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Sensory-motor performance in seven-year-old children born extremely preterm

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ABSTRACT

Background: Children born preterm are prone to motor problems. Research on their motor performance has, however, rarely been integrated with sensory processing.**Aim:** To examine sensory-motor performance in children born extremely preterm (EPT).**Method:** In a longitudinal prospective cohort study, 49 EPT (born < 28 gestational weeks; 32 boys and 17 girls) and 33 term-born (16 boys and 17 girls) children were assessed with six individual subtests from the Sensory Integration and Praxis Tests at the age of 7.0 to 7.3 years.**Results:** The rate of test z-scores indicating dysfunction [from -2 standard deviations (SD) to < -1 SD for mild and < -2 SD for moderate-to-severe] was significantly higher in EPT children than in term-born children in all the subtests. When comparing mean performance adjusted for gender and mother's education, EPT children performed worse than term-born children in Design Copying (z-score difference - 0.83; 95% confidence interval -1.32 to -0.34), Motor Accuracy (-0.82; -1.26 to -0.38), Postural Praxis (-0.95; -1.45 to -0.45), Manual Form Perception (-0.59; -1.12 to -0.06), and Finger Identification (-0.88; -1.45 to -0.31). Additional adjustment for Full-Scale Intelligence Quotient rendered difference in Manual Form Perception non-significant.**Conclusion:** Seven-year-old EPT children perform worse than their term-born peers in tests for visual-motor, somatosensory, and motor planning performance.

1. Introduction

Children born preterm are at a greater risk than their term-born peers of developing poor motor coordination in both gross and fine motor domains [1,2]. At school-age, the prevalence of mild-to-moderate motor impairment in preterm children is approximately 40% [2], and poor motor coordination persists throughout childhood [1] into adulthood [3]. Motor coordination skills are positively associated with attention and executive function [4], which constitute a specific area of weakness among very preterm children [5]. Motor coordination in conjunction with perceptual abilities in preterm children has been widely studied regarding visual-motor integration [6].

The context for preterm children's motor and other neurodevelopmental problems most likely lies within altered brain white and grey matter structures [7], cerebellar injury [8], and disrupted thalamocortical connections [9]. The mechanisms for how these micro- and

macrostructural alterations of the developing brain become evident as mild or moderate motor impairment are, however, unclear. One underlying factor for preterm children's motor problems may be poor integration of sensations from the body and the environment. The sensory integration (SI) concept draws attention to a person's abilities to organize sensations for perception, modulation, and sensory-motor functions. This ongoing process influences the dynamic use of the body and the limbs spatially in relation to each other and the environment, affecting daily activities and behaviors, and learning new skills [10,11].

The role of sensory processing in motor performance is rarely addressed in studies on preterm children. The purpose of our study was to describe both sensory and motor performance in seven-year-old children born extremely preterm (EPT) without major neurosensory disabilities [cerebral palsy, Full-Scale Intelligence Quotient (FSIQ) < 70, blindness or deafness]. Based on previous research and our clinical experience, we hypothesized that EPT children would perform worse

Abbreviations: EPT, extremely preterm; FSIQ, Full-Scale Intelligence Quotient; SD, standard deviation; SIPT, Sensory Integration and Praxis Tests

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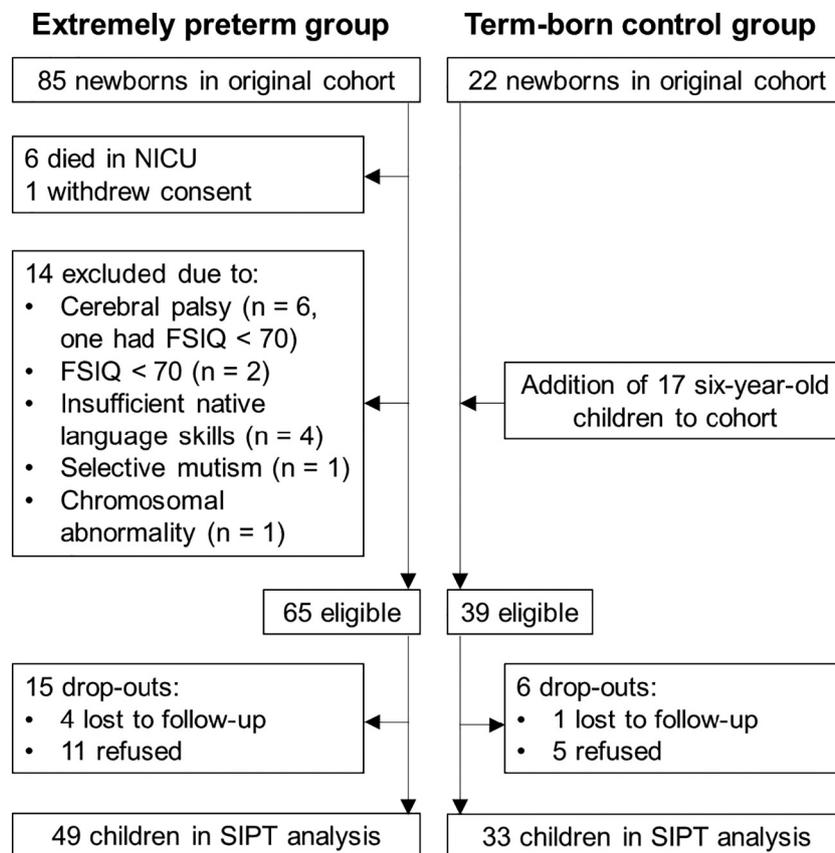


Fig. 1. Flow-chart of the study groups.

FSIQ, Full-Scale Intelligence Quotient; NICU, neonatal intensive care unit; SIPT, Sensory Integration and Praxis Tests.

than their term-born peers in tests of visual-motor, somatosensory (i.e., proprioception, haptic perception, and passive tactile perception), and bilateral integration abilities. This study is one of the first to explore the sensory processing difficulties that may underlie motor impairment experienced by EPT children.

2. Material and methods

2.1. Study design and participants

This study included 49 EPT children and 33 term-born children (inclusion, exclusion criteria and drop-outs summarized in Fig. 1). The children originally participated in a longitudinal prospective cohort study of 85 EPT children who were consecutively born at < 28 weeks' gestation between May 2006 and September 2008 and were actively treated after birth at the neonatal intensive care unit of the Helsinki University Hospital, Finland (KeKeKe Study - Extremely Preterm Birth and Development of the Central Nervous System [12]). Controls of the original cohort were 39 children born healthy at term age between September 2006 and June 2009 in the Hospital District of Helsinki and Uusimaa, Finland. They were recruited to the study shortly after birth from the maternity ward of the Department of Obstetrics, Helsinki University Hospital or at six years of age through an advertisement that was delivered to nursery schools in Helsinki and also distributed by an association of premature babies' parents (Fig. 1). Inclusion criteria included gestational age from 37⁺⁰ to 42⁺⁰ weeks, birth weight > 2500 g and no need for observation or treatment in the neonatal ward.

The Ethics Committee for gynecology and obstetrics, pediatrics and psychiatry of the Hospital District of Helsinki and Uusimaa granted ethical approval for the original study and the follow-up at 6–7 years. Parents or guardians of the participating children provided written

informed consent to participation and publication of the results. In addition, all children received age-appropriate information about the study and provided consent to participate in the study.

2.2. Clinical data

Obstetric, neonatal, maternal, and paternal data were obtained from the hospital records and parental questionnaires. When available, gestational age was determined from the first-trimester ultrasound. Small for gestational age was defined as birth weight z-score < -2 SD according to the Finnish growth reference data [13]. The highest grade of intraventricular hemorrhage in serial cranial ultrasound during the neonatal period was recorded. White matter injury in brain magnetic resonance imaging at term equivalent age was classified into four categories from none to severe [12,14]. Information regarding hearing and vision were collected from the child's health records and, when necessary, a visual acuity test and cover tests for strabismus were performed.

Cognitive development (Full-Scale, Performance, and Verbal Intelligence Quotient) was measured at 6–7 years [median (IQR): EPT children 6.5 (0.2) years, term-born children 6.5 (0.1) years, $p = 0.80$] with three Performance (Block Design, Matrix Reasoning, and Picture Completion) and two Verbal (Information and Vocabulary) subtests of the Finnish edition of the Wechsler Preschool and Primary Scale of Intelligence - Third Edition (WPPSI-III) [15] or the Wechsler Intelligence Scale for Children - Fourth Edition (WISC-IV) [16]. Missing subtest data were imputed by the mean of the available Performance or Verbal subtest scores.

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