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Object engagement and manipulation in extremely preterm and full term infants at 6 months of age

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ABSTRACT

Delays in the motor domain have been frequently observed in preterm children, especially those born at an extremely low gestational age (ELGA; <28 weeks GA). However, early motor exploration has received relatively little attention despite its relevance for object knowledge and its impact on cognitive and language development. The present study aimed at comparing early object exploration in 20 ELGA and 20 full-term (FT) infants at 6 months of age during a 5-minute mother-infant play interaction. Object engagement (visual vs manual), visual object engagement (no act vs reach), manual object engagement (passive vs active), and active object manipulation (mouthing, transferring, banging, turn/rotating, shaking, fingering) were analyzed. Moreover, the Griffiths Mental Development Scales 0-2 years (1996) were administered to the infants. Relative to FT peers, ELGA infants spent more time in visual engagement, and less time in manual engagement, active manipulation, mouthing, and turning/rotating. Moreover, they had lower scores on general psychomotor development, eye & hand coordination, and performance abilities. Close relationships emerged between manual object engagement and psychomotor development. Clinical implications of these results in terms of early evaluation of action schemes in ELGA infants and the provision of intervention programs for supporting these abilities are discussed.

1. Introduction

Preterm children, defined by the World Health Organization as born before 37 weeks of gestational age (GA), are at risk for developmental difficulties, delays, and impairments, even in the absence of cerebral damage (Saigal & Doyle, 2008; Sansavini, Guarini, & Caselli, 2011). In the early years of life, they are more likely to lag behind full-term (FT) infants in motor skills,

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language, and cognitive development (Sansavini et al., 2014). In later years, they may also show neuropsychological deficits in the domains of attention, memory, and executive function, learning disabilities, and behavioral problems, especially with regard to emotional control (Aarnoudse-Moens, Smidts, Oosterlaan, Duivenvoorden, & Weisglas-Kuperus, 2009; Aylward, 2002; Bhutta, Cleves, Casey, Cradock, & Anan, 2002). These delays increase as a function of neonatal immaturity, medical complications, and cerebral damages, and affect up to 50% of preterm children with lower gestational ages (very low- VLGA- <32 weeks and extremely low- ELGA- <28 weeks) or birth weight (very low- VLBW- <1500 g and extremely low- ELBW- < 1000 g) (Aylward, 2002; Johnson, Wolke, Hennessy, & Marlow, 2011; Marlow, Roberts, & Cooke, 1993; Sansavini, Savini et al., 2011).

Several authors have underscored the importance of identifying and describing early behaviors that can affect subsequent development in the preterm population (Rose, Feldman, & Jankowski, 2009; Sansavini, Guarini, & Caselli, 2011). Research has demonstrated that the motor domain is frequently compromised in very preterm children from the first months of life (de Kievet, Piek, Aarnoudse-Moens, & Oosterlaan, 2009). Thus, the principal goal of the present study was to contribute to our understanding of these motor difficulties by investigating early manual object exploration and its relationship to cognitive abilities in ELGA infants.

1.1. Motor development in preterm children

Motor delays are frequently observed among preterm infants from early in life, presumably because of the early interruption of neurological and physical maturation in utero and the subsequent postural constraints imposed by the prolonged recovery in the Neonatal Intensive Care Unit (NICU). As described in de Kievet et al.'s (2009) meta-analytic review, preterm children obtain lower scores in early gross motor and fine motor skills with respect to FT samples, and this gap is more evident between VLGA and ELGA children. In a recent longitudinal study (Sansavini, Savini et al., 2011), ELGA infants showed difficulties in locomotor, eye-hand coordination, and non verbal performance abilities compared to VLGA and FT peers, with an increase in these difficulties and rate of impairments from 6 to 24 months of corrected age. Another longitudinal study (Sansavini et al., 2014) found an increasing divergence in the developmental trajectory of motor skills – both fine and gross – in ELGA infants from 12 to 30 months of corrected age in comparison to that of a FT group, confirming that the motor domain may be particularly compromised in ELGA infants. In addition, there is no indication of improvement within the first three years of life. Delays with respect to FT peers persist at preschool and school age in fine and gross motor development, particularly in balance skills, ball skills, and manual dexterity (de Kievet et al., 2009).

These findings stress the importance of further investigating diverse aspects of motor functioning and identifying early motor delays, which may have possible cascading effects on several developmental domains beyond the motor system. For instance, 6-month-old VLGA infants, who present signs of neck, elbow and trunk hyperextension due to their poor regulation of muscle tone (but not to permanent neurological damage), scored significantly lower on cognitive measures 6-18 months later (Wijnroks & van Veldhoven, 2003). Motor scores in 12-month-old ELBW infants predicted cognitive performance at 4 years (Burns, O'Callaghan, McDonell, & Rogers, 2004). Moreover, motor skills at 6 years in VLBW children were the best predictor of learning disabilities and poor cognitive performance at 8 years (Marlow et al., 1993). A strong predictive relationship between motor skills and cognitive outcomes has also been observed in typical development: gross motor skills assessed from 4 months to 4 years through a parental questionnaire were predictive of IQ measures between 6 and 12 years (Piek, Dawson, Smith, & Gasson, 2008).

1.2. Early fine motor exploration abilities in preterm children

Motor development in preterm infants has been primarily investigated using global measures and standardized assessments. However, a more fine-grained analysis is needed in order to determine *how* infants use their motor repertoires when relating to external objects. To this end, infants' exploration of objects should be observed. As noted by several authors (Ruff, 1984; Rochat, 1989; Bushnell & Boudreau, 1993; Needham, 2000; Baumgartner & Oakes, 2013) manipulative skills such as holding and mouthing allow infants to discover a range of object properties that advance their knowledge at both perceptual and functional level, thus contributing to object categorization, a foundational ability for subsequent cognitive and language development (Oakes & Madole, 2000). Not only does the current manipulation of the object reveal infants' exploratory ability; so also does their attention to the object before initiating the manual contact with it. According to Ruff (1986), the time spent in looking at the object before reaching for it reflects the time is needed to organize an exploratory response and thus is a part of the ability to deal with object properties. Latencies to reach for and grasp an object after its first presentation decreases with increasing age and improved exploratory abilities (Ruff, 1986). This measure may also be relevant for further cognitive development since, as underscored by Perone, Madole, Ross-Sheehy, Carey & Oakes (2008) and later by Baumgartner & Oakes (2013), it is related to the infant's recognition of object appearance features.

Given the well recognized motor difficulties in premature infants and the possible negative effects of delayed object exploration on development, it would be of a great value to determine whether preterm infants differ from FT infants in the organization and deployment of manipulative schemes for object exploration and whether these abilities may be related to cognitive performance. Existing research on this topic is relatively sparse. Kopp (1976) assessed a variety of object-related action schemes in low risk preterm infants at 8 months, revealing that they displayed the same types of manipulative actions and spent similar proportions of time engaging in these actions compared to FT infants. Nevertheless, the durations