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Object exploration in extremely preterm infants between 6 and 9 months and relation to cognitive and language development at 24 months



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ABSTRACT

Although early object exploration is considered a key ability for subsequent achievements, very few studies have analyzed its development in extremely low gestational age infants (ELGA < 28 weeks), whose early motor skills are delayed. Moreover, no studies have examined its developmental relationship with cognitive and language skills. The present study examined developmental change in Motor Object Exploration (MOE) and different types of MOE (Holding, Oral, Manual and Manual Rhythmic Exploration) in 20 ELGA and 20 full term (FT) infants observed during mother-infant play interaction at 6 and 9 months. It also explored whether specific types of MOE were longitudinally related to 24-month language and cognitive abilities (GMDS-R scores). ELGA infants increased MOE duration from 6 to 9 months, eliminating the initial difference with FT infants. In addition, ELGA infants showed a different pattern of Oral Exploration, that did not increase at 6 months and decrease at 9 months. Oral and Manual Exploration durations at 6 months were longitudinally related to 24-month GMDS-R language and cognitive performance scores respectively. We discuss the relevance of assessing early exploratory abilities in ELGA infants in order to implement customized intervention programs for supporting the development of these skills.

What this paper adds?

The motor domain is particularly vulnerable in extremely low gestational age infants (ELGA < 28 weeks) whose motor skills are delayed from the outset, even in absence of brain damage. Among early fine-motor abilities, very few studies have analyzed the development of object exploration in this population, although this is considered a key ability for subsequent achievements. Moreover, no studies have examined its developmental relationship with cognitive and language. This paper adds a detailed description of the longitudinal change of the exploratory abilities in ELGA infants from 6 to 9 months and explore whether specific

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exploratory behaviors at 6 months are related to 24-month language and cognitive abilities. The findings reveal that ELGA infants show different developmental patterns in object exploration compared to FT infants. In particular, they increase Motor Object Exploration duration from 6 to 9 months but, differently from FT infants, they do not show an increase in Oral Exploration at 6 months and a decrease at 9 months. In addition, our results show that 6-month duration of Oral and Manual Exploration contribute to predict the 24-month Hearing & Language and cognitive Performance scores, respectively, suggesting that early motor abilities are closely related to cognitive and language development. Considering the potential cascading effects that subtle difficulties in object exploration may have on language and cognitive development, our findings point out the relevance of assessing early exploratory abilities in ELGA infants in order to implement customized intervention programs for supporting the development of these skills.

1. Introduction

Although advances in neonatal intensive care have improved the survival rate of extremely low gestational age infants (ELGA-born < 28 weeks of gestation) in the last two decades, the risk of cognitive, language and motor impairments in this population remains a concern, with an increasing likelihood of adverse developmental outcomes in multiple domains (Anderson & Doyle, 2008; de Kievet, Piek, Aarnoudse-Moens, & Oosterlaan, 2009; Marlow, Wolke, Bracewell, & Samara, 2005; Sansavini, Savini, Guarini et al., 2011; Sansavini et al., 2014; Wolke & Meyer, 1999).

In the motor domain, some studies have revealed that compared to full-term (FT) infants, ELGA infants show slower developmental trajectories and a higher number of difficulties, even in the absence of cerebral abnormalities. These differences are evident by the first year of life and persist until adulthood (de Kievet et al., 2005; Hille et al., 2008; Husby, Skranes, Olsen, Brubakk, & Evensen, 2013; Sansavini et al., 2014; Sansavini, Savini, Guarini et al., 2011). Motor difficulties could be also detrimental for development in other domains, since, as described in several studies on typically developing (TD) infants, the achievement and improvement of motor skills at an early age may afford later advances in linguistic and cognitive functions. In particular, the infant capacity for action can offer a unique contribution in that direction. Iverson (2010) noted that early motor achievements, including object exploration, provide infants with the opportunity to practice skills that are critically shared with language, and allow infants to experiment changes in the relationships with objects and people that are relevant for communicative development in general and for language acquisition in particular. In support of this suggestion, research has found that early manipulative practice related significantly with larger vocabulary and psychomotor general scores at later age (Ruddy & Bornstein, 1982); moreover, it has also found that the effects of motor abilities on development persist until childhood, as revealed by Oudgenoeg-Paz, Leseman, and Volman (2014) with respect to early spatial exploration as related to later spatial memory, and until adolescence, as showed by Bornstein, Hahn, Suwalsky (2013), with respect to the extent and efficiency of early exploration as related to later academic achievement.

Although these studies are correlational and do not permit causal conclusions, they underscore the existence of a significant relationship between exploratory skills and later development. However, very few studies have analyzed exploratory skills in the ELGA population, and the nature of this relationship remains largely unexplored. The aim of the current study is to address this gap in the literature by examining developmental change in object exploration behaviors in ELGA and FT infants between 6 and 9 months of age and by analyzing developmental relationships between specific exploratory behaviors observed at 6 months and language and cognitive abilities assessed at 24 months.

1.1. Object exploration in TD and preterm infants

From an early age, TD infants actively explore objects in their environment. Although exploratory behaviors are first observable at 2 months of age (Lobo, Kokkoni, de Campos, & Galloway, 2014; Rochat, 1989), they consistently improve with the onset of reaching and the emergence of the sitting posture around 4–5 months of age (Berthenthal & Von Hofsten, 1998; Lobo & Galloway, 2013; Rochat & Goubet, 1995). The achievement of these milestones promotes significant changes in object exploration, increasing the number, variety, and duration of the available behaviors (Rochat, 1989). Some studies have shown that 6 month-old infants exhibit different types of object exploration based on object affordances (Lobo et al., 2014), thereby obtaining different perceptual information based on object characteristics (Bushnell & Boudreau, 1993; Palmer, 1989; Rochat, 1989; Ruff, 1984). In addition, the frequency of exploratory behaviors changes over time. In particular, Oral Exploration (e.g. mouthing) shows higher frequency and duration at 6 months, then decreases between 6 and 9 months (Belsky & Most, 1981; Lobo et al., 2014; Ruff, 1984); Manual exploratory behaviors (e.g. transferring, turn rotating, and fingering) increase over time, reaching higher frequency and duration between 6 and 9 months (Lobo et al., 2014; Ruff, 1984); Manual Rhythmic behaviors such as banging and shaking increase before 6 months and do not change significantly between 6 and 9 months (Lobo et al., 2014).

As noted previously, the development of object exploration has been studied in TD infants, whereas less it is known about object exploration in infants at risk for delays in motor development, such as preterm infants. The studies that addressed this issue are few in number and have included preterm infants with neurological damage and across a wide range of gestational ages. Kopp (1976) found that preterm infants without neurological damage spent similar proportions of time manipulating objects as FT infants at 8 months, but types of exploration were different, with preterm infants spending less time mouthing than their FT counterparts. Unfortunately, the gestational ages and the use of corrected age in the preterm group were not specified; thus, the findings of this study cannot be generalized. Another study (Ruff, McCarton, Kurtzberg, & Vaughan, 1984), which examined preterm infants with a gestational age < 34 weeks, reported that preterm infants with neurological damage (high risk) showed less advanced object exploration than preterm infants without neurological damage (low risk) and FT infants at 9 months corrected age, with a shorter time spent in transferring, turn rotating, and fingering. No differences were found between low risk preterm infants and FT peers. In these studies,

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