The Science Journal of the Lander College of Arts and Sciences

Volume 9
Number 2 *Spring 2016*

Article 4

1-1-2016

Cognitive Effects of Breastfeeding

Abraham Englard
Touro College

Cognitive Effects of Breastfeeding

Abraham Englard
Abraham Englard is graduating in September 2016 with a BS in Biology.

Abstract
This paper explores the cognitive effects of breastfeeding through Intelligence Testing and Imaging Testing that compares IQ, success, and brain structure of individuals that were breastfed, formula fed, and both breastfed and formula fed. Intelligence studies available are widespread for all age groups and signify a causal relationship between breastfeeding and intelligence. However, imaging testing is not as extensive, but shows a strong correlation between cognitive development and breastfeeding. The mechanism of breast milk's impact on cognitive development is at an exploratory phase, with a possibility that docosahexaenoic and arachidonic acids, along with other nutrients found in breast milk, contribute to preferential neural development. Altogether, the biological principle that structure equals function, is supported by evidence from Intelligence and Imaging tests that structural differences in the brains of those who were breastfed, caused by the components of breast milk, results in superior intelligence (than non-breastfed individuals) throughout life.

Introduction

The development of human beings, like any other organisms, is affected by the method and means of feeding. Breastfeeding has many undisputed benefits recognized across the board by the medical community. However, modern life makes it that physical breastfeeding effects are not an issue of life or death, or even keeping serious illnesses away (Christakis, 2013). Consequently, women need an alternative motive for choosing to breastfeed, and continuing to breastfeed. This paper examines some of the cognitive developmental findings related to prolonged breastfeeding. Indeed, intelligence testing and imaging studies show an encouraging correlation between elevated IQ and babies who were breastfed.

With all research indicating that breastfeeding is the superior option when it comes to feeding babies, continued exploration of the benefits may seem superfluous. Discovered benefits of breastfeeding, however, are mostly limited to physical health advantages, which is not enough to motivate women to breastfeed. Reason being, the physical benefits are usually limited to early childhood, and do not have effects beyond that. Some examples of benefits that do not extend past early childhood include reduction of gastroenteritis, otitis media, and atopic eczema (Christakis, 2013,). On the other hand, cognitive effects from breastfeeding have lifelong implications, starting at infancy, and extending way beyond early childhood. This compilation brings together research studies on IQ and brain structure of different age groups to present a significant correlation between breastfeeding and cognitive development.

Methods

The perusal of journal articles and research papers through the Touro College online library system.

Breastfeeding and Infant Intelligence

Intelligence in infants is a difficult factor to determine, as much of the cognitive functions of babies are shrouded in mystery. Yet, we know that a baby's visual acuity gradually increases until it reaches a standstill at around twelve months. Consequently, researchers used visual acuity as a determining factor in intelligence to look for a correlation between breastfeeding and early infant intelligence. Two groups of infants, one consisting of breastfed infants and the other consisting of formula fed infants, were assessed for intellectual ability using visual acuity as an indicator. Behavioral testing analyzed infants' tendencies to look at patterned cards versus blank cards at ages one, two, three, and four months. From the two groups that were assessed, both improved significantly from the first to fourth month. However, the group of breastfed babies significantly surpassed the formula fed babies in visual acuity scoring. These results were parallel to findings of "a decrease in docosahexaenoic acid (DHA) of red blood cells in formula fed infants" (Michaelsen et al, 2003).

DHA is an omega-3 fatty acid found in breast milk. DHA seems to play a role in cognitive development. This is evidenced by the combination of results of the former study and a randomized intervention study that supplemented infant formula with DHA and tested the visual acuity of these infants. When infants took formula supplemented with DHA, their scores on the visual acuity test were better than infants who were drinking non-supplemented formula, but not as well as infants who were breastfeeding (Michaelsen, 2003).

Yet, DHA cannot be the only ingredient in breast milk influencing cognitive development. If it were, the supplement of DHA in infant-formula would be enough to produce the same visual acuity results as breastfed infants. However, DHA along with other nutrients can be responsible for the cognitive benefits of breast milk over formula. These nutrients, which are not found in cow milk or formula, have positive effects on cognitive development, and cannot be duplicated because they are not all known elements. "Nobody has been able to reproduce human breast milk because there are lots of elements in it that we probably don't even know about" (Lisser, 2002). At least until we figure out how to duplicate all the nutrients found in breast milk, breastfeeding will remain the single, most-effective way to ensure the highest level of cognitive development in infants.

Breastfeeding and Toddler Intelligence

Toddlers too, display higher levels of cognitive functioning when they are breastfed for prolonged periods, compared to babies who are breastfed for less than four months, or formula fed. This was determined by assessing the cognitive development of two-year olds via mental and psychomotor development, using the Bayley Infant Developmental Tests. Psychologists administering the tests found that "at 24 months, infants breastfed for longer than 4 months scored higher than those breastfed for 4 months or less and higher than formula fed infants" (Gomez-Sanchiz et al., 2004). In another instance, toddlers who were breastfed up to three months scored 4-5 points higher than those who were formula fed on psychometric tests, determining IQ (Jedrychowski, 2011).

Exclusive breastfeeding, as opposed to complementary breastfeeding also plays a positive role in the IQ of toddlers. The younger the child, the more significant the difference in IQ is between exclusively breastfed toddlers, and complementary fed toddlers. In one year-olds, exclusive breastfeeding resulted in a .0547 disparity between intelligence scores of toddlers that were exclusively breastfed, and toddlers that were complementary breastfed. At two years, a notable disparity between the intelligence scores of the two groups still remained, but shrunk to .0386. Exclusive breastfeeding affects IQ in toddlers positively, even if the time period of exclusive breastfeeding is short (Jedrychowski et al., 2011).

Breastfeeding and Intelligence in School-Aged Children

During the first year of school, children who are breastfed have an academic advantage over children who are formula fed. According to teacher-assessed education assessments of five year old children in England, using FSP (Foundation Staged Profile), duration of breastfeeding influenced the children' academic success. In areas of personal, social, and emotional development, as well as communication, literacy, and language, longer breastfeeding caused higher scores to be more likely (Heikkilä, 2014). Duration of breastfeeding was divided into four categories; never, less than two months, two to four months, and longer than four months. Children breastfed for up to two months were 9% more likely than children never breastfed to receive good overall achievement scores. Additionally, the longer a child was breastfed, the more likely he/she was to receive good overall achievement scores. Putting the three categories of breastfeeding together, and comparing it to children who were never breastfed, shows a 10-16% greater chance of good overall achievement scores for children who were breastfed (Heikkilä, 2014).

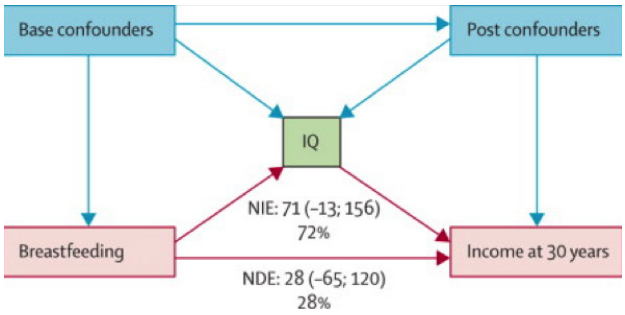
Notably, the relationship between breastfeeding and cognitive development is not exclusive to academic success. Rather, breastfeeding affects cognitive development in areas that include emotional and social intelligence, as well. Emotional and social intelligence first begin to influence success in earlier grades of school, but continue through high school and adulthood to have a more significant impact on success. Consequently, the influences of breastfeeding on emotional and social cognitive development are more prevalent throughout adulthood, compared to early childhood. This directly supports the notion that positive cognitive effects of breastfeeding are long-term, and a better reason than the well-known, short-term physical health effects of breastfeeding, for which women choose to breastfeed (Heikkilä, 2014).

Breastfeeding and Intelligence in Adolescents

The effects of breast-feeding on cognitive development also extend into the realm of adolescent intelligence, which is a long way off from the actual act of breastfeeding. "In New Zealand, breastfeeding duration was positively associated with performance in secondary school tests in students aged 18 years" (Victora et al., 2015). Students who are breastfed are also more likely to finish a higher grade of school. A study of 2,000 male Brazilian adolescents ages 18, found an increasing trend in finishing higher grades

with students who were breastfed. "Those breastfed for 9 months or more were ahead by 0.5-0.8 school grades, relative to those breastfed for less than 1 month" (Victora et al., 2005).

Breastfeeding and Intelligence in Adults



Various studies on the effects of breastfeeding positively influencing adult intelligence found a correlation between the two. In Brazil, intelligence, educational attainment, and income were all higher in 30 year-olds who were breastfed as infants. The table on the left shows that IQ mediated 72% of all incomes, with external factors only mediating 28% of income (Victora et al., 2015).

.This was after base cofounders, including family income at birth, parental education, household score index, genomic ancestry, maternal smoking during pregnancy, and birth weight, were

taken into account. The post-cofounder (educational attainment) was also taken into account. The results of this study strongly supports the notion that breastfeeding influences IQ, which in turn influences income and educational attainment (Victora et al., 2015).

Other studies found a positive correlation between breastfeeding and IQ in adults. For example, an IQ test administered to 27 year old Danish citizens in Copenhagen found a six-point difference in the IQ scores of people breastfed for a while versus people who were not breastfed for a long period of time. "Babies breastfed less than a month had a mean IQ of 99, compared with an average of 106 among infants breastfed seven to nine months" (Lisser, 2002). Similarly, in Belarus, IQ scores were on average 7.5 points higher in 65 year-old adults who were breastfed. Another study also shows that 53 year olds in Britain who were breastfed scored better on the National Adult Reading Test than their non-breastfed counterparts (Victora et al., 2015). Altogether, the studies on adult intelligence and breastfeeding support the thesis that breastfeeding affects intelligence at all ages.

Breastfeeding and Brain Structure

Now that a comprehensive analysis of breastfeeding effects on overall intelligence, from infant through adulthood, is understood, it is important to examine the physical effects of breastfeeding on the brain structure. Since we know structure parallels function, the development of an organ should correlate with the function it carries out. Consequently, if the brains of children who are breastfed have higher IQs, then something in their brains' structure ought to represent the higher functioning intelligence emitted from the brain. Moreover, finding a specific occurrence in the brains of people who are breastfed that cannot be found in the brains of those who are not breastfed would solidify the conclusion that breastfeeding has long lasting cognitive effects.

Breastfeeding and Brain Structure in Toddlers

The brain structure of breastfed toddlers compared to the brain structure of non-breastfed toddlers show increased myelin water fraction (VFM) in the brain structure of the breastfed infants. Myelinated white matter makes up the backbone of the brain's neural systems, and facilitates "rapid and synchronized brain messaging" needed for higher levels of cognitive functions (Deoni, 2013). "Aberrations in myelination, or deficiencies in myelin content or integrity, can have profound deleterious effects on brain function" (Fields, 2008).

A study investigated brain white matter maturation in 133 toddlers, ages 10 months to 4 years. Imaging times lasted 19 minutes in the younger toddlers, and 24 minutes in the 4 year olds. "Each infant was scanned using the mcDESPOT (multicomponent Driven Equilibrium Single Pulse Observation of T1 and T2) white matter imaging technique which provides a quantitative measure of the myelin water fraction (VFM) at each imaging point throughout the brain" (Deoni et al., 2013).

Results found that breastfed toddlers, in comparison to both formula fed, and to those that were breast and formula fed, had more VFM in many regions of the brain associated with visual reception skills, and receptive language scores. "In contrast with children who

received both breast milk and formula, exclusively breastfed children had significantly greater VFM ($p < 0.05$, FER corrected) in brain regions including: left optic radiation adjacent to the angular gyrus; right inferior parietal lobe, near the somatosensory cortex; bilateral premotor cortex; and right prefrontal cortex" (Deoni, 2013). Additional brain regions expected to mature later on had more VFM including the corpus callous, internal capsule, corticospinal tract, cerebellum, and left optic radiation. The results of this study support the researchers' initial hypothesis that docosahexaenoic and arachidonic acids found in breast milk, and not present in formula, causes preferential brain development in breastfed toddlers (Deoni, 2013).

Breastfeeding and Brain Structure in Adolescents

The brain structure of breastfed adolescents compared to the brain structure of non- breastfed adolescents shows a notable difference in cortical thickness. From an MRI analysis of cortical regions associated with cognitive abilities relating to general intelligence, cortical thickness was assessed. Findings suggest that exclusive breastfeeding predicts cortical thickness in the superior and inferior parietal lobules of the parietal cortex (Kafouri et al., 2013). Even after adjustments were made for age and sex, findings show that the longer the duration of breastfeeding, the thicker the cortex (Kafouri et al., 2013). Although the mechanism for a correlation between cortical thickness and breastfeeding is unclear, one possibility was recently suggested: "long-chain polyunsaturated fatty acids (LC-PUFAs), mainly docosahexaenoic acid (DHA), underlie neurodevelopmental benefits of breast milk" (Kafouri et al., 2013). This possibility is supported by Deoni's hypothesis that docosahexaenoic and arachidonic acids found in breast milk causes preferential brain development. Michaelson's finding of "a decrease in DHA of red blood cells in formula fed infants" also supports this possibility (Michaelson, 2003).

Conclusion

Relative to breastfeeding, intelligence testing on all age groups establishes a causal relationship between breastfeeding and IQ. Once imaging testing gets involved, however, the relationship

between cognitive development and breastfeeding is solidified. According to the basic biological principle that structure equals function, the function of greater intelligence, paired with different brain structure in people who are breastfed, confirms, beyond a reasonable doubt, that breastfeeding has widespread and long-term positive effects on cognitive development. Indeed, studies conducted thus far are enough to conclude breastfeeding's effects on cognition. However, more studies on the structure of the brain might help us conclusively determine the mechanism of how breast milk positively influences cognitive development.

References

Christakis D.A. (2013). Breastfeeding and Cognition: Can IQ Tip the Scale?. JAMA Pediatr. 2013;167(9):796-797. doi:10.1001/jamapediatrics.2013.470.

Deoni, S., Dean, D., Piryatinsky, I., O'muircheartaigh, J., Waskiewicz, N., Lehman, K., Dirks, H. (2013). Breastfeeding and early white matter development: A cross-sectional study. NeuroImage, 82, 77-86.

Fields, R. (2008). White matter in learning, cognition and psychiatric disorders. Trends in Neurosciences, 31, 361-370.

Gómez-Sanchiz, M., Cañete, R., Rodero, I., Baeza, J. E., & González, J. A. (2004). Influence of Breast-feeding and Parental Intelligence on Cognitive Development in the 24-Month-Old Child. Clinical Pediatrics, 43(8), 753-761.

Heikkilä, K., Kelly, Y., Renfrew, M. J., Sacker, A., & Quigley, M. A. (2014). Breastfeeding and educational achievement at age 5. Maternal & Child Nutrition, 10(1), 92-101. doi:10.1111/j.1740-8709.2012.00402.x

Jedrychowski, W., Perera, F., Jankowski, J., Butscher, M., Mroz, E., Flak, E., & ... Sowa, A. (2011). Effect of exclusive breastfeeding on the development of children's cognitive function in the Krakow prospective birth cohort study. European Journal Of Pediatrics, 171(1), 151-158. doi:10.1007/s00431-011-1507-5

Kafouri, S., Kramer, M., Leonard, G., Perron, M., Pike, B., Richer, L., & ... Paus, T. (2013). Breastfeeding and brain structure in adolescence. International Journal Of Epidemiology, 42(1), 150-159.

Lisser, E.D. (2002, May 08). Breast-feeding boosts adult IQ, research suggests. Wall Street Journal

Michaelsen, K. F., Lauritzen, L., Jørgensen, M. H., & Mortensen, E. L. (2003). Breast-feeding and brain development. Scandinavian Journal Of Nutrition, 47(3), 147-151.

Victora, C., Horta, B., Mola, C., Quevedo, L., Pinheiro, R., Gigante, D., Barros, F. (2015). Association between breastfeeding and intelligence, educational attainment, and income at 30 years of age: A prospective birth cohort study from Brazil. The Lancet Global Health, 3(4), 199-205.

Victora, C. G., Barros, F. C., Horta, B. L., & Lima, R. (2005). Breastfeeding and school achievement in Brazilian adolescents. Acta Paediatrica, 94(11), 1656-1660. doi:10.1080/08035250500252658