

# An “Imperative Appraisal” on Biological Factors Affecting Intelligence in School Going Children

Srihari S<sup>1</sup>, Jyothy KB<sup>2</sup>

<sup>1&2</sup> Asst. Professor, Dept. of Kaumarabhritya, MGACH & RC, DMIMS (DU), Wardha, Maharashtra, India  
(dr.srihari@rediffmail.com)

JISM1403H Received for publication: January 19, 2014; Accepted: February 11, 2014



---

*How to cite the article: Srihari S, Jyothy K B, An imperative appraisal on Biological Factors Affecting Intelligence in School Going Children J-ISM, V2 N2, Apr-June 2014, pp.84-90*

---

## Abstract:

Intelligence is a vital essentiality in day today life in its purest and enriched form, especially in children who have to build up their life in an appropriate manner. Individuals with high level of intellectual power are inevitable for the current competitive era and factors influencing them are numerous as they embark to relate with one's life from birth till death. Biological factor has a significant impact in influencing the intelligence. Few references in this regard are also found in Ayurveda which indicate their importance in influencing both the physical as well as the psychological health of an individual. The review focuses on to amplify these concepts and to emphasize upon the need to understand them by which the needy are dealt effectively. Upon analyzing the role of biological factors it can be concluded that these factors indeed affect the intelligence of School going children both positively and negatively.

Key words: *Intelligence, School going children, Factors influencing intelligence*

## Introduction:

“Quantity disintegrates but quality does not”. Twenty first century has witnessed a huge demand for people with quality and has offered them in return magnanimously. Academic success of children in schools is a commonest way of assessment and demonstration of their quality which is prejudiced principally by the echelon of intelligence inherited by them either by birth or through the influence of nature. Building an individual with consecrated quality starts right from pregnancy, more pronounced in childhood period and continues till his death. Ongoing feelings of anxiety fear or nervousness can rob people of their quality of life and even negatively impact their health [1]

Early identification of those factors and dealing them appropriately is the aim of the medical man.

The memory demands for school age children are much greater than they are for adults as they are continuously fed with new knowledge in various areas which might be interesting or not. Moreover children are expected to learn and remember them and repeat it during exams [2]. Except when there is a marked deviation from the normal, young children are not aware of what their intellectual level is. The bright, for e.g., do not realise how bright they are, the dull are unaware of their dullness and the average take their intelligence for granted. After they enter the school, children measure their level of intellectual power by the kind of adjustment they make to school work. [2]

Intelligence is the capacity to acquire and apply knowledge where intellectual ability is a complex phenomenon, influenced by various factors like biological, psychological and social etc. Used in its broadest sense, intelligence is what people use to learn, remember, solve problems and in general deal effectively with the world around them [3].

For a person to develop certain intellectual abilities they need to be assessed for potential causes which could hamper them and should be provided with appropriate stimuli during childhood, before the critical period of adapting their neuronal connections ends. It should be mentioned that some researchers believe 'the critical period effect' is a result of the manner by which intellectual abilities are acquired- these changes in a neuronal connections inhibit or prevent possible future changes which may explain the differences in intelligence types between people of different cultures [4].

The potential causes for hampering and stimulating the intellectual abilities due to biological influence may be grouped into.

<b>Biological</b>
Race and genetic constitution
Gender
Nutritional status
Infestations of helminthes
Recurrent infections
Gestational maturity
Nature of delivery
Birth weight
Trauma
Antenatal well being of mother
Breast feeding

Table1: Showing the Factors afflicting the Intelligence

**Observations and Discussion:**

**BIOLOGICAL FACTORS**

**1)Race and genetic constitution** - No one race is endowed with better intelligence than others. Differences in achievement of races are due to better opportunities and facilities found in developed countries. All traits of an individual are inherited from his ancestors only. "Most of what is currently known about the genetics of intelligence comes from twin

and adoption studies, which have documented significant and substantial genetic influence." Developmental genetic analyses have found that the magnitude of genetic effects increase during the life span and that genetic factors are primarily responsible for stability during development but also affect age-to-age changes. Multivariate genetic analyses suggest that the same genes largely overlap in their effect across most specific cognitive abilities, that the strong association between intelligence and scholastic achievement is almost exclusively due to the same genes that affect both domains, and that genetic factors mediate the association between cognitive development and home environment. Genetic analyses also suggest that genetic effects on high intelligence may merely be the high end of the normal distribution of genetic influences on individual differences in intelligence [5]. Galton Francis, in 1869, prepared a list of 977 famous individuals, their nearest blood relations out of whom 536 were also famous. He made another list consisting of 977 laymen out of them only 4 were famous enough. However, not all individuals are endowed with the same intelligence and many believe this must have something to do with genes and the way they interact with the environment [6].

Ayurveda also gives due importance to the genetic and hereditary aspect of *Buddhi*(intelligence) and *Medha* (intelligence quotient). During the embryogenesis it is mentioned that these *Gunas* (factors) are inherited.

*Medha cha satmyajani //*

Indicate that *Medha* is also influenced by the adapted lifestyle of ancestors [7-9]

Consanguineous marriage, congenital anomalies and mentally retarded parents/ siblings all contribute negatively.

A few studies [10, 11] in which the effects of inbreeding on cognitive performance have been examined revealed that offspring of first-cousin marriages had lower IQ scores than offspring of unrelated parents.

Saadat (2008) [12] and Woodley (2009) [13] suggested that inbreeding depression and associated

reduced phenotypic quality is a cause of the variation in cognitive ability across the world. They found cross-national correlations of  $r = -0.77$  ( $n = 35, p < 0.0001$ ) and  $r = -0.62$  ( $n = 71, p < 0.01$ ), respectively, between average IQ and measures of inbreeding. Woodley (2009), however, noted that rates of consanguineous marriage itself may not account for the magnitude of this variation because (i) the statistical significance of the effect disappears when education and gross domestic product (GDP) are controlled for, and (ii) the effect of inbreeding on intelligence had previously been shown to be relatively small.

**2) Gender** When standardized IQ tests were first developed in the early 20th century, girls typically scored higher than boys up to the age of 14 [14]. As testing methodology was revised, efforts were made to equalize gender performance [14-16]. The mean IQ scores between men and women very little [17-20]. One study concluded that after controlling for socio-demographic and health variables, "gender differences tended to disappear on tests for which there was a male advantage and to magnify on tests for which there was a female advantage" [21]. A study from 2007 found a 2-4 IQ point advantage for females in later life [22]. One study investigated the differences in IQ between the sexes in relation to age, finding that girls do better at younger ages but that their performance declines relative to boys with age [23]. While research has shown that males and females do indeed excel in different abilities, maths and science might be an exception to this. Achievement in maths and the science gives females an advantage because it requires effective communication and the ability to comprehend abstract ideas. On the other hand, males have an advantage also, due to the fact that on average men perform better at visuo-spatial abilities [24].

The results from research on sex differences in memory are mixed and inconsistent, with some studies showing no difference, and others showing a female or male advantage [25]. Most studies have found no sex differences in short term memory, the rate of memory decline due to aging, or memory of

visual stimuli [25]. Females have been found to have an advantage in recalling auditory and olfactory stimuli, experiences, faces, names, and the location of objects in space [25-26]. However, males show an advantage in recalling "masculine" events [25]. A study examining sex differences in performance on the California Verbal Learning Test found that males performed better on Digit Span Backwards and on reaction time, while females were better on short-term memory recall and Symbol-Digit Modalities Test [22].

**3) Nutritional status** The brain is the most complex and costly organ in the human body. In human newborns, the brain demands 87 per cent of the body's metabolic budget, 44 per cent at age five, 34 per cent at age ten, and 23 per cent and 27 per cent for adult males and females, respectively (Holliday 1986). Presumably, if an individual cannot meet these energetic demands while the brain is growing and developing, the brain's growth and developmental stability will suffer [27].

"The food that is good for the heart is likely to be good for the brain." Hippocrates. The role of nutrition in intelligence remains obscure. Severe childhood malnutrition has clear negative effects, but the hypothesis that certain 'micro-nutrients' may affect intelligence in otherwise adequately-fed populations has not been convincingly demonstrated. A balanced diet will provide all the foods required to maintain the correct balance of neurotransmitters. Proper academic performance is consistently associated with the degree of malnutrition and it is a prime factor in Indian primary school children [28].

Optimal nutrition during pregnancy and first 3 years of life is most crucial because 70% of the human brain develops during fetal life and the remaining 30% during preschool years. Every baby must be breast fed to promote rapid brain growth during infancy. Optimal nutrition of nursing mother improves the quality of breast milk by ensuring adequate concentration of smart nutrients. Children should be encouraged to take brain-friendly diet rich in smart nutrients and antioxidants. Intake of junk

food and soft drinks should be discouraged. School-going children should not miss their breakfast because of its adverse effects on physical growth and learning capabilities [29].

Studies reveal that a low standard fat, low cholesterol diet during the first 5 years of life affects normal neurological development (JAMA; leena.Rask et.al) but no need to become fatty for brilliancy [30].

The fear of neurological dysfunction in children exposed early to fat- modified diets is based on the rapid development of the central nervous system during the first year of life. Because 75% of brain growth is completed by the age of 3 years, [31] the ability of the brain to recover from early nutritional deficiencies is limited. Severe malnutrition in the first year of life, even if corrected later, is associated with intelligence deficiencies at ages 11 to 18 years [32]

The basic concept of the amount and quality of food in Ayurveda is abbreviated as *Matravat Aharasya Yat Phalam Shubham* [33] if proper quantity and quality of food is not supplied, it can cause several disorders both on psyche and soma. In Ashtanga Samgraha it is told that *Heenamatra Ahara* can cause *Buddhi Aghata*.

*Tatra heena matramashanam*

.....*manobudhindriyopaghata*[34]

Acharya Charaka mentions, *Heena Matra Ahara* (Low/less quality of food) may hamper the optimal functioning of *Manas* and *Buddhi Indriya*

*Na Cha Kshut Pipasa Vyadhi Vaimanasyadi yukto abhyaset*[35]

*Acharya* Kashyapa Advocates a child studying should not do any studies when he is hungry or thirsty as the mind will not be able to grasp due to lack of energy.

**4) Infestations of helminthes** - Helminthes infestation are impairing normal growth and development of a child and it is an alarming problem in the country like India. From different studies it is well proved that these infestations consistently impair the cognitive development of a child [36]

**5) Recurrent infections** - Cognitive deficiencies are

being noted in case of immunologically challenged patients like AIDS [37]. Any recurrent infection especially those involving the nervous system contain the risk of disabilities in general functioning and thus also the intellectual functioning.

The negative relationship between infectious disease and IQ was statistically significant at the national level both worldwide and within five of Murdock's (1949) six world regions. All analyses showed that infectious disease was a significant predictor of average national IQ, whether using either of Lynn and Vanhanen's (2006) two datasets or Wicherts *et al.*'s (2010b) data [38-40].

**6) Gestational maturity** - Preterm infants are vulnerable to sub-optimal early nutrition and their cognitive performance notably, language based skills are highly reducing at 7 1/2 - 8 years [41]. According to *Acharya* Kashyapa proper gestational maturity is inevitable to produce an ideally intellectual child and this is assessed by certain anthropological measurements which are given in detail in the *Lakshanadhyaya* [42].

According to Charaka Samhita this concept is abbreviated as

*Tatra prapta kala: Sarvendriyopapannaparipurna shariro balavarna Satwa samhanana sampatupeta*||

*Satwa sampat* and *Indriya* perfection is only attained to a fully matured infant [43]. Hence completing full gestational period is inevitable for a better *Buddhi* and *Medha*.

**7) Nature of delivery** Even minor hypoxia can hamper the cognitive ability. Premature babies are at a moderate or even minor risk for birth-related hypoxia. Children who have oxygen deprivation within the body, score lower on "IQ" tests and language skills, according to a study published in the Neuropsychological magazine [44].

Children who had been at a risk of hypoxia scored 10 points lower on average in IQ tests compared with those who had not been at risk. Also, those who had been at higher risk for hypoxia tended to score the lowest in cognitive performance and expressive communication.

**8) Birth Weight:** Children who are born with birth



weight of more than 2.5kgs have higher mean IQ score which suggests that babies who are a little bigger at birth have a marked advantage in terms of intelligence later in childhood. This is probably because heavier babies have been better nourished in the womb at crucial stages of brain development. Other studies have clearly shown that being underweight at birth seems to correspond with poorer mental development. Premature babies are at a much greater risk of being born underweight. However, the latest study, published in the British Medical Journal, suggests that the weight to intelligence link extends to normal-sized babies [45].

**9) Trauma-** Neuropsychological deficit and academic performance in children and adolescents following traumatic brain injury is well studied one. Severity of injury has a significant impact on nonverbal IQ performance. Children and adolescents with more severe head injuries used less effective learning strategies to encode and recall information [46]. Trauma to head is therefore a significant precursor of low intelligence and any damage or insult to the developing brain does produce marked changes in the cognitive performance of children.

**10) Antenatal well being of mother-** Better antenatal care is of absolute necessity for children having better intelligence in later part of life. The last 3 months of pregnancy and first 3 years of post-natal life are most crucial for brain development. Also certain drugs if consumed during pregnancy can hamper brain development of the child. Healthcare during pregnancy and childbirth also influences cognitive development. Preventable causes of low intelligence in children include infectious diseases such as meningitis, parasites, and cerebral malaria, prenatal drug and alcohol exposure, newborn asphyxia, low birth weight, head injuries, and endocrine disorders [47].

All regimens described in *Jatisutriya Shareera* chapter aims at this point. If one follows these regimens it will lead to the birth of a good quality progeny [48].

**11) Breast feeding-** Breast milk is the one and only complete food to an infant. *Acharya* Susrutha while

classification of age [49] gives a special attention for *Bala* (children), he classifies them based on nature of food intake at that age as *Ksheerapa* period (first year of life) where exclusive breast feeding is done suggests it is the only complete food for children of those ages and *Ksheerannada* period (till 2years of life) during which breast feeding is supplemented with external dietary substances suggesting. *Acharya* Vagbhata while explaining the qualities of *Sthanya* (breast milk) [50] suggests *Bala* and *Deha Vriddhi* is fast if the children who consume *Sthanya*. *Acharya* Charaka while enlisting the ideal qualities of *Sthanya*, mentions the benefits of *Sthanyapana* as *Pushtikara* and *Arogyakara* [51]. *Pushti* means nourishment (of both mind and body) whereas *Arogya* means healthy status (of mind and body). Studies often find higher IQ in children and adults who were breastfed [52-53]. It has also been proposed that the omega-3 fatty acids that are found in high doses in breast milk, and that are known to be essential constituents of brain tissues, could at least partially account for an increase in IQ. Breast milk contains docosahexaenoic acid (DHA) and arachidonic acid (AA) a long-chain polyunsaturated fatty acids that appear to support brain development. Formulated milk lacks these nutrients. Apart from this, breast milk, providing easy digestion, a battery of other benefits include, providing natural antibodies supplement that confer natural passive immunity, helping to protect newborns from common childhood ailments, and also cheaper compared to infant formula. In a study of 17,046 children, the team found that breastfeeding exclusively during the first year of life was associated with an increase in a child's intelligence by first grade. Long-term, exclusive breastfeeding appears to improve children's cognitive development (thinking, learning and memory). Researchers at McGill University found that those who are breastfed exclusively for the first three months - with many also extending to 12 months - scored an average of 5.9 points higher in IQ tests in childhood. Teachers also rated these children significantly higher academically than control children in both

reading and writing. Canada's McGill University found breastfed babies ended up performing better in IQ tests by the age of six. But the researchers were unsure whether it was related to breast milk itself or the bond from breastfeeding. The study of nearly 14,000 children is the latest in a series of reports to have found such a positive link. They found that babies who are breast-fed for less than a month had an average IQ of 99.4 as adults, close to 100, average for the population as a whole. Those who are breast-fed for two to three months had IQs on average of 101.7, while those breast-fed for seven to nine months scored highest with 106. They found that breastfeeding beyond nine months had no further benefit on IQ, with the score dropping to 104 [54].

### Conclusion:

Importance of childhood has been emphasized right from the ancient medical literature up to current modern medical science as every incidence in the childhood has an influence in the adult life. A healthy childhood is therefore mandatory for expecting a healthy adult life; it is indeed a foundation of the adulthood. Higher mental faculty i.e. the instrument of knowledge, the discriminating power, and final decision maker is considered as intelligence and the most common method which contend to measure it is Intelligence Quotient Test (IQ test). It of absolute imperativeness to identify those biological factors which negatively affect the intelligence of School going children as early as possible and deal with them effectively with suitable measures, while ignoring them may change the course of the child future. Biological factors tend to have a drastic and long term influence on intelligence. More emphasis on the measures of preventing these biological factors affecting children should be the aim of the every medical man.

### References

- 1] [http://www.naturalnews.com/030135\\_anxiety\\_herbal\\_medicine.html](http://www.naturalnews.com/030135_anxiety_herbal_medicine.html), Last accessed on 13/04/2013
- 2] Glenda Thorne, Ph.D., "Strategies to enhance student's memory" CDL's on-line library. [http://www.cdl.org/resourcelibrary/articles/memory\\_strategies\\_May06.php](http://www.cdl.org/resourcelibrary/articles/memory_strategies_May06.php), Last accessed on 13/04/2013
- 3] Clinical Psychology, Lesson 19, 'INTELLIGENCE',

- 19A.203, pg.no 54 © Copy Right: Rai University.
- 4] [Http://iqandenvironmental.blogspot.in/2008/05/list-of-environmental-factors-that.html?m=1](http://iqandenvironmental.blogspot.in/2008/05/list-of-environmental-factors-that.html?m=1), Last accessed on 13/04/2013
- 5] Plomin, R, Genetics and intelligence. Talent Development III, pp. 19-39 Gifted Psychology Press 1995
- 6] [Www.shareyouressays.com/116599/5-studies-regarding-the-influence-of-heredity-on-development-of-a-child](http://www.shareyouressays.com/116599/5-studies-regarding-the-influence-of-heredity-on-development-of-a-child), Last accessed on 13/04/2013
- 7] Acharya Sushruta, Sushruta Samhita, Sharira sthana, 3<sup>rd</sup> chapter, Shloka 3, Chaukhamba Publication, Varanasi, 2009
- 8] Acharya Vagbhata, Astanga Sanghaha, Shareera Sthana, Chpater 5, shloka 17<sup>th</sup>, with Sasilekha commentary by Indu, Chaukhamba Sanskrit series, Varanasi, 2006
- 9] Acharya Agnivesha, Charaka, Dridhabala, Charaka Samhitha, Shareera Sthana, chapter 3, Shloka 11, with Chakrapani commentary, Choukhamba Krishnadas Academy, Varanasi, 2006
- 10] Cohen, T., Block, N., Flum, Y., Kadar, M. and Goldschmist, E. in E. Goldschmist (ed.). *The Genetics of Migrant and Isolated Populations* (Williams and Wilkins, Baltimore, 1963).
- 11] Schull, W. J. and Neel, J. V. *The Effects of Inbreeding on Japanese Children*. (Harper and Row, New York, 1965).
- 12] Saadat, M. 2008 Consanguinity and national IQ scores. *J. Epidemiol. Commun. H.* 62, 566567. (doi:10.1136/jech.2007.069021)
- 13] Woodley, M. A. 2009 Inbreeding depression and IQ in a study of 72 countries. *Intelligence* 37, 268276. (doi:10.1016/j.intell.2008.10.007)
- 14] Rider, Elizabeth A. (2000). *Our Voices: Psychology of Women*. Belmont, California: Wadsworth. p. 202. ISBN 0-534-34681-2.
- 15] Archer, John, Barbara Bloom Lloyd, Sex and gender, Cambridge University Press, 2002, ISBN 0-521-63533-0, ISBN 978-0-521-63533-2
- 16] Sternberg, Robert J., *Handbook of intelligence*, Cambridge University Press, 2000, ISBN 0-521-59648-3
- 17] Baumeister, Roy F (2001). *Social psychology and human sexuality: essential readings*. Psychology Press. ISBN 1-84169-019-8, 9781841690193.
- 18] Baumeister, Roy F. (2010). *Is there anything good about men?: how cultures flourish by exploiting men*. Oxford University Press. ISBN 0-19-537410-X, 9780195374100.
- 19] Hedges, L.; Nowell, A. (1995). "Sex differences in mental test scores, variability, and numbers of high-scoring individuals". *Science* 269 (5220): 4145. doi:10.1126/science.7604277. PMID 7604277.
- 20] Colom, R.; García, L. F.; Juan-Espinosa, M.; Abad, F. J. (2002). "Null sex differences in general intelligence: Evidence from the WAIS-III". *The Spanish journal of psychology* 5 (1): 2935. PMID 12025362.
- 21] Jorm, A. F.; Anstey, K. J.; Christensen, H.; Rodgers, B. (2004). "Gender differences in cognitive abilities: The mediating role of health state and health habits". *Intelligence*

- 32: 7. Doi:10.1016/j.intell.2003.08.001.
- 22] Keith, T. Z.; Reynolds, M. R.; Patel, P. G.; Ridley, K. P. (2008). "Sex differences in latent cognitive abilities ages 6 to 59: Evidence from the WoodcockJohnson III tests of cognitive abilities". *Intelligence* 36 (6): 502. Doi:10.1016/j.intell.2007.11.001.
- 23] Colom, R.; Lynn, R. (January 2004). "Testing the developmental theory of sex differences in intelligence on 1218 year olds". *Personality and Individual Differences* 36: 7582. Doi:10.1016/S0191-8869(03)00053-9.
- 24] Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., and Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. Association for Psychological Science, 8, 1-51
- 25] Ellis, Lee, Sex differences: summarizing more than a century of scientific research, CRC Press, 2008, ISBN 0-8058-5959-4, ISBN 978-0-8058-5959-1
- 26] Halpern, Diane F., Sex differences in cognitive abilities, Psychology Press, 2000, ISBN 0-8058-2792-7, ISBN 978-0-8058-2792-7
- 27] Holliday, M. A. 1986 Body composition and energy needs during growth. In Human growth: a comprehensive treatise, vol. 2 (eds F. Falkner and J. M. Tanner), pp. 1011-17. New York, NY: Plenum.
- 28] Singh. Et.al; Indian journal of psychometry and education; 1976; vol: 7; 5-8.
- 29] Meharban Singh, Nutrition, Brain and Environment: How to have Smarter Babies? Indian Pediatrics 2003; 40:213-220
- 30] Leena Rask-Nissilä, MD; Eero Jokinen, MD, PhD; Pirjo Terho, MD; et al, Neurological Development of 5-Year-Old Children Receiving a LowSaturated Fat, Low-Cholesterol Diet Since Infancy A Randomized Controlled Trial, *JAMA*. 2000;284(8):993-1000
- 31] Nelson WE, Behrman RE, Kliegman RM, Arvin AM, eds. Nelson Textbook of paediatrics. 15th ed. Philadelphia, Pa: WB Saunders Co; 1996: chap 3.1-3.10.35
- 32] Galler JR, Ramsey FC, Forde V Salt P, Archer E. Long term effects of early kwashiorkor compared with Marasmus, II: intellectual performance. *J Pediatr Gastroenterol Nutr*. 1987; 6: 847-854.
- 33] Acharya Agnivesha, Charaka, Dridhabala, Charaka Samhitha, Vimana Sthana, chapter 1, Shloka 4, with Chakrapani commentary, Choukhamba Krishnadas Academy, Varanasi, 2006
- 34] Acharya Vagbhata, Astanga Sanghrah, Sutra Sthana, Chpater 11, shloka 18<sup>th</sup>, with Sasilekha commentary by Indu, Chaukhamba Sanskrit series, Varanasi, 2006
- 35] Maharshi Marichi, Vriddhajeekava, Kashyapa Samhitha, Vimana Sthana, 2<sup>nd</sup> Chapter, shloka 8<sup>th</sup>, Chaukhambha Visvabharati, Varanasi, 2002
- 36] Nokes C, Bundy D, APJournal: Parasitology Today, 10:14-18, Year: 1994
- 37] Tamula MA, Wolters PL, Walsek C, Zeichner S, Civitello L. HIV and AIDS Maligancy Branch, National Cancer Institute, National Institutes of Health, Bethesda, MD 20892-1868, USA
- 38] Murdock, G. P. 1949 Social structure. New York, NY: Macmillan.
- 39] Lynn, R. and Vanhanen, T. 2006 IQ and global inequality. Augusta, GA: Washington Summit.
- 40] Wicherts, J. M., Dolan, C. V. and van der Maas, H. L. J. 2010b A systematic literature review of the average IQ of sub-Saharan Africans. *Intelligence* 38, 120. (doi:10.1016/j.intell.2009.05.002)
- 41] A Lucas et.al *bmj*. 1998; 317:1481-1487, 28 November.
- 42] Maharshi Marichi, Vriddhajeekava, Kashyapa Samhitha, Sutra Sthana, 28th Chapter, shloka 3, Chaukhambha Visvabharati, Varanasi, 2002
- 43] Acharya Agnivesha, Charaka, Dridhabala, Charaka Samhitha, Shareera Sthana, chapter 3, Shloka 3, with Chakrapani commentary, Choukhamba Krishnadas Academy, Varanasi, 2006
- 44] Sarah Raz, PhD, and Tracy Hopkins- Golightly, PhD, and neonatologist Craig J. Sanders, MD, 'Neuropsychological magazine', Vol. 17, No. 1.
- 45] <http://news.bbc.co.uk/2/hi/health/1483134.stm>, last accessed on 13/04/13
- 46] Elsa Arroyos-Jurado, 'Traumatic Brain Injury in Children and Adolescents: Academic and Intellectual Outcomes Following Injury', *EXCEPTIONALITY*, 14(3), 125140, Copyright © 2006, Lawrence Erlbaum Associates, Inc.
- 47] Olness K (April 2003). "Effects on brain development leading to cognitive impairment: a worldwide epidemic". *J Dev Behav Pediatr* 24 (2): 12030. PMID 12692458
- 48] Acharya Agnivesha, Charaka, Dridhabala, Charaka Samhitha, Shareera Sthana, chapter 8, Shloka 11, with Chakrapani commentary, Choukhamba Krishnadas Academy, Varanasi, 2006
- 49] Acharya Sushruta, Sushruta Samhitha, Sutra sthana, 35<sup>th</sup> chapter, shloka 21, Chaukhamba Sanskrit Sansthan, Varanasi, 2005
- 50] Acharya Vagbhata, Astanga Hrudaya, Uttara Sthana, Chpater 1, shloka 15-16<sup>th</sup>, Chaukhamba Krishnadas Academy, Varanasi, 2006
- 51] Acharya Agnivesha, Charaka, Dridhabala, Charaka Samhitha, Shareera Sthana, chapter 3, Shloka 54, with Chakrapani commentary, Choukhamba Krishnadas Academy, Varanasi, 2006
- 52] Perlmutter, David; Carol Colman (2006). Raise a Smarter Child By Kindergarten: Raise Iq Points By Up to 30 Points and Turn on Your Child's Smart Genes Points. Morgan Road Books. ISBN 978-0-7679-2301-9
- 53] Masters R (1997). "Brain biochemistry and social status: The neurotoxicity hypothesis". In White, Elliott. *Intelligence, political inequality, and public policy*. New York, N.Y: Prager. pp. 141-183. ISBN 0-275-95655-5
- 54] <http://www.iqtestexperts.com/iq-breastfeed.php>, last accessed on 13/04/13