Early Human Development 90 (2014) 565–569

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

Emotional and effortful control abilities in 42-month-old very preterm and full-term children

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ARTICLE INFO

Article history:
Received 26 March 2014
Received in revised form 4 July 2014
Accepted 15 July 2014

Keywords:
Very preterm children
Emotion
Emotional regulation
Executive functions
Effortful control
Development

ABSTRACT

Background: Very preterm (VP) infants are at greater risk for cognitive difficulties that may persist during school-age, adolescence and adulthood. Behavioral assessments report either effortful control (part of executive functions) or emotional reactivity/regulation impairments.
Aims: The aim of this study is to examine whether emotional recognition, reactivity, and regulation, as well as effortful control abilities are impaired in very preterm children at 42 months of age, compared with their full-term peers, and to what extent emotional and effortful control difficulties are linked.
Study design: Children born very preterm (VP; < 29 weeks gestational age, $n = 41$) and full-term (FT) aged-matched children ($n = 47$) participated in a series of specific neuropsychological tests assessing their level of emotional understanding, reactivity and regulation, as well as their attentional and effortful control abilities.
Results: VP children exhibited higher scores of frustration and fear, and were less accurate in naming facial expressions of emotions than their aged-matched peers. However, VP children and FT children equally performed when asked to choose emotional facial expression in social context, and when we assessed their selective attention skills. VP performed significantly lower than full terms on two tasks of inhibition when correcting for verbal skills. Moreover, significant correlations between cognitive capacities (effortful control) and emotional abilities were evidenced.
Conclusions: Compared to their FT peers, 42 month-olds who were born very preterm are at higher risk of exhibiting specific emotional and effortful control difficulties. The results suggest that these difficulties are linked. Ongoing behavioral and emotional impairments starting at an early age in preterms highlight the need for early interventions based on a better understanding of the relationship between emotional and cognitive difficulties.

1. Introduction

Children born prematurely are at greater risk for cognitive and behavioral difficulties [1,2] which may persist during school-age, adolescence and adulthood [3,4]. Follow-up studies show that very preterm (VP) and very low birth weight (VLBW) infants are likely to exhibit poor motor, cognitive, behavioral [5,6] and socio-emotional development [7,8], all of which may entail negative consequences for their future social well-being and academic achievements [9]. Emotional and effortful control (EC) impairments are frequently reported in preterm infants. In typical children and adults, emotion and cognition appear interconnected [10]. Emotions influence cognition [11] and cognitive processes contribute to emotion regulation [12]. So far, few studies explored the emotion–cognition interplay in preterm children. These studies showed a link between emotion regulation and executive functions in children [13,14], with parent reports of child temperament correlating with individual differences in executive functions, and more specifically with EC [15]. For instance, children high in EC are less likely to express negative emotionality [16].

During the first year of life, VP children show some difficulties in regulating emotional arousal responses and in allocating and sustaining their attention [17]. Compared to full-term (FT) born peers, 12-

Abbreviations: VP, very preterm; VLBW, very low birth weight; FT, full-term.

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http://dx.doi.org/10.1016/j.earlhumdev.2014.07.008
0378-3782/

month-old VP infants expressed higher anger reactivity and lower fear reactivity, and showed a distinct attentional pattern with a higher initial attention level that significantly decreased throughout the experimental task [18]. Also, 24-month-old children born VP had difficulties in maintaining inhibitory control and exhibited a distinct attentional pattern compared to FT children [19]. Furthermore, parents reported VP children as having lower sustained attention and a higher level of negative affect than FT children. At an older age, sustained attention and inhibitory control have been also highlighted as potential areas of difficulty for these children [20]. Despite a clear relationship between preterm birth and later cognitive and socio-emotional risks [21], the early precursors of these difficulties and their developmental trajectory between 2 and 5 years-old in VP children remain unclear.

The present study aimed to compare the emotional and EC development in VP children at 42 months of age and in FT children of the same age. We hypothesized that VP children will perform significantly lower in tasks measuring EC and emotional abilities, as compared to FT children. Moreover, we expected that EC abilities and emotional abilities will be correlated in both populations.

2. Methods

2.1. Participants

Forty-one preterm children (23 girls, 18 boys) born before 29 weeks of gestation ($M = 26.7$; SD = 1.13), who have participated in previous assessments at 12 and 24 months of age [18,19], were examined at 42 months of age ($M = 43$ months and 22 days; SD = 2 months and 18 days) at the Division of Child Development and Growth at the University Hospital of XXX and the Child Development Unit at the University Hospital of XXX to undergo general cognitive and motor evaluation and neuropsychological assessment. Children with major brain lesions in the neonatal period (hemorrhage grade III–IV according to Papile [22]), or with mental delay (IQ < 70) were excluded. Table 1 presents the characteristics of the preterm sample. A control group (27 girls, 20 boys) of 47 FT born (>37 weeks of gestation) infants matched on chronological age ($M = 42$ months and 26 days; SD = 2 months and 18 days; $t(86) = -1.74$, $p = .08$) was also assessed. Written informed consent was obtained from the parents of each child. The study was approved by the Research and Ethics Committees of the University Hospitals, XXX and XXX. Socioeconomic status was determined according to the Largo et al.'s 12-point scale [23].

Table 1
Characteristics of very preterm children: mean (standard deviation) or count (percentage).

Characteristics	Very preterm children
Gestational age (weeks)	26.7 (1.13)
Birth weight (g)	935.76 (221.5)
SGA	4 (9.75%)
IVH grades III and IV	0
PVL	3 (7.31%)
NEC	0
PDA	5 (12.19%)
Days of ventilation	4.47 (11.53)
WPPSI III total IQ	95.43 (15.97)
WPPSI III verbal IQ	99.29 (16.3)
WPPSI III performance IQ	92.33 (18.88)
SES (Largo)	4.95 (2.15)

Note. SGA, small for gestational age (<10th percentile for birth weight as a function of GA and gender); IVH, intraventricular hemorrhage (Grade III: intraventricular with distension, Grade IV: hemorrhagic parenchymal infarction, according to Papile, Burstein, Burstein, & Koffler, 1978); PVL, periventricular leukomalacia (based on magnetic resonance imaging); NEC: necrotising enterocolitis needing surgical treatment; PDA: surgical treatment of patent ductus arteriosus; Days of ventilation ($M = 4.475$; SD = 11.53; span = 0–63), with 18 children not ventilated at all and only 5 children having spent more than 10 days with ventilation; WPPSI III, Wechsler Preschool and Primary Scale of Intelligence—Third Edition (Weschler, 2002); Largo, 6-point scale for both paternal occupation and maternal education determining the socioeconomic status; with the lowest combined SES score is 2 (signifying the highest SES), the highest 12 (Largo et al. 1989).

2.2. Outcome measures

Multiple specific tasks or standardized tests assessed different aspects of children's behavior, as described below.

2.2.1. Emotional abilities

2.2.1.1. Emotional reactivity and regulation. Two tasks were selected from the Laboratory Temperament Assessment Battery (Lab-TAB) [24] and assessed the children's reaction to fear- and anger-frustration-eliciting situations. The tasks are videotaped for later coding by two independent raters.

Mask (LabTAB): Experimenter leaves the room for 30 s, wears a scary mask and a jacket, then he walks back into the room and seats facing the child for 30 s. The child's reactions are videotaped. Intensity of fear facial expression and intensity of vocal distress were rated on a 3 point scale by interval of 5 s.

Attractive sweet in box (LabTAB): Experimenter puts an attractive cookie in a 16 × 16 cm transparent box locked with a padlock. Experimenter shows the child how to open the box with the key and locks it again. The child receives keys which do not open the box. Parent and experimenter leave the room, after encouraging the child to try to open the box to eat the cookie during their absence. Child is left for 3 min facing the camera. The intensities of facial anger expression, of bodily anger, of frustration, of sadness facial expression and of gaze aversion were rated on a 3 point scale. Protest vocalizations scored one point. These variables were scored by 10 s intervals.

2.2.1.2. Affect recognition. The subtest from the Neuropsychological Test Battery for Children—Second edition (NEPSY II) [25] assesses the ability to understand and to recognize the appropriate affect given various social contexts. In addition, we created a free labeling of emotions task using the Radboud Faces database [26].

Free labeling: The child is asked to tell "how this daddy or mommy feels" for pictures from the "Radboud Faces Database", 6 male and 6 female adult faces, presented in a random order and displaying happy, sad, angry, fearful, surprised or neutral emotions. No response option is provided. The percentage of correct responses was calculated.

Theory of Mind (TOM, NEPSY II): The child is asked to select a photograph from four options that depicts the appropriate facial expression of one of the characters in a picture depicting a social context. Percentage of correct response was calculated.

2.2.2. Effortful control

2.2.2.1. Hot and cool inhibition. The subtests were selected from the NEPSY [27] and the Effortful Control Battery (ECB) [28]. Cool inhibition is involved in problem resolution skills, decontextualized of any emotional load whereas *hot* inhibition involves an affective or motivational issue [29,30].

Tongue task (ECB) measures motivational (*hot*) inhibition. The child is asked to put a sweet on his tongue keeping his mouth open without chewing or swallowing of the sweet. The score reflects the average latency to produce one of the forbidden behaviors. This is done three times with a waiting time between trials of 20 till 40 s.

Statue (NEPSY) assesses motor persistence and *cool* inhibition. The child is asked to maintain a body position with eyes closed during a 75-second period and to inhibit the impulse to respond to sound distractors. Each motor or vocal infraction makes the score decreased.