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Review

Breastfeeding and language outcomes: A review of the literature

J. Mahurin-Smith *

Illinois State University, Normal, IL 61790, United States

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ABSTRACT

Many researchers have investigated the potential impact of breastfeeding in infancy on a child's subsequent development, but only a small subset of these studies considers language development and impairment. This paper reviews that literature, discussing postnatal neurodevelopment, potential mechanisms for dietary influences on communication outcomes, studies of typically developing children, and studies of children with communication concerns. For population based studies of language development, a modest but statistically robust relationship is seen across large samples that account for breastfeeding exclusivity. A similar protective relationship is seen in studies that evaluate the relationship between breastfeeding and language disorders; effect sizes are typically larger in these papers. Implications for researchers and service providers are reviewed.

Learning outcomes: Readers will be able to describe possible mechanisms by which early diet might influence neurodevelopment. They will be able to describe the relationships observed between diet in infancy and language outcomes in large population-based studies, as well as the trends observed in studies of the relationship between infant diet and communication impairment.

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* Tel.: +1 309 438 5308.
E-mail address: j.m.smith@ilstu.edu

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1. Introduction

Imagine that two communities in two different parts of the world are building a network of roads. As a cost-saving measure, the planning teams opt to use lower-grade building materials for half of each community. One community's climate is mild: temperatures tend to stay in the 40–70 °F range. The second community experiences much more temperature variability: winter temperatures might plummet to −20 °F or cycle rapidly from freeze to thaw and back again, while summer temperatures might hover around 100 °F.

Drivers who have navigated pothole-ridden streets in spring might guess that the roads built with lower-grade materials could show signs of wear more rapidly in Community #2. When the strains on the materials are greater, the breakdowns in the network may be apparent more rapidly. Drivers in Community #1 might notice only minor signs of wear on the lower-grade sections of their roadways, while drivers in Community #2 might find a conspicuous difference.

The neurological system can be envisioned as a vast network of roads, undergoing large-scale construction projects during pregnancy, infancy, and toddlerhood. The "road-building" materials available to children can vary with their early diet, leading to differences in brain structure (Farquharson, Jamieson, Logan, Cockburn, & Ainslie Patrick, 1992; Farquharson et al., 1995; Jamieson et al., 1999; Makrides, Neumann, Byard, Simmer, & Gibson, 1994). These differences in brain structure may be associated with differences in brain function (Greiner, Moriguchi, Hutton, Slotnick, & Salem, 1999; Salem et al., 2000). For children whose network of genetic and other environmental effects does not predispose them to language difficulties – similar to the roads in Community #1 – diet in infancy may be linked to modest differences in later life (Anderson, Johnstone, & Remley, 1999). For children whose genotype renders them more vulnerable to language impairment, like the roads in Community #2, early diet may make a more significant difference as they mature (Schultz et al., 2006).

Breastfeeding is widely recommended for infants, and the differences in morbidity between breastfed and formula-fed children are well-documented (American Academy of Pediatrics, 2012; World Health Organization, 2003). Less familiar, perhaps, are the differences in neurodevelopment that have also been observed in studies of breastfed versus formula-fed children. Although a subset of this literature looks explicitly at the relationship between feeding mode in infancy and subsequent speech-language development, these investigations are seldom referenced in communication sciences and disorders (CSD) journals (Rogers et al., 2015). This paper will first describe the process of postnatal brain development and the mechanisms through which diet might influence neurodevelopment, followed by a review of the existing literature on associations between breastfeeding and subsequent language development and impairment. It will conclude with a review of potential implications arising from these findings.

2. Postnatal neurodevelopment

Lawrence and Lawrence (2005) report that the average newborn will arrive with a brain weighing approximately 350 g; a year later, that brain will have grown to approximately 1100 g. By age 3 the brain will have quadrupled relative to its size at birth; the steepness of this early trajectory is particularly clear when one considers that the brain will require a further 15 years to approach the quintuple mark (Dekaban & Sadowsky, 1978). Neurons proliferate in regions including the dentate gyrus of the hippocampus, a region associated with memory; during the first 2 weeks of life this process is especially vulnerable to environmental influences such as the presence or absence of growth factors (Watson, DeSesso, Hurtt, & Cappon, 2006). In addition to the rapid growth of the brain itself, other types of neural tissue proliferate during the early years of life. The most rapid period of postnatal myelination occurs during the first 2 years of life; the major fiber tracts are clearly visible in 3-year-old children (Matsuzawa et al., 2001). During the first 18 months of life neurons must migrate to other parts of the brain, including the prefrontal cortex (Sanai et al., 2011). This is also a period of dramatic growth in synapse formation, so much so that at the point of peak synaptic density there are 55 synapses per 100 μm^3 in the human brain (Watson et al., 2006).

The decline in synaptic density observed between toddlerhood and adulthood is the result of a form of programmed cell death known as pruning. It is common to think of brain cell death as undesirable, but pruning is a critical part of normal neurodevelopment, distinct from other causes of cell death such as injury or toxin exposure (Watson et al., 2006). Inadequate pruning has been posited as a factor in autism (Hill & Frith, 2003), highlighting the potential importance of this neurodevelopmental process.

During infancy the brain is also building its own protective mechanisms, a process that takes time to complete. In the first 6 months of life the blood-brain barrier is more permeable than it will be in later life, increasing the infant's vulnerability to neurotoxins (e.g., methylmercury) with the potential to affect future cognitive skills (see Watson et al., 2006; Dzwilewski et al., in this issue). To sum up, then, infants not only must build brain cells, they must also establish connections between them, re-sculpt brain architecture, and create a selectively permeable wall between the brain and the outside world. Their diet provides the raw materials available for these tasks.

3. Why would diet influence language development? Potential mechanisms

The idea that breastfeeding or formula-feeding could influence language development immediately raises the question of mechanism: why would children's diets in infancy exert any long-term influence over their speech-language skills? Four possibilities will be reviewed in the section that follows. The explanation most often proposed is that differences in the fatty

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