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Interventions and Management

1. *Dev Med Child Neurol.* 2015 Jun 11. doi: 10.1111/dmcn.12819. [Epub ahead of print]

Children with unilateral cerebral palsy show diminished implicit motor imagery with the affected hand.

Jongsma M, Baas CM, Sangen AF, Aarts PB, van der Lubbe RH, Meulenbroek RG, Steenbergen B.

AIM: Motor imagery refers to the mental simulation of a motor action without producing an overt movement. Implicit motor imagery can be regarded as a first-person kinesthetic perceptual judgement, and addresses the capacity to engage into the manipulation of one's body schema. In this study, we examined whether children with unilateral cerebral palsy (CP) are able to engage in implicit motor imagery. **METHOD:** A modified version of the hand laterality judgment task was employed. Erroneous responses, reaction times, and event-related potentials from the electroencephalograph were analysed. **RESULTS:** In 13 children with typical development (mean age 10y 7mo, SD 1y 2mo; seven male, six female), we observed the classic rotation direction effect. Specifically, when comparing outward rotated with inward rotated hand pictures, decreased accuracy and increased response times were observed. Event-related potentials analyses of the electroencephalogram revealed a more marked N1 and an enhanced rotation-related negativity.

INTERPRETATION: These findings suggest that an implicit motor imagery strategy was used to solve the task. However, in 10 children with unilateral CP (mean age 10y 7mo, SD 2y 5mo; five male, five female), these effects were observed only when the less-affected hand was involved. This observation suggests that children with CP could benefit from visual training strategies.

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2. *Res Dev Disabil.* 2015 Jun 19;41-42C:86-93. doi: 10.1016/j.ridd.2015.05.003. [Epub ahead of print]

Improvements in bimanual hand function after baby-CIMT in two-year old children with unilateral cerebral palsy: A retrospective study.

Nordstrand L, Holmefur M, Kits A, Eliasson AC.

The common assumption that early-onset intensive intervention positively affects motor development has rarely been investigated for hand function in children with unilateral cerebral palsy (CP). This retrospective study explored the possible impact of baby constraint-induced movement therapy (baby-CIMT) on hand function at two years of age. We hypothesized that baby-CIMT in the first year of life would lead to better bimanual hand use at

two years of age than would not receiving baby-CIMT. The Assisting Hand Assessment (AHA) was administered at age 21 months (SD 2.4 months) in 72 children with unilateral CP, 31 of who received baby-CIMT. When dividing the children into four functional levels based on AHA, the proportional distribution differed between the groups in favour of baby-CIMT. Logistic regression analysis indicated that children in the baby-CIMT group were more likely than were children in the no baby-CIMT group to have a high functional level, even when controlling for the effect of brain lesion type (OR 5.83, 95% CI 1.44-23.56, $p=0.001$). However, no difference was found between groups in the odds of having a very low functional level (OR 0.31, 95% CI 0.08-1.17, $p=0.084$). The result shows that baby-CIMT at early age can have a positive effect. Children who received baby-CIMT were six times more likely to have a high functional level at two years of age than were children in the no baby-CIMT group.
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3. Neuroimage Clin. 2015 Apr 9;8:104-9. doi: 10.1016/j.nicl.2015.04.005. eCollection 2015.

Validity of semi-quantitative scale for brain MRI in unilateral cerebral palsy due to periventricular white matter lesions: Relationship with hand sensorimotor function and structural connectivity.

Fiori S, Guzzetta A, Pannek K, Ware RS, Rossi G, Klingels K, Feys H, Coulthard A, Cioni G, Rose S, Boyd RN.

AIM: To provide first evidence of construct validity of a semi-quantitative scale for brain structural MRI (sqMRI scale) in children with unilateral cerebral palsy (UCP) secondary to periventricular white matter (PWM) lesions, by examining the relationship with hand sensorimotor function and whole brain structural connectivity. **METHODS:** Cross-sectional study of 50 children with UCP due to PWM lesions using 3 T (MRI), diffusion MRI and assessment of hand sensorimotor function. We explored the relationship of lobar, hemispheric and global scores on the sqMRI scale, with fractional anisotropy (FA), as a measure of brain white matter microstructure, and with hand sensorimotor measures (Assisting Hand Assessment, AHA; Jebsen-Taylor Test for Hand Function, JTTHF; Melbourne Assessment of Unilateral Upper Limb Function, MUUL; stereognosis; 2-point discrimination). **RESULTS:** Lobar and hemispheric scores on the sqMRI scale contralateral to the clinical side of hemiplegia correlated with sensorimotor paretic hand function measures and FA of a number of brain structural connections, including connections of brain areas involved in motor control (postcentral, precentral and paracentral gyri in the parietal lobe). More severe lesions correlated with lower sensorimotor performance, with the posterior limb of internal capsule score being the strongest contributor to impaired hand function. **CONCLUSION:** The sqMRI scale demonstrates first evidence of construct validity against impaired motor and sensory function measures and brain structural connectivity in a cohort of children with UCP due to PWM lesions. More severe lesions correlated with poorer paretic hand sensorimotor function and impaired structural connectivity in the hemisphere contralateral to the clinical side of hemiplegia. The quantitative structural MRI scoring may be a useful clinical tool for studying brain structure-function relationships but requires further validation in other populations of CP.

[PMID: 26106533](#) [PubMed - in process] PMID: PMC4473818 Free PMC Article

4. Br J Sports Med. 2015 Jun 23. pii: bjsports-2015-094929. doi: 10.1136/bjsports-2015-094929. [Epub ahead of print]

The effect of strengthening interventions on strength and physical performance in people with cerebral palsy: PEDro systematic review update.

Stubbs PW, Diong J.

[PMID: 26105018](#) [PubMed - as supplied by publisher]

5. Muscle Nerve. 2015 Jun 10. doi: 10.1002/mus.24735. [Epub ahead of print]

A potential mechanism by which torque output is preserved in cerebral palsy during fatiguing contractions of the knee extensors.

Moreau NG, Knight H, Olson MW.

INTRODUCTION: The purpose of this study was to compare agonist and antagonist electromyography (EMG) during an isokinetic fatigue protocol in subjects with cerebral palsy (CP) and typical development (TD). **METHODS:** Nine individuals with CP and 11 TD completed 50 repetitions of maximum concentric knee extension (KE) and flexion (KF) at 60 degrees/second. **RESULTS:** Rate of decline in peak torque for KE was significantly less in CP compared to TD. Rate of decline in agonist EMG was not significantly different between groups, however the rate of decline in antagonist EMG was significantly greater in CP. There were no differences between groups for KF. **DISCUSSION:** Declining agonist EMG occurs in parallel with declining antagonist hamstring activity in CP, decreasing the relative opposing force and resulting in a lesser decline in net torque. This finding illustrates a potential mechanism by which net torque is preserved in those with CP who are inherently weaker. This article is protected by copyright.

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6. J Child Orthop. 2015 Jun 25. [Epub ahead of print]

Effects of ankle-foot braces on medial gastrocnemius morphometrics and gait in children with cerebral palsy.

Hösl M, Böhm H, Arampatzis A, Döderlein L.

PURPOSE: In children with cerebral palsy (CP), braces are used to counteract progressive joint and muscle contracture and improve function. We examined the effects of positional ankle-foot braces on contracture of the medial gastrocnemius (MG) and gait in children with CP while referencing to typically developing children. **METHODS:** Seventeen independently ambulant children with CP and calf muscle contracture (age 10.4 ± 3.0 y) and 17 untreated typically developing peers (age 9.5 ± 2.6 y) participated. Children with CP were analysed before and 16 ± 4 weeks after ankle-foot bracing. MG muscle belly length and thickness, tendon and fascicle length, as well as their extensibility were captured by 2D ultrasound and 3D motion capturing during passive, manually applied stretches. In addition, 3D gait analysis was conducted. **RESULTS:** Prior to bracing, the MG muscle-tendon unit in children with CP was 22 % less extensible. At matched amounts of muscle-tendon unit stretch, the muscle belly and fascicles in CP were 7 % and 14 % shorter while the tendon was 11 % longer. Spastic fascicles displayed 32 % less extensibility than controls. Brace wear increased passive dorsiflexion primarily with the knees flexed. During gait, children walked faster and foot lift in swing improved. MG muscle belly and tendon length showed little change, but fascicles further shortened (-11 %) and muscle thickness (-8 %) decreased. **CONCLUSIONS:** Use of ankle-foot braces improves function but may lead to a loss of sarcomeres in series, which could explain the shortened fascicles. To potentially induce gastrocnemius muscle growth, braces may also need to extend the knee or complementary training may be necessary to offset the immobilizing effects of braces.

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7. Ann Nutr Metab. 2015 Jun 19;66(4):224-232. [Epub ahead of print]

Cerebral Palsy in Children as a Risk Factor for Malnutrition.

Perenc L, Przysada G, Trzeciak J.

AIM: The main aim of this study was to determine some malnutrition risk factors among children with cerebral palsy (CP). Children with CP often require the assistance of physical therapy centers. Experience suggests that, apart

from physical disabilities, this group often suffers from malnutrition. **METHODS:** Data were gathered in the hospital among 128 children aged 3-18 years who were suffering from CP. The children were admitted from 2011 to 2013 to the Center for Neurological Physical Therapy for children in the Regional Hospital No. 2. St. Queen Jadwiga in Rzeszow (RORE). Statistical analyses were conducted for data on gender, age, type of CP, motor function level according to Gross Motor Function Classification Scale (GMFCS), body mass index (BMI) and hemoglobin levels in blood. **RESULTS:** The risk of anemia differs based on gender - the risk is 6 times greater among boys than among girls ($p = 0.0398$). Risk of malnutrition is 3.5 times higher in children with tetraplegia than in children with diplegia or hemiplegia ($p = 0.0043$). Higher GMFCS scores are connected to greater proportions of malnourished children (for BMI z-score < -1.64 , $p = 0.0010$). **CONCLUSIONS:** Among children with CP, malnourishment risk factors are male gender for anemia and tetraplegia and high GMFCS values.

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8. Childs Nerv Syst. 2015 Jun 23. [Epub ahead of print]

The whole spectrum of cystic periventricular leukomalacia of the preterm infant: results from a large consecutive case series.

Resch B, Resch E, Maurer-Fellbaum U, Pichler-Stachl E, Riccabona M, Hofer N, Urlesberger B.

PURPOSE: The purpose of this study is to describe features of cystic periventricular leukomalacia (PVL) in a large consecutive cohort study including long-term neurodevelopmental follow-up. **METHODS:** We performed a retrospective single-centre cohort study including all preterm infants ≤ 35 weeks of gestational age with PVL diagnosed by ultrasound scans (US) from a tertiary care university hospital between 1988 and 2012. **RESULTS:** The majority of 160 consecutively diagnosed cases had a gestational age between 28 and 32 weeks (60.6 %), and male sex was predominant (60.6 %). The most common associated clinical findings included respiratory distress syndrome, preterm premature rupture of the membranes, and chorioamnionitis (57.5, 49.4, and 39.4 %, respectively). Infants presented with apnoeas in 66.3 and neonatal seizures in 23.1 %. Any kind of respiratory support was present in 75.0 %. Associated low-grade intraventricular haemorrhage was evident in 33.1, high-grade haemorrhage in 9.4 %. Cysts were located on both hemispheres in 75 % and PVL grades 3 and 4 were predominant (75.6 %). Neurodevelopmental follow-up of 146 cases at a median age of 72 months revealed normal development in 11.0, mental retardation in 50.0, and cerebral palsy in 83.6 %. Visual impairment was diagnosed in 21.9 % and hearing impairment in one case. A quarter of cases (27.4 %) developed seizure disorders. Outcome data were significantly better in unilateral compared to bilateral PVL. **CONCLUSIONS:** Long-term neurodevelopmental outcome of bilateral PVL always was adverse and different from unilateral PVL. The latter might be negatively influenced by associated intra- and periventricular haemorrhages.

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9. Epilepsy Behav. 2015 Jun 18;50:18-22. doi: 10.1016/j.yebeh.2015.05.038. [Epub ahead of print]

Mozart's music in children with drug-refractory epileptic encephalopathies.

Coppola G, Toro A, Operto FF, Ferrarioli G, Pisano S, Viggiano A, Verrotti A.

Mozart's sonata for two pianos in D major, K448, has been shown to decrease interictal EEG discharges and recurrence of clinical seizures in both adults and young patients. In this prospective, open-label study, we evaluated the effect of listening to a set of Mozart's compositions, according to the Tomatis method, on sleep quality and behavioral disorders, including auto-/hetero-aggression, irritability, and hyperactivity, in a group of children and adolescents with drug-resistant epilepsy. The study group was composed of 11 outpatients (7 males and 4 females), between 1.5 years and 21 years of age (mean age: 11.9 years), all suffering from drug-resistant epileptic encephalopathy ($n=11$). All of them had a severe/profound intellectual disability associated with cerebral palsy. During the study period, each patient had to listen to a set of Mozart's compositions 2h per day for fifteen days for a total of 30h, which could be distributed over the day depending on the habits and compliance of each patient. The music was filtered by a device preferably delivering higher sound frequencies ($>3000\text{Hz}$) according to the Tomatis

principles. The antiepileptic drug therapy remained unchanged throughout the study period. During the 15-day music therapy, 2 out of 11 patients had a reduction of 50-75% in seizure recurrence, and 3 out of 12 patients had a reduction of 75-89%. Overall, 5 (45.4%) out of 11 patients had a $\geq 50\%$ reduction in the total number of seizures, while the percentage decrease of the total seizure number (11/11) compared with baseline was -51.5% during the 15-day music therapy and -20.7% in the two weeks after the end of treatment. All responders also had an improvement in nighttime sleep and daytime behavior.
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10. Cudas. 2015 Mar-Apr;27(2):135-41. doi: 10.1590/2317-1782/20152013060.

Communication skills in individuals with spastic diplegia.

Lamônica DA, Paiva CS, Abramides DV, Biazon JL.

PURPOSE: To assess communication skills in children with spastic diplegia. **METHODS:** The study included 20 subjects, 10 preschool children with spastic diplegia and 10 typical matched according to gender, mental age, and socioeconomic status. Assessment procedures were the following: interviews with parents, Stanford - Binet method, Gross Motor Function Classification System, Observing the Communicative Behavior, Vocabulary Test by Peabody Picture, Denver Developmental Screening Test II, MacArthur Development Inventory on Communicative Skills. Statistical analysis was performed using the values of mean, median, minimum and maximum value, and using Student's t-test, Mann-Whitney test, and Paired t-test. **RESULTS:** Individuals with spastic diplegia, when compared to their peers of the same mental age, presented no significant difference in relation to receptive and expressive vocabulary, fine motor skills, adaptive, personal-social, and language. The most affected area was the gross motor skills in individuals with spastic cerebral palsy. The participation in intervention procedures and the pairing of participants according to mental age may have approximated the performance between groups. **CONCLUSION:** There was no statistically significant difference in the comparison between groups, showing appropriate communication skills, although the experimental group has not behaved homogeneously.

[PMID: 26107078](#) [PubMed - in process] Free full text

11. Pediatr Phys Ther. 2015 Fall;27(3):258-66. doi: 10.1097/PEP.000000000000163.

Two Seating Systems' Effects on an Adolescent With Cerebral Palsy and Severe Scoliosis.

Lephart K, Kaplan SL.

BACKGROUND AND PURPOSE: To compare physiological functioning, communication switch activation, and response accuracy in a 19-year-old young man with quadriplegic cerebral palsy and neurological scoliosis using 2 seating systems within the school setting. **METHODS:** Prospective single-subject alternating treatment design with 2 conditions: baseline phase with standard planar inserts (A1), custom-molded back with original seat (B), and return to baseline (A2). Measures included oxygen saturation (SaO₂), heart rate (HR), respiration rate (RR), body temperature (BT), processing time to activate switches, and response accuracy. **RESULTS:** SaO₂ levels increased from "distressed" to "normal"; variability decreased. HR, RR, and BT fluctuations decreased with the custom-molded back. Processing time decreased with increased variability, affected by subject's motivation; accuracy improved slightly. Reported social approachability and student-initiated communication increased. **CONCLUSIONS:** SaO₂ increased and HR, RR, and BT fluctuations decreased with a custom-molded back. Graphing data may help determine seating effect with complex clients.

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12. *Pediatr Phys Ther.* 2015 Fall;27(3):266. doi: 10.1097/PEP.000000000000164.

Commentary on "Two Seating Systems' Effect on an Adolescent With Cerebral Palsy and Severe Scoliosis".

Arnold S, Morris D.

[PMID: 26102167](#) [PubMed - in process]

13. *Phys Ther.* 2015 Jun 25. [Epub ahead of print]

Functional Task Constraints Foster Enhanced Postural Control in Children With Cerebral Palsy.

Schmit JM, Riley M, Cummins-Sebree S, Schmitt L, Shockley K.

BACKGROUND: Postural instability is a classical characteristic of cerebral palsy (CP), but it has not been examined during simultaneous functional play activity. Recent work demonstrates that when motor tasks are made functionally more relevant, performance improves, even in individuals with movement pathology. It may be that in a disease state, the underlying control mechanisms that are associated with healthy physiology must be elicited. **OBJECTIVE:** To explore the utility of the functional play task methodology as a more rich and interpretable approach to the quantification of postural instability in children with CP. **DESIGN:** Postural stability measures obtained from a cross sectional cohort of children with CP (n = 30; were compared to stability measures taken from children with typical development (TD; n=30) during a single measurement period. **METHODS:** Postural stability data were obtained using an AMTI AccuSway PLUS portable force platform system. Postural sway was quantified during a precision manual functional play task. A baseline condition (no task) was also included. Postural sway variability and postural sway regularity were analyzed using analyses of variance. **RESULTS:** Children with CP demonstrated an apparent difference in postural control (greater irregularity, greater sway variability) during quiet stance, relative to peers with TD that was mitigated during performance of a functional play precision task. **CONCLUSIONS:** The findings illustrate flexibility and adaptability in the postural control system, despite the pathological features associated with CP. © 2015 American Physical Therapy Association.

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14. *Eur J Paediatr Neurol.* 2015 Jun 14. pii: S1090-3798(15)00108-7. doi: 10.1016/j.ejpn.2015.06.001. [Epub ahead of print]

Language comprehension in nonspeaking children with severe cerebral palsy: Neuroanatomical substrate?

Geytenbeek JJ, Oostrom KJ, Harlaar L, Becher JG, Knol DL, Barkhof F, Pinto PS, Vermeulen RJ.

BACKGROUND AND AIMS: To identify relations between brain abnormalities and spoken language comprehension, MRI characteristics of 80 nonspeaking children with severe CP were examined. **METHODS:** MRI scans were analysed for patterns of brain abnormalities and scored for specific MRI measures: white matter (WM) areas; size of lateral ventricles, WM abnormality/reduction, cysts, subarachnoid space, corpus callosum thinning and grey matter (GM) areas; cortical GM abnormalities, thalamus, putamen, globus pallidus and nucleus caudatus and cerebellar abnormalities. Language comprehension was assessed with a new validated instrument (C-BiLLT). **RESULTS:** MRI scans of 35 children were classified as a basal ganglia necrosis (BGN) pattern, with damage to central GM areas; in 60% of these children damage to WM areas was also found. MRI scans of 13 children were classified as periventricular leukomalacia (PVL) with little concomitant damage to central GM areas, 13 as malformations and 19 as miscellaneous. Language comprehension was best in children with BGN, followed by malformations and miscellaneous, and was poorest in PVL. Linear regression modelling per pattern group (malformations excluded), with MRI measures as independent variables, revealed that corpus callosum thinning in BGN and parieto-occipital WM reduction in PVL were the most important explanatory factors for poor language comprehension. No MRI measures explained outcomes in language comprehension in the miscellaneous group. **CONCLUSIONS:** Comprehension of spoken language differs between MRI patterns of severe CP. In children with BGN and PVL differences in language comprehension performance is attributed to damage in

the WM areas. Language comprehension was most affected in children with WM lesions in the subcortical and then periventricular areas, most characteristic for children with PVL.

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15. J Res Med Sci. 2015 Apr;20(4):321-2.

National cerebral palsy minimum data set.

Ajami S, Maghsodlorad AA.

[PMID: 26109984](#) [PubMed] Free PMC Article

Prevention and Cure

16. Glia. 2015 Jun 19. doi: 10.1002/glia.22877. [Epub ahead of print]

Prenatal exposure to inflammatory conditions increases Cx43 and Panx1 unopposed channel opening and activation of astrocytes in the offspring effect on neuronal survival.

Avendaño BC, Montero TD, Chávez CE, von Bernhardt R, Orellana JA.

Several epidemiological studies indicate that children born from mothers exposed to infections during gestation, have an increased risk to develop neurological disorders, including schizophrenia, autism and cerebral palsy. Given that it is unknown if astrocytes and their crosstalk with neurons participate in the above mentioned brain pathologies, the aim of this work was to address if astroglial paracrine signaling mediated by Cx43 and Panx1 unopposed channels could be affected in the offspring of LPS-exposed dams during pregnancy. Ethidium uptake experiments showed that prenatal LPS-exposure increases the activity of astroglial Cx43 and Panx1 unopposed channels in the offspring. Induction of unopposed channel opening by prenatal LPS exposure depended on intracellular Ca²⁺ levels, cytokine production and activation of p38 MAP kinase/iNOS pathway. Biochemical assays and Fura-2AM/DAF-FM time-lapse fluorescence images revealed that astrocytes from the offspring of LPS-exposed dams displayed increased spontaneous Ca²⁺ dynamics and NO production, whereas iNOS levels and release of IL-1 β /TNF- α were also increased. Interestingly, we found that prenatal LPS exposure enhanced the release of ATP through astroglial Cx43 and Panx1 unopposed channels in the offspring, resulting in an increased neuronal death mediated by the activation of neuronal P2X7 receptors and Panx1 channels. Altogether, this evidence suggests that astroglial Cx43 and Panx1 unopposed channel opening induced by prenatal LPS exposure depended on the inflammatory activation profile and the activation pattern of astrocytes. The understanding of the mechanism underlying astrocyte-neuron crosstalk could contribute to the development of new strategies to ameliorate the brain abnormalities induced in the offspring by prenatal inflammation. GLIA 2015.

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17. Neonatology. 2015 Jun 20;108(2):124-129. [Epub ahead of print]

Cerebral Palsy and Polymorphism of the Chemokine CCL18 in Very Preterm Children.

Kallankari H, Huusko JM, Kaukola T, Ojaniemi M, Mahlman M, Marttila R, Kingsmore SF, Haataja L, Lavoie PM, Synnes A, Hallman M.

BACKGROUND: Prematurity and hereditary factors predispose to cerebral palsy (CP). Previously, low cord blood

levels of the anti-inflammatory chemokine CCL18 have been found to be associated with risk of CP in preterm children. OBJECTIVES: To investigate the association between single nucleotide polymorphisms (SNPs) in CCL18 and susceptibility to CP, as well as the association between the SNPs and cord blood levels of CCL18. METHODS: The original population comprised very-low-gestational-age (VLGA; <32 weeks) children from northern and central Finland (25 cases, 195 controls). Five CCL18 SNPs were genotyped and examined for associations with CP and cord blood CCL18. The replication population comprised Caucasian VLGA children from southern Finland and Canada (23 cases, 248 controls). RESULTS: In the original population, SNP rs2735835 was associated with CP; the minor allele A was underrepresented in cases compared to controls (OR = 0.42, 95% CI: 0.21-0.83, p = 0.01). This association remained significant after adjustment for multiple testing and risk factors of CP, and after combining the original and replication populations (OR = 0.52, 95% CI: 0.33-0.83, p = 0.005). Intraventricular hemorrhage (IVH) additively predicted CP. The Rs2015086 genotype was modestly associated with CCL18 concentration. CONCLUSIONS: A common CCL18 polymorphism together with IVH had an additive influence on CP susceptibility. Developmentally regulated CCL18, confined to primates, may be involved in the complex sequence of events leading to brain injury and predisposition to CP phenotype.
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