Spastic diplegia in preterm-born children: Executive function impairment and neuroanatomical correlates

Maria Chiara Di Lieto a, Paola Brovedani a,*, Chiara Pecini a, Anna Maria Chilosi a, Vittorio Belmonti a, Franco Fabbro b, Cosimo Urgesi b, Simona Fiori a, Andrea Guzzetta a, c, Silvia Perazza a, Elisa Sicola a, Giovanni Cioni a, c

a Department of Developmental Neuroscience, IRCCS Stella Maris, Viale del Tirreno 331, 56128, Calambrone, Pisa, Italy
b Department of Human Sciences, University of Udine, Via Margreth 3, 33100, Udine, Italy
c Department of Clinical and Experimental Medicine, University of Pisa, Via Savi 10, 56126, Pisa, Italy

A R T I C L E   I N F O

Article history:
Received 10 August 2016
Received in revised form 12 December 2016
Accepted 18 December 2016
Number of reviews completed is 2

Keywords:
Preterm spastic diplegia
Neuropsychological profile
Neuroanatomical correlates
Executive functions
NEPSY-II
Children

A B S T R A C T

Background: The neuropsychological literature on preterm-born children with spastic diplegia due to periventricular leukomalacia is convergent in reporting deficits in non-verbal intelligence and in visuo-spatial abilities. Nevertheless, other cognitive functions have found to be impaired, but data are scant and not correlated with neuroimaging findings.

Aims: This study analyzes the neuropsychological strengths and weaknesses in preterm-born children with spastic diplegia (pSD) and their relationships with neuroanatomical findings, investigated by a novel scale for MRI classification.

Methods and procedures: Nineteen children with pSD, mild to moderate upper limb impairment and Verbal IQ > 80, and 38 normal controls were evaluated with a comprehensive neuropsychological battery (NEPSY-II), assessing Attention/Executive Functioning, Language, Memory, Sensorimotor, Social Perception and Visuospatial Processing domains. The MRIs were quantitatively scored for lesion severity.

Outcomes and results: The results showed that, beyond core visuo-spatial and sensory-motor deficits, impairments in attention and executive functions were present in more than half of the sample, particularly in children with damage to the anterior corpus callosum.

Conclusions and implications: The findings are discussed in terms of clinical and rehabilitative implications tailored for pSD subgroups diversified for neuropsychological and neuroanatomical characteristics.

© 2016 Elsevier Ltd. All rights reserved.

What this paper adds

Deficits in visuo-spatial skills have been extensively documented as being a marker of spastic diplegia due to preterm birth (pSD), with severity of deficits being correlated to the degree of posterior white matter damage. Less is known on the integrity of other cognitive skills, such as memory, attention and executive functions and their neuroanatomical underpinnings. The few data available point to executive function deficits in pSD but their brain bases and their effects on other cognitive aspects are largely unexplored.

* Corresponding author.
E-mail addresses: mcdilieto@fsm.unipi.it (M.C. Di Lieto), pbrovedani@fsm.unipi.it (P. Brovedani), cpecini@fsm.unipi.it (C. Pecini), achilosi@fsm.unipi.it (A.M. Chilosi), vbemonti@fsm.unipi.it (V. Belmonti), franco.fabbro@uniud.it (F. Fabbro), cosimo.urgesi@uniud.it (C. Urgesi), sfiori@fsm.unipi.it (S. Fiori), aguzzetta@fsm.unipi.it (A. Guzzetta), sperazza@fsm.unipi.it (S. Perazza), esicola@fsm.unipi.it (E. Sicola), gcioni@fsm.unipi.it (G. Cioni).

http://dx.doi.org/10.1016/j.ridd.2016.12.006
0891-4222/© 2016 Elsevier Ltd. All rights reserved.
functions are not fully understood. In order to address these issues, studies concurrently assessing relative neuropsychological strengths and weaknesses and their neuroanatomical correlates are needed. With a comprehensive neuropsychological battery (NEPSY-II) and a novel and reliable semi-quantitative scale for MRI classification, the study, although based on a relatively small sample, brings a new contribution to the literature by suggesting the presence of two possible pSD subgroups, diversified for neuropsychological and neuroanatomical profiles. A subgroup presented deficits in visuo-spatial and sensory-motor skills, related to involvement of temporo-parieto-occipital white matter and posterior callosal portions. Another pSD subgroup with additional impairment in executive functions included those children with abnormalities also in the anterior callosal portions. In this second group, the executive functioning impairment, mainly involving selective attention and inhibition speed, was also associated to worse skills in visuo-spatial processing, sensory-motor integration and social perception.

1. Introduction

1.1. Spastic diplegia and neuropsychological outcome

Cerebral palsy (CP) describes a group of disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. Spastic diplegia is a sub-type of CP, in which both sides of the body are involved, with a predominance to the lower limbs (Rosenbaum, Paneth, Leviton, Goldstein, & Bax, 2007). It commonly occurs in preterm-born children (pre-term spastic diplegia, pSD) and it is generally due to periventricular leukomalacia, a form of white matter brain injury typically affecting neural pathways lying close to the lateral ventricles, as the corticospinal tract and the optic radiations (Cioni et al., 2000; Fazzi et al., 2009; Guzzetta, Tinelli, Bancale, & Cioni, 2010; Jacobson & Dutton, 2000; Pavlova & Krägeloh-Mann, 2013). In preterm-born children with spastic diplegia due to periventricular leukomalacia, general cognitive abilities are usually within low average-borderline range, but a large discrepancy is consistently reported between Verbal and Performance Intelligence Quotients, with the latter typically being in the deficit range (Fazzi et al., 2009; Ito et al., 1996; Pirila et al., 2004; Sigurdardottir et al., 2008).

Whereas significant deficits in visuo-perceptual skills have been very frequently documented in this clinical population (Fazzi et al., 2009; Pagliano et al., 2007; Van den Hout et al., 2004), less is known on the integrity of other cognitive functions such as memory, attention and executive functions, which may negatively impact on scholastic achievement and quality of life (Korkman et al., 2008; Pirila et al., 2004; Schatz, Craft, White, Park, & Figiel, 2001). Few studies performed in children with spastic diplegia have focused on attention and executive functions, with particular regard to inhibition tasks. Deficits in visual and auditory attention and in the inhibition of previously learned auditory responses, were reported in preterm-born children with spastic diplegia and periventricular leukomalacia both at school-age (Pirila et al., 2004), and pre-school age (Korkman et al., 2008). Impaired inhibition was reported in a similar population, i.e., pSD mostly associated to periventricular leukomalacia, in a visual orienting task measuring the ability to quickly shift visual attention from a novel position to another previously observed (inhibition of return) (Schatz et al., 2001). Impaired speed and accuracy in inhibition and switching tasks were also reported by Bottcher, Flachs, and Uldall (2009) in a cohort of children including both unilateral and bilateral CP.

Most of these studies did not test various cognitive domains at the same time point in the same patient and combined tests with different standardization samples, thus making it hard to clearly define the neuropsychological profile of pSD due to periventricular leukomalacia as well as the impact of specific deficits as executive function impairments on other cognitive domains. The effect of executive function impairments on school readiness, school success as well as on mental health and quality of life has been frequently documented in other populations (see the review by Diamond, 2013 and the longitudinal study by Moffitt et al., 2011).

1.2. Neuroanatomical correlates of neuropsychological outcome

In addition to scant research on the comprehensive neuropsychological functioning of children with pSD, also their neuroanatomical correlates have been rarely investigated. Some of the studies presented above recruited children according to the clinical diagnosis of CP (diplegia or bilateral CP) and not to the neuroradiological characteristics of the lesion. In other studies, neuroimaging findings were only based on cranial ultrasound and no correlations were found between lesion characteristics and neuropsychological data (Korkman et al., 2008; Pirila et al., 2004). Research with magnetic resonance imaging (MRI), the gold standard for the study of brain injury in CP, has focused mainly on the association between the extent of periventricular leukomalacia and visuo-spatial functions, confirming the strong relationship between the extension of periventricular white matter damage to parietal and occipital regions and the degree of impairment of visual functions, including high-level skills (Ito et al., 1996; Fazzi et al., 2004; Guzzetta et al., 2010; Pagliano et al., 2007; Pavlova, Sokolov, & Krägeloh-Mann, 2007; Van den Hout et al., 2004). Studies with advanced MRI techniques such as diffusion tensor imaging found correlations between alterations of connectivity in periventricular leukomalacia and low intelligence but not with specific neuropsychological functions (Wang, Fan, Xu, & Wang, 2013).
دریافت فوری متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات