar system. In: Schmahmann JD (ed). The cerebellum and cognition. San Diego: Academic Press, 1997.

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## Acquired cerebellar mutism in children

Childs Nerv Syst (2013) 29:717–718
DOI 10.1007/s00381-013-2074-z

LETTER TO THE EDITOR – REPLY

### Inconsistent terminology for cerebellar mutism

Ulrich-Wilhelm Thomale · Pablo Hernaiz Driever

**Table 1** Review of the syndrome terminology mutism symptoms caused by cerebellar pathology in the available literature from 2000 to 2013 ($n$= 86) and their use for differentiation or as synonyms

| Terminology | Cited ($n$) | Used for differentiation ($n$) | | Used as synonyms ($n$) | |
|---|---|---|---|---|---|
| Cerebellar mutism (CM) | 77 | CM vs. CMS | 7 | CM and CMS | 14 |
| Cerebellar mutism syndrome (CMS) | 27 | | | CM and PFS | 5 |
| Posterior fossa syndrome (PFS) | 35 | PFS = CM+ | 15 | CM and MSD | 6 |
| Transient cerebellar mutism (tCM) | 14 | | | CM and CCAS | 3 |
| Mutism with subsequent dysarthria (MSD) | 9 | | | CM and akM | 4 |
| Akinetic mutism (akM) | 8 | akM in frontal lesions | 5 | CMS and PFS | 12 |
| Cerebellar cognitive affective syndrome (CCAS) | 16 | CCAS term for adults | 10 | PFS and CCAS | 2 |
| Transient cerebellar eye closure (TCES) | 3 | | | PFS and akM | 1 |
| Cerebellar syndrome (CS) | 4 | | | CCAS and akM | 2 |

CM+ describes cerebellar mutism together with symptoms like hypotonia, ataxia, neurobehavioral changes, and emotional lability

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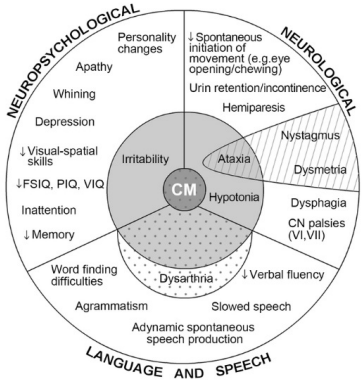
## Changing Perspective on Cerebellar Research: Clinical (Patient-Related) Evidence

- PFS (CM+) is a neuropsychological and neurological syndrome consisting of cognitive, emotional, behavioral, motor, language and speech-related problems.
- CCAS refers to a persistent pattern of executive, visual-spatial, affective and language-related symptoms.
[http://www.posteriorfossa.org/]




http://www.posteriorfossa.org

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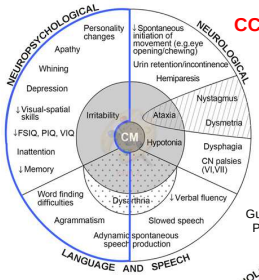
## Changing Perspective on Cerebellar Research: Clinical (Patient-Related) Evidence

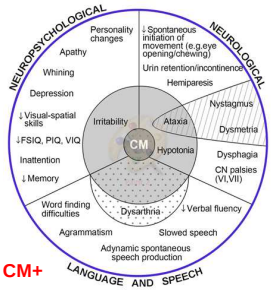
PFS (CM+) versus CCAS:

- Both syndromes represent the same pattern of cerebellar dysfunction, occurring either acutely and designated the PFS (CM+), or persistently over time and termed the CCAS.
- In contrast to the PFS (CM+), those affected by the CCAS do not per definition suffer from mutism or neurological (motor) deficits.
[http://www.posteriorfossa.org/]




**CCAS**

Gudrunardottir T. Consensus meeting on the Posterior Fossa Syndrome and Cerebellar Mutism. Reykjavik, 2015.




**PFS = CM+**

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## Post-operative Pediatric Cerebellar Mutism Syndrome

"Post-operative Pediatric CMS is characterized by delayed onset mutism/reduced speech and emotional lability after cerebellar or 4th ventricle tumor surgery in children. Additional common features include hypotonia and oropharyngeal dysfunction/dysphagia. It may frequently be accompanied by the cerebellar motor syndrome, cerebellar cognitive affective syndrome and brain stem dysfunction including long tract signs and cranial neuropathies. The mutism is always transient, but recovery from CMS may be prolonged. Speech and language may not return to normal, and other deficits of cognitive, affective and motor function often persist."

Consensus Paper on Pediatric Post-operative Cerebellar Mutism Syndrome: The Iceland Delphi Results. Submitted.

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## Post-operative Pediatric Cerebellar Mutism Syndrome

- Several long-term cognitive sequelae have been identified:
  - Scholarly underachievement
  - Decline of general intelligence
  - Executive dysfunction
  - Disrupted memory
  - Attentional deficits
  - Distorted spatial cognition

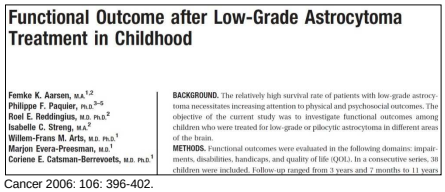
⇒ phenomenon of ***growing into deficits***


CME

**Long-term sequelae in children after cerebellar astrocytoma surgery**

F.K. Aarsen, MA; H.R. Van Dongen, PhD; P.F. Paquier, PhD; M. Van Mourik, PhD; and C.E. Catsman-Berrevoets, MD, PhD

Neurology 2004: 62: 1311-1316.

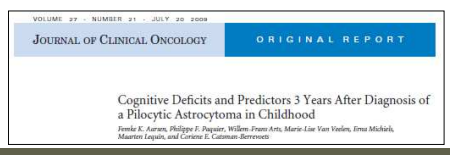

**Functional Outcome after Low-Grade Astrocytoma Treatment in Childhood**

Femke K. Aarsen, M.A.[1,2] Philippe F. Paquier, Ph.D.[3–5] Roel E. Reddingius, M.D. Ph.D.[2] Isabelle C. Streng, M.A.[2] Willem-Frans M. Arts, M.D. Ph.D.[1] Marjon Evera-Preesman, M.D.[1] Coriene E. Catsman-Berrevoets, M.D. Ph.D.[1]

**BACKGROUND.** The relatively high survival rate of patients with low-grade astrocytoma necessitates increasing attention to physical and psychosocial outcomes. The objective of the current study was to investigate functional outcomes among children who were treated for low-grade or pilocytic astrocytoma in different areas of the brain.

**METHODS.** Functional outcomes were evaluated in the following domains: impairments, disabilities, handicaps, and quality of life (QOL). In a consecutive series, 38 children were included. Follow-up ranged from 3 years and 7 months to 11 years

Cancer 2006: 106: 396-402.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Cognitive Deficits and Predictors 3 Years After Diagnosis of a Pilocytic Astrocytoma in Childhood

*Femke K. Aarsen, Philippe F. Paquier, Willem-Frans Arts, Marie-Lise Van Veelen, Erna Michiels, Maarten Lequin, and Coriene E. Catsman-Berrevoets*

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*Have a nice meal, folks !*