Research in Developmental Disabilities 35 (2014) 3096–3107

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Differences between late preterm and full-term infants: Comparing effects of a short bout of practice on early reaching behavior

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ARTICLE INFO

Article history:
Received 31 March 2014
Received in revised form 17 July 2014
Accepted 22 July 2014
Available online

Keywords:
Movement training
Premature birth
Motor learning
Early intervention

ABSTRACT

This study compared the effects of a short bout of practice on reaching behavior between late preterm and full-term infants at the onset of goal-directed reaching. Twelve late preterm infants and twelve full-term infants received reaching practice based on a serial schedule. Late preterm and full-term infants were assessed in 3.3 ± 1.4 and 2.6 ± 1.0 days after the onset of goal-directed reaching in two measures in a single day: immediately before practice (pre-test) and immediately after practice (post-test). During the assessments, the infants were placed in a baby chair and a rubber toy was presented at their midline within reaching distance for 2 min. Between assessments, the infants received practice of toy-oriented reaching in 3 activities repeated for approximately 4 min. The activities were elicited in a pre-established serial sequence and were applied by a physical therapist. During the pre-test, late preterm infants presented lower range of proximal adjustments, greater proportion of reaches with semi-open hand, and greater proportion of reaches without grasping than the full-term infants. During the post-test, late preterm infants presented greater motor variability of proximal adjustments, but explored and selected distal control and grasping outcomes less compared to the full-term group. Differences in reaching and gross motor behavior between late preterm and full-term infants can be found at the age of reaching onset. Practice provided new opportunities for late preterm infants to improve perception-action coupling to reach; however, relative to full-terms, they seemed less advanced in benefiting from the experience for more refined manual tasks.

1. Introduction

Late preterm newborns (born at 34–36 6/7 weeks of gestation) have been an emerging focus of concern (Engle, 2006; Engle, Tomashek, & Wallman, 2007; Raju, Higgins, Stark, & Leveno, 2006). Although they may seemingly be as healthy as full-term infants at birth, late preterm infants are at higher risk for developmental alterations (Engle et al., 2007; Odd, Lingam,

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http://dx.doi.org/10.1016/j.ridd.2014.07.041
0891-4222/

Emond, & Whitelaw, 2013). At 34–35 gestational weeks the neural tissues are still in dramatic growth and the brain weighs only 60–65% that of term age (Adams-Chapman, 2006; Guihard-Costa & Larroche, 1990; Kinney, 2006). Their physiologic jaundice is more prolonged, which makes late preterm infants at a higher risk for bilirubin-induced brain damage than full-term infants (Gartner & Herschel, 2001). Also, late preterm infants are 2.7 times more likely to present with cerebral palsy in adulthood than those born full-term (Moster, Lie, & Markestad, 2008) and present worse motor coordination and higher rate of cerebral palsy at school age than full-term peers (Odd et al., 2013). Therefore, if late preterm infants are assumed to be similar as full-term infants at birth, they may be discharged too early from hospital without proper follow-up (Watchko & Maisels, 2003) and receive insufficient guided stimulation in a phase of large neuroplasticity (Dusing, Lobo, Lee, & Galloway, 2013; Kolb & Gibb, 2011).

During guided stimulation, as in sessions of early intervention, infants usually are stimulated to interact with toys. However, late prematurity has been associated to constraints that limit toy exploration and the spontaneous acquisition of toy-oriented reaching early in life (Guimarães, Cunha, Soares, & Tudella, 2013; Soares, von Hofsten, & Tudella, 2012; Soares, van der Kamp, Savelsbergh, & Tudella, 2013). This might be extended to later months as differences in reaching strategies relative to full-term infants (Soares et al., 2013). For example, at 6 months of corrected age late preterm infants reach with an open hand more often (Toledo, Soares, & Tudella, 2011), reduce the hand velocity and prolong the hand deceleration prior to contact with a midline toy compared to full-term infants (Toledo & Tudella, 2008). This may reflect differences in distal adjustments (i.e., hand configurations, such as hand opening) and upper limb control to facilitate the approach of the hand toward a midline toy (Soares et al., 2013). However, it is still unknown whether such differences between late preterm infants and full-term infants are already present at the onset of reaching and, if so, whether reaching practice can minimize them.

These issues are of valuable interest for clinicians for a number of reasons. First, differences between preterm and full-term infants in the development of reaching might represent early signals of difficulties for the learning and performance of fine manipulative skills that may only become observable later in childhood (Fallang, Øien, Hellem, Saugstad, & Hadders-Algra, 2005). Secondly, in light of the Dynamic System approach (Kugler, 1986; Thelen & Smith, 1994), developmental skills can be positively influenced by enhanced experience. In addition, according to the Neuronal Group Selection Theory, during the initial phase of reaching development the infant uses afferent information provided by experience to continuously explore movements (Hadders-Algra, 2000; Sporns & Edelman, 1993). This generates motor variability, that is, several attempts at the same task lead to different patterns of performance, including variation of action strategies and kinematic parameters (Latash, Scholz, & Schöner, 2002), which enables alternative solutions to achieve the task goal (Manoel & Connolly, 1995). This allows the selection of movement patterns better adapted to the task demands, which result in reduced motor variability (Hadders-Algra, 2000). Hence, if late preterm infants use poorer strategies to reach for objects than full-term infants at the period of reaching onset but can benefit from enhanced reaching experience, it is relevant to investigate potential practice protocols that could be adjusted by parents and therapists as tools to prevent further alterations in the manual function of late preterm infants.

Heathcock, Lobo, and Galloway (2008) were pioneers in showing that preterm infants can benefit from reaching practice relative to full-term infants. After 8 weeks of daily practice of hand-toy interaction and reaching for 45 min initiated before the onset of goal-directed reaching, preterm infants with less than 33 weeks of gestation and low birth weight enhanced distal adjustments for reaching similarly as untrained full-term infants, by performing more reaches with open and ventrally oriented hand. In the study by Soares et al. (2013), late preterm infants were guided to practice 3 reaching activities based on either a blocked schedule (111-222-333), a serial schedule (123-123-123), or no practice, in a single session of approximately 4 min. The major findings were increased number of reaches and bimanual proximal adjustments (i.e., upper limb movements resulted from shoulder, such as uni or bimanual movements), immediately and temporarily after the practice based on the serial schedule. Whereas it is of general knowledge that the learning of motor skills requires multiple training sessions (Karni et al., 1998; Kleim, Lussnig, Schwarz, Comery, & Greenough, 1996; Kleim, Barbay, & Nudo, 1998; Nudo, Milliken, Jenkins, & Merzenich, 1996), Soares et al. (2013) indicated the relevance of each single and immediate experience, as changes in the reaching behavior of late preterm infants were quickly initiated after a few minutes of toy-oriented experience based on the serial schedule. Yet, it is unknown how such "fast" and initial changes are displayed in late preterm infants relative to full-term infants. Interestingly, Cunha, Soares, Ferro, and Tudella (2013), and Cunha, Woollacott, and Tudella (2013) found that immediately after 4 min of reaching practice based on a blocked schedule at the onset of reaching, full-term infants performed faster reaches and higher number of total reaches, unimanual reaches, reaches with semi-open hand and oblique hand, which consist of functional patterns to reach for a malleable toy in midline. In addition, Cunha, Kokkoni, et al. (2013) found increased functional patterns for hand opening and positioning in newly-reaching full-term infants immediately after 4 min of reaching practice based on a serial schedule. However, in the study by Soares et al. (2013) the blocked practice did not affect reaching behavior, and also hand opening and kinematic parameters of reaching related to movement control and smoothness (straightness index, deceleration time, number of movement units, velocity) were not affected by practice in late preterm infants in any way. Hence, the potential to benefit from a small set of reaching movements at the onset of reaching may be limited in late preterm infants (Soares et al., 2013) compared to a population without further risk of reaching limitations (i.e., full-term infants) (Heathcock et al., 2008). Nevertheless, as a direct comparison has not been investigated yet, differences between late preterm and full-term infants in the ability to benefit from early and immediate reaching practice remains speculative.