Language, motor and cognitive development of extremely preterm children: Modeling individual growth trajectories over the first three years of life

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ABSTRACT

Survival rate of extremely low gestational age (ELGA) newborns has increased over 80% in the last 15 years, but its consequences on the short- and longer-term developmental competencies may be severe. The aim of this study was to describe growth trajectories of linguistic, motor and cognitive skills among ELGA children, compared to full-term (FT) peers, from the first to the third year of life, a crucial period for development. Growth curve analysis was used to examine individual and group differences in terms of initial status at 12 months and rate of growth through the second and the third year of life with five points of assessment. Twenty-eight monolingual Italian children, of whom 17 were ELGA (mean GA 25.7 weeks) and 11 were FT children, were assessed through the BSID-III at 12, 18, 24, 30 and 36 months for language skills and at 12, 24 and 30 months for motor and cognitive skills. ELGA children presented significantly lower scores than FT peers in language, motor and cognitive skills and they did not overcome their disadvantage by 3 years, even if their corrected age was taken into account. Concerning growth curves, in motor development a significant increasing divergence was found showing a Matthew effect with the preterm sample falling further behind the FT sample. In linguistic and cognitive development, instead, a stable gap between the two samples was found. In addition, great inter-individual differences in rate of change were observed for language development in both samples. Our findings highlight the theoretical and clinical relevance of analyzing, through growth curve analyses, the developmental trajectories of ELGA children in language skills taking into account their inter-individual variability also across motor and cognitive domains.

Learning outcomes: After reading this article, the reader will interpret: (a) characteristics and growth trajectories of ELGA children from the first to the third year of life with respect to FT children in language, motor and cognitive development; (b) the method of growth curve analyses to describe group as well as inter-individual trajectories; (c) the rate of inter-individual variability in language as well as motor and cognitive skills, which gives useful indications for early interventions.

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1. Introduction

Rate of preterm birth, defined by the World Health Organization as a birth that occurs before 37 weeks of gestational age (GA), is about 10–12% in the United States and in Africa, and about 5–9% in Europe and other developed countries (Beck et al., 2010). GA is often used to stratify typologies of preterm children with late (34–36 weeks GA, 60%) and moderate preterm birth (32–33 weeks GA, 20%) being more common, while very preterm (28–31 weeks GA, 15%) and extremely preterm (<28 weeks GA, 5%) representing about one of five preterm births (Goldenberg, Culhane, Iams, & Romero, 2008). Recent results from a multi-site consortium conducting in-depth assessments of the physical and developmental consequences of preterm birth support the notion that GA conveys important information about developmentally regulated changes in the developing fetus (e.g., O'Shea et al., 2009). In particular, for extremely low gestational age (ELGA) newborns, whose survival rate has increased to about 80% in the last 15 years thanks to technological and pharmacological advances, the consequences of their extreme neonatal immaturity on the short- and longer-term developmental competencies are more severe than those observed among children born at later gestational ages (Johnson, Wolke, Hennessy, & Marlow, 2011; Marlow, Wolke, Bracewell, Samara, & EPICure Study Group, 2005; Sansavini, Guarini, & Caselli, 2011). Improving our understanding about the early growth trajectories of language, motor and cognitive development among ELGA children was the principal goal of the present study.

1.1. Early cognitive development among preterm children

Meta-analyses and systematic reviews have shown that preterm children exhibit developmental differences in relation to full-term (FT) peers in general intellect (difference of about 10 standard IQ points; Bhutta, Cleves, Casey, Cradock, & Anand, 2002) and learning abilities (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009) over the years of childhood and adolescence on a range of competencies, but also that there are individual differences among preterm children in these competencies. One reason is linked to the level of neonatal immaturity in terms of GA. In fact, differences between preterm and FT children in general cognitive abilities are most pronounced for ELGA (Marlow et al., 2005; Sansavini, Guarini, & Caselli, 2011), less severe for very preterm children (Larroque et al., 2008) and more attenuated for moderate to late preterm children (De Jong, Verhoeven, & van Baar, 2012). For instance, Sansavini, Savini, et al. (2011) described performance of 29 ELGA children at 2 years on a general norm-referenced index of development. They showed a more substantial range in scores (50–131 standard score points), with a standard deviation of 16 points, than that of very low gestational age (VLGA; 29–32 weeks; range in scores: 77–115, $SD = 8.6$) and FT children (GA > 37 weeks; range in scores: 98–116, $SD = 5.4$). Such data indicate the potential need to improve our understanding of individual differences among ELGA children in their development over time.

There have been some efforts to advance understanding of individual differences within groups of preterm children rather than focusing solely on mean differences in competencies as compared to FT peers or among the various typologies of preterm birth (e.g., ELGA vs. VLGA children). In fact, outcomes of preterm children are very heterogeneous because of the complex interaction among biological and environmental constraints characterizing preterm children and the timing in which these constraints occur (Sansavini, Guarini, & Caselli, 2011). Some studies have described the percentage of ELGA children who have significant physical and developmental disabilities (Hack & Fanaroff, 1999; O'Shea et al., 2012) and the characteristics of children and families associated with presence of disabilities, but knowledge on ELGAs' developmental trajectories taking into account individual differences is still lacking.

1.2. Early linguistic development among preterm children

A reasonable body of work has examined the developmental achievements (and risk thereto) of very preterm children through the preschool years (e.g., Sansavini et al., 2010), into kindergarten (e.g., Guarini et al., 2009), primary grades (e.g., Guarini et al., 2010) and adolescence (e.g., Luu, Vohr, Allan, Schneider, & Ment, 2011), showing that one of the more commonly affected domains is communication and language (for reviews, see Sansavini, Guarini, & Caselli, 2011). As revealed by a recent meta-analysis (Barre, Morgan, Doyle, & Anderson, 2011), scores in receptive and expressive lexicon and receptive grammar of very preterm children, analyzed through linguistic standardized tests and parental questionnaires at preschool and school age, lie between 0.38 and 0.77 SD below those of control samples. Sansavini et al. (2010) examined the rate of language impairment (LI) among very preterm children (mean GA 30 ± 2 weeks) finding that about one-third of these children could be characterized as LI at 3.5 years. The predominant predictor of LI was prior history of communicative and linguistic skills as reported at 2.5 years. Such work helps us recognize that there are specific subgroups of preterm children who are most vulnerable for ongoing developmental difficulties and research on their early linguistic acquisition is needed.

In the first two years of life, even by considering corrected age, very preterm children show lower scores than FT children on measures of vocabulary (D'Odorico, Fasolo, Majorano, Salerni, & Suttora, 2011; Ortiz-Mantilla, Choudhury, Leevers, & Benasich, 2008; Sansavini, Guarini, Savini, Broccoli et al., 2011; Stolt et al., 2009). Stolt et al. (2009) followed 32 very low birthweight (VLBW) Finnish preterm children (mean GA 28 ± 2 weeks), comparing their vocabulary growth to 35 FT peers using the MacArthur-Bates CDI (MB-CDI) long form. The receptive lexicon sizes from 9 to 15 months of the FT children were estimated to be 1.7 times larger than those of preterm ones. Expressive vocabulary was similar between the two samples from 9 to 18 months; by 24 months, however, FT children knew significantly more words than preterm peers, suggesting that differences in expressive language between preterm and FT children become evident around the end of the second year.