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Breastmilk and Brain: The Effects of Breastfeeding on Cognitive Development

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Breastmilk and Brain:

The Effects of Breastfeeding on Cognitive Development

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Abstract

This paper explores the effects of breastfeeding on cognitive development, with an emphasis on early childhood development. It will explore whether breastfeeding duration has any implications, in addition to whether breastfeeding has a lasting influence on cognition, and if so, to what extent. Though not the primary focus, this paper will also touch on the biological components that are linked with cognition, essential to understanding the breadth of breastfeeding's effects on cognitive development. Additionally, this paper will cover some of the methods the studies used, to understand which aspects of cognition were examined, as well as discuss the studies issues and limitations. Much of the research examined have similar claims; breastmilk is associated with cognitive development. Regarding lasting effects, some research claims that the effects of breastmilk on cognitive development are long-term. Whereas other research suggests the long-term effects are minimal, if any, and that environmental and parental factors have a greater influence.

Breastmilk and Brain:

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The way many of us feed throughout infanthood and into early childhood is by breast. This is precisely why researching the potential effects of breastfeeding on cognitive development, notably early childhood cognitive development, is so important. If there is an association between breastfeeding and cognitive development, it is critical to understand how so and to what degree. Whether the effects are positive or negative, if the effects are lasting, it is necessary to be aware of such when we decide to breastfeed our children and for how long to do so. The goal of this paper is to review some of the recent findings on the effects of breastfeeding on cognitive development. Each of the studies reviewed have different focuses and various methods of obtaining and organizing data in their research. As such, for simplicity sake, this paper will be organized by general theme of the reviewed research. Moreover, this paper will discuss breastmilk's effect on the brain biologically. The associations between breastmilk and the biological aspects of brain development are fundamental to include in this paper because "everything psychological is simultaneously biological" (Myers & DeWall, 2018, p.50). Breastfeeding's effects on the brain show an association with cognitive development, although its lasting effects may mitigate with time.

Literature Review

Research which utilizes magnetic resonance imaging (MRI) scans allows us to understand the scope of breastfeeding's effects on cognitive development. For instance, a cross-sectional study, by Deoni et al. (2013) found the brains of exclusively breastfed children, whose ages ranged from ten months to four years, had increased white matter development in several

regions including “frontal brain and left temporal lobe, as well as early maturing regions such as corpus callous, internal capsule and corticospinal tract, cerebellum, and left optic radiation” (Deoni, et al., 2013, p. 82). Furthermore, that “infant breastfeeding is associated with improved developmental growth in late maturing white matter association regions” (Deoni et al., 2013, p.85). This demonstrates breastfeeding’s association with the brain and more specifically, which parts of the brain are affected. Moreover, Belfort et al. (2016) conducted a study which sought to examine the neurological effects of breastfeeding on premature infants. MRI scans conducted when the premature infants reached term equivalent age and again at seven years of age, in addition to developmental assessments. Their findings concluded that there are “associations of breast milk intake with size of the deep nuclear gray matter and hippocampus at term equivalent age” (Belfort et al., 2016, p.136-137). Overall, several of the areas shown by MRI to be affected by breastmilk, areas such as the frontal brain, left temporal lobe, and hippocampus, are those which are linked with cognition. For instance, the hippocampus processes spatial memories (Myers & DeWall, 2018, p,51). Furthermore, as both Grossman and Johnson (2007) and Johnson (2003) add, these regions are associated with “higher-order cognition, such as executive functioning, planning, social-emotional functioning, and language” (as cited in Deoni et al., 2013, p.83). It is important to expand on executive function to further accentuate the specific cognitive relevancy. Shonkoff and Phillips (2000) refer to executive function as “a broad set of neurocognitive processes involved in purposeful, goal directed control of thought, behavior, and emotion that allow for adaptation to fluctuating environmental demands” (as cited in Ahmed, Tang, Waters & Davis, 2018, p.1). In brief, MRI scans allow us to view which areas of the brain are affected by breastfeeding. Therefore, we can understand which specific aspects of cognition

breastfeeding effects. Hence, we gain insight to the breadth of breastfeeding's effects on cognitive development.

More recently, another MRI study, by Deoni, Dean, Joelson, O'Regan and Schneider (2018), examined the differences in brain development with a focus on myelination. The importance of myelination is that it "helps provide the foundation for brain connectivity and supports the emergence of cognitive and behavioral functioning." (p.649). The study compared children, varying in ages from three months to nine years of age, amongst whom were breastfed or formula-fed. Their results suggest "a strong link between brain structure and cognitive performance" (p.653) as well as specifically noting, "improved overall cognitive ability and rates of cognitive development, including verbal and non-verbal functioning, in breast-fed children versus those who received only infant formula" (p.654). By examining how breastfeeding effects the brain and myelination, we have further insight to how breastfeeding influences cognitive development.

Breastfeeding duration may also influence cognitive development. The duration for which a mother breastfeeds may vary for a variety of reasons. For example, the ability to produce breastmilk, economic factors, and the convenience of formula are just some of the rationale that affects breastfeeding duration. In any case, prolonged breastfeeding may affect cognitive development, hence it is important to understand their correlations. For instance, not only is extended breastfeeding duration associated with improved white matter in the brain, but cognitive performance as well (Deoni et al., 2013). Furthermore, to echo other previously mentioned MRI-based research findings, Julvez et al., (2013) found "a clear positive trend between categories of full-breastfeeding duration and executive function," (p.151) in breastfeeding durations longer than six months. Moreover, research by Bernard et el. (2013)

found an association between longer breastfeeding length and improved cognitive and motor development. Correspondingly, that “both exclusive and any-breastfeeding durations were positively associated with cognitive development in early childhood” (Bernard et al., 2013, p.39). The importance of understanding the influence breastfeeding duration has on cognitive development is so that mothers, provided they have the option to, can make a more educated decision on how long to breastfeed their children for.

Breastfeeding may have lasting influence on the cognitive developmental outcome of children in later years. For instance, Bernard et al. (2013) used a French version of the Communicative Development Inventory (CDI); evaluating language abilities in addition to a French version of the Ages and Stages Questionnaire (ASQ); evaluating communication, motor skills, problem solving, and personal-social skills to measure cognitive development in breastfed children. The study found breastfed children, particularly those breastfed for longer durations, to score higher on the CDI and ASQ assessments at two and three years of age. This is a very short-term example of breastfeeding’s lasting effects. Furthermore, Belfort et al. (2016) issued neurodevelopmental assessments; evaluating general cognition, intelligence, academic achievement, attention, working memory, and language at two years of age and again at seven years of age. The study found that preterm infants who had been breastfed within the first twenty-eight days of life later showed “higher IQ [scores], academic achievement, working memory, and motor scores at 7 years of age” (Belfort et al., 2016, p.138). Moreover, Julvez et al. (2013) used a Spanish version of the McCarthy Scales of Children's Abilities (MSCA) test; evaluating general cognition, as well as verbal, quantitative, memory perception, and motor functions to compare neuropsychological development. The study found higher MSCA scores in children, those categorized as who had breastfed for very long-term durations, at four years of

age. This example importantly ties together the implications of both breastfeeding duration and lasting effects. Indeed, Victora et al. (2015) found that breastfeeding duration has an association with IQ much later in life, at thirty years of age. This makes considering the length one breastfeeds for even more compelling.

Nevertheless, not all research is as optimistic of breastfeeding's very long-term lasting influence. Although, to emphasize the aspects in which cognition is affected, it is important to detail the various methods in which the reviewed researchers carried out their studies. For example, Yang et al. (2018) conducted a sixteen-year follow-up of a study to evaluate the lasting effects of breastfeeding on neurocognition. The original study included various and frequent assessments; infant feeding questionnaires at one, two, three, six, nine, and twelve months of age. At six-and-a-half years of age, the Wechsler Abbreviated Scale of Intelligence (WASI) was used, assessing IQ. The sixteen-year follow-up measured neurocognitive function using NeuroTrax; assessing general cognitive development as well as "both verbal and nonverbal domains of cognitive function, including immediate and delayed verbal and nonverbal memory, word recognition, executive function, visual–spatial orientation, information-processing speed, and fine motor skills." (Yang et al., 2018, p.4). The follow-up study found exclusive breastfeeding for a duration of at least three months to have marginal effect on neurocognitive function at sixteen years of age. The "beneficial effects of breastfeeding on verbal ability persist at older ages, however, with a substantially reduced magnitude" (p.12). Incidentally, Gibbs and Forste (2014) utilized math assessments; evaluating "relative size/quantity, match patterns, counting, number recognition, and ordering" abilities and reading assessments; evaluating "phonological awareness, letter knowledge, awareness of the conventions of print, and word recognition" (p.488) to examine the association between breastfeeding and cognitive

development. Their results did indeed show an association between breastfed children and higher math and reading skills and test scores at four years of age. However, despite these findings, the study concluded, regarding breastfeeding, "it may be that the association is better understood as a proxy for parenting practices that foster cognitive development in early childhood." (p.490). We can understand that research sometimes has conflicting or challenging findings. However, by assessing the methods in which data is collected, we can see the specific cognitive functions researchers are looking to study. While we understand cognition, in more abstract terms, to be "all the mental activities associated with thinking, knowing, remembering, and communicating" (Myers & DeWall, 2018, p.174), by noting specific measures of cognition; intelligence, memory perception, attention, word recognition, language, and counting, we have a more concrete view of how breastfeeding effects cognitive development.

Discussion

Many of the examined studies have similar findings; breastfeeding has an association with cognitive development (Bernard et al., 2013; Deoni et al., 2013; Julvez et al., 2013; Victora et al., 2015). Moreover, breastfeeding duration is also associated with improved cognitive development, (Deoni, Dean, Joelson, O'Regan & Schneider, 2018). Furthermore, breastfeeding may have lasting influence into later childhood, if not adulthood, (Victora et al., 2015). However, not all research is as decisive. Yang et al. (2018) importantly noted the benefits of breastfeeding on cognition to lessen with time. Moreover, Gibbs and Forste (2014) argue that "home learning environment" has a greater importance over breastfeeding in "determining early cognitive development" (p.492). In the end, the studies reviewed ultimately have opposing findings. Regardless, the importance of reviewing studies with opposing findings is that we look to see why that is. Many of the studies researching the association between breastfeeding and cognitive

development are observational, as it would be unethical to experiment on breastfeeding mothers. As such, the findings of the studies can only show the correlations and associations between the two, and therefore are inconclusive about the direct causes. Whilst considering conflicting findings, we must also address several issues, such as the confounding variables and limitations, of the reviewed studies. Furthermore, each of the studies classify and categorize "breastfed," and "breastfeeding duration" differently. The classifications of "breastfed" and "breastfeeding duration," as well as examples of study-specific limitations will be examined further below.

Classification of Terminology

There are discrepancies for the definitions of "breastfeeding duration" and "breastfed" in each of the studies reviewed. Furthermore, each study uses different methods of categorization and classification for each of the terms. For instance, with regards to classifying "breastfed," Deoni et al. (2013) included children who exclusively breastfed for a minimum of three months, exclusively formula-fed, and those who received a mixture of breast milk and formula. Whereas, Bernard et al. (2013) defined exclusive breastfeeding as "not receiving formulas, as few infants (5%) received other liquids or food in addition to breast milk" (p.38). Additionally, their study included both partial and exclusive breastfeeding as "any-breastfeeding," and "ever-breastfed" as having consumed breastmilk at any point. Regarding classification of breastfeeding duration, Deoni et al. (2013) included a very wide range, "from 90 to 900 days . . . in the exclusively breastfed group, and from 14 to 610 days . . . in the breast milk plus formula-fed group." (Deoni et al., 2013, p.78). While, Victora et al. (2015), for example, included multiple durations of any breastfeeding, including less than one month, one to two months, three to five months, six to eleven months, and longer than twelve months. The study included less durations of predominant breastfeeding; less than one month, one month, two months, three months, and longer than four

months. However, the study did not include exclusive breastfeeding in analysis, although assessed, “because it was seldom [practiced] at [the] time.” (Victora et al., 2015, p.200). Yet, Gibbs and Forste (2014) were not able to define exclusive breastfeeding duration. Considering that each study uses different classifications of terminology, we can gather that it may cause for skewed representation of their samples. For example, Julvez et al. (2013), included partially breastfed children, including those partially breastfed for long durations, in their reference group.

Limitations

Each of the studies have limitations. Again, like all observational studies, their results cannot determine cause, and therefore are inclined to confounding. For instance, many of the studies reviewed relied on maternal recall, depending on the mothers to remember breastfeeding durations to answer questionnaires, and therefore are subject to recall bias. Moreover, Victora et al. (2015) found that mothers misclassified breastfeeding durations. Other confounding variables include, but are not limited to, environmental factors and socioeconomic circumstances. As such, it can be understood that many other factors may be contributing to cognitive development. The main limitation of cross-sectional studies is that causation cannot be determined from them, only the comparisons drawn. In addition, many studies do not account for the different formula compositions and nutritional content in formula-fed samples. For instance, Deoni, Dean, Joelson, O'Regan, and Schneider (2018) noted the “retrospective nature of [their] investigation” (p.655), adding that “specific nutritional formulations may have changed in the 6 years since the earliest [MRI] data was acquired” (p.655). Moreover, an important confounding variable to note is the unaccounted maternal and family characteristics (Yang et al., 2018). For instance, neither Bernard et al. (2013) nor Gibbs and Forste (2014) accounted for maternal IQ in their studies. Maternal IQ is significant to consider because it can, not only “potentially influence child

cognitive ability genetically," but also "indicate an enriched learning environment," (Gibbs & Forste, 2014, p. 492) and therefore may have an effect cognitive development. It is important to note a study's limitations so that their findings can be interpreted within the context of such limitations.

Conclusion

In the final overview of the various research studying the effects of breastfeeding on cognitive development, there is copious evidence of positive correlation between the two. MRI scans of the brain show us that breastmilk consumption has a physical, biological effect on the brain (Belfort et al., 2016; Deoni et al., 2013; Deoni, Dean, Joelson, O'Regan, & Schneider, 2018). Understanding this allows us to gauge the scope of breastfeeding's effects on cognitive development. Moreover, breastfeeding duration is to be considered. The cognitive developmental effects of breastfeeding seem to have a lasting effect into later childhood (Belfort et al., 2016; Bernard et al., 2013; Julvez et al., 2013). However, it is important to note that not all research is perfectly cohesive and in total unison in their findings. Whilst acknowledging beneficial aspects of breastfeeding on verbal ability in young children, Yang et al. (2018) did not agree that the lasting effects of breastfeeding on cognitive development to be substantial. Furthermore, the benefits of breastfeeding were noted to lessen over time. Still, the takeaway is not that challenging findings entirely diminish all other positively associated research. Rather, opposing conclusions suggest the implications of breastfeeding on cognitive development are highly complex and therefore should be researched further. As breastfeeding is prevalent in much of our lives, is it important to examine the effects it has on cognitive development. Although breastfeeding's effects may mitigate over the years, the positive benefits breastfeeding has on cognitive development are paramount.

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