CHAPTER - III

REVIEW OF WORK RELATED LITERATURE

(A) Studies on Main Variables

1. Malnutrition and Intelligence

2. Malnutrition and Emotional Maladjustment

3. Intelligence and Emotional Maladjustment

4. Malnutrition, Intelligence and Emotional Maladjustment

(B) Studies on Other Related Variables

1. Sex Difference

2. Educational Status

3. Other (Environment, Poverty)
CHAPTER III

REVIEW OF WORK RELATED LITERATURE:

The basic concepts, definitions and theories in the field of work have been dealt with earlier, to form the base for a review of the related literature. This literature survey is reported under two broad headings.

(A) Studies on Main Variables:

1. Malnutrition and Intelligence:

Several groups of workers in different parts of the world have carried out studies to determine the impact of childhood malnutrition on mental development and intellectual performance in later life. It has been accepted now that malnutrition leads to change in many organs and systems including behaviour and learning both in animals and man (Stewart, 1974; Deo and Paul, 1975).

Mental development covers all such abilities, aspects and functions which contribute to the learning and problem solving ability of the individuals. It includes some complex intellectual activity such as ability for reasoning, judgement and arithmetic. Malnutrition retards development of all these abilities to some extent or the other. Many studies have reported mental subnormality in children who suffered some malnutrition during intra-uterine life and early infancy.
If this prolongs, intellectual competence is irreversibly damaged (Cheek, 1973).

Dobbing (1965) puts forth that the chemical maturation of human brain starts during the last trimester of intrauterine life and continues for 9 to 12 months after birth. This physiological explanation indicates that significant impairment in mental development may be expected if nutritional deprivation occurs during the last three months of ante-natal, 9 to 12 months of postnatal life.

Studies on the development of children in areas where protein malnutrition is common, have shown that infants are born in a more advanced state of mental development which is maintained during the first year and then declines progressively until in the second year of life, when the mental age is only about three quarters. (Geber and Dean, 1957).

During the last decade there has been a growing interest and concern about the role of nutrition in the growth and development of the brain and its effect on mental performance (Stewart, 1974). Severe under nutrition in life has been associated with structural changes in brain composition and with poor performance on intelligence, sensory and motor function tests. Such effects appear more pronounced, longer lasting and less ammendable to rehabilitation, the earlier the malnutrition occurs during development (Prescott, et al, 1975; Winick, 1976; Galler et al, 1986).

It has been pointed out that malnutrition effects both
physical and biochemical maturation such as: it retards the ability to metabolize certain amino acids. (Kaplan, 1972).

Winick (1973) has elaborately described the physical, chemical and functional changes of the CNS, associated with early malnutrition. Due to fewer brain cells and lower brain weight in a malnourished child some permanent deficit in height, weight, head circumference as well as resistance to stress and intellectual functioning results. (Medinnus, and Johnson 1976). A balanced diet is a must for normal physiological keep and psychological functions. Starvation puts a great stress on the nervous system (Leukel, 1968).

Cravioto (1970) has criticized psychological testings as a procedure to assess mental development since they have a cultural, social, regional bias. Thus he advocates that a better measurement of mental development is the ability of intersensory integration by the CNS. The results of his studies (Cravioto et al, 1967) show that malnourished children have delayed development of the ability to integrate auditory and visual stimuli as well as visual and kinesthetic stimuli.

The simplest hypothesis that can be arrived at, from these studies is that, PEM directly affects intellect by producing damage in brain in some way or the other. Amongst the nutrients, protein occupies a central place in human growth and development. Brain development and most specifically cerebral development has an irreversible character and the deprivation of dietary protein is the cause of its chemical
and structural alterations which lead to irreversible consequences. Protein deficiency results in reduction in cell size, number, retardation of mental and physical abilities, retardation in perceptual and abstract abilities and in visual discrimination and also deficiency in language development (Deo and Paul, 1975).

It is always not necessary that malnutrition effects the total nervous system, but if dietary protein level falls below a critical level, it effects intelligence and learning ability since amino acids - protein of CNS are intimately connected in the process of Memory, and Information processing in brain (Leukel, 1968).

Devdas et al. (1971) in a study with 60 selected rural pre-school children, correlated the protein intake and mental abilities of the sample. A test on mental abilities which included reasoning, picture vocabulary, spatial relationships, discrimination abilities, numeral relationships and memory was used to assess the I.Q. of the sample. On the basis of their nutritional status, the sample was also classified into good, fair and poor. It was found that the mean I.Q. for the three groups was 122, 90 and 76 respectively. The protein intake and clinical score correlated significantly with I.Q.

Morgan and Stellar (1950) has quoted many studies on rats which have shown the adverse effects of deprivation of amino-acids on maze learning. It is interpreted that the poorer performance of the malnourished children results from a direct effect of PEM on intellectual ability. (Dickerson, 1982).
Monckeberg et al (1972) studied whether chronic, but not severe, undernutrition affected mental development of pre-school children. A group of mostly malnourished children from a slum area was compared with a group of well-fed middle-class children. A high incidence of retardation in psychomotor development was observed in the slum area group. The degree of retardation was directly related to the amount of animal protein consumed and also to the retardation of physical and cranial growth.

In a study of 107 children, 12 to 15 years old, belonging to low socio-economic status, it was found that the lowest I.Q. was associated with the poorest nutritional state. (Winick, 1976). Gupta et al (1975) also support these results. Cervioto and others carried out extensive studies in Mexico and Guatemala in population of uniform socio-economic background. Performance on psychological tests was found to be related to dietary practices (Winick, 1976).

From their study on 20 pre-school children, Devdas et al (1973) found that children whose food intakes were adequate in both protein and calories, scored highest in mental abilities test.

Very recently Singh and Sidhu (1987) studied 6 to 8 year-old children from the slums of Ludhiana city, India, for assessing the intelligence of well-fed and malnourished amongst them. Draw a man test was used for this purpose and it was found that well-nourished children scored significantly better and with increasing age, their I.Q. also increased.
significantly, whereas the increase of I.Q. with age was not significant amongst the malnourished children.

Mc Laren et al (1973) assessed the intelligence by Stanford Binet scale of three groups of 15 Arab lebanese children who had been malnourished, 15 of their healthy young siblings, and a control group of 15 unrelated children of the same low socio-economic class. Parents were tested on Raven's Progressive Matrics. It was found that malnourished group had significantly lower I.Q. than their siblings and control group. Development Quotient (D.Q.) was also higher in control group. Parent's I.Q. was higher in control group where families had no malnourished children.

Klein et al (1969) compared the performance of Guatemalan children who had been rehabilitated from malnutrition in Day Care Centres with children from the same social setting, who were never malnourished. Using a variety of tests, they report results consistent with the interpretation that the malnourished children do not develop the set to invest sustained attentional involvement in different cognitive tasks and are less motivated to perform. Klein et al (1972) further found an association between measures of physical growth (used as indices of nutritional status) and mental development, independent of socio-cultural factors.

A study of the learning ability of malnourished children was made at the Tulane University by Early Childhood Research Centre in New Orleans (Opportunity, 1971). Learning ability was measured with different practical learning tests and a
significant relationship was found between malnutrition and impaired learning ability. The positive relationship between nutrition and learning abilities of children has been reinforced by Devadas et al. (1970), who studied the nutritional status and learning ability of 72 children between 5 to 7 years of age and found that children who were adequate in their nutrient intake had higher mean scores in academic and learning abilities. Many other studies have also shown lack of learning ability due to malnutrition both in man (Berke, 1967; Birch, 1967; Cravioto, 1970) and animals (Frankova and Barnes, 1968).

Even as early as 1938, Foull conducted an investigation with 41 malnourished children (physician's clinical diagnosis) where nutritional level was raised and a control group of matched children, who were well nourished throughout the period. It was found that the experimental children gained about 10 I.Q. points during the improved nutritional period of 10 to 24 months, while two control group did not change in I.Q. level.

Hemlatha (1979) while studying intelligence of malnourished and well nourished children, for her Ph.D. research work, found a significant positive correlation between mental abilities and nutritional status. Further, critical ratios revealed that there was a significant mean difference between the mental abilities of the well nourished samples who were matched in age, sex, family income and educational attainments of parents, in favour of well nourished subjects.
Harrell (1946) conducted one of the most carefully controlled studies on the effects of diet on children's mental growth. An experimental group of 55 children and a control group of 55 children were carefully matched for height, weight, sex, educational achievement, intelligence scores and length of residence in a Virginia orphanage. Two milligram per day of thiamine (Vitamin B₁) was administered in tablet form to the experimental group and placebos (no significant nutrient value) to the control group over a period of one year. At the end of this period the experimental group was significantly superior in reading achievement. Although this study throws no direct light on I.O. changes, the findings do indicate that sufficient quantity of thiamine taken by orphanage children over a long period of time is beneficial to general intellectual functioning.

Kalra et al (1980) studied 1 to 12 year old 100 malnourished and well fed controls all from low socio-economic group families. I.O. and S.Q. (Social Quotient) was assessed on Vineland Social Maturity Scale, Seguin Form Board and Stanford Binet test. Mean I.Q./S.Q. of malnourished children was 61.22 in comparison to 92.57 of the controls, the difference significant. No child in the malnourished group had I.Q. above 90, and 57% were mentally subnormal (I.Q. below 70). In control group 64% had I.Q. above 90, 2% had above average intelligence and only 1% were mentally subnormal. It was also seen that with increasing severity of malnutrition, there was a significant fall in intellectual performance when 35 of the malnourished children were reassessed. Six months later after nutritional rehabilitation, their intelligence had improved.
Rajlakshmi (1969) along with Latifa Khanam have shown that animals having no difference in heredity or environment, show poor growth, body composition and learning capacity if given a poor diet.

Chaudhary et al (1984) studied the association of growth status and mental function in pre-school children. They found that I.Q. was lower in children with chronic or current severe, or chronic moderate malnourished children than in those with current moderate malnutrition or normally nourished. Mc Gregor et al, (1983) compared severely malnourished children with normally nourished children from the time they left hospital till 2 years. One group of malnourished children was given intervention. Those malnourished children who did not receive intervention showed less development than of control children throughout the study. Both groups of malnourished children remained behind the control children in nutritional state and locomotor development. Dasen et al, (1982) studied the effect of malnutrition in later childhood by testing intelligence by tests based on the tasks devised by Piaget. He found that development of infant sensory motor intelligence upto 2 year old seem not to be affected by malnutrition whereas later stages are definitely affected.

Kadam et al (1984) reports that when post weaning undernutrition becomes so severe as to prevent any increase in body weight, psychological performances are impaired. Such impairment is much greater with a protein deficient diet. Hoorweg and Stanfield (1972) studied 3 groups of 20 children each who
suffered an acute episode of malnutrition and compared them with a group of 20 control children. 5 of the 10 psychological tests revealed significant better performance in the control group as compared with the 3 malnourished group taken together. These results suggest that an impairment in general intelligence, spatial abilities, memory and learning is higher in the subjects who have an acute episode of malnutrition in early childhood as compared to a normal group. Birch and Richardson (1972) reported the results of a study conducted in Jamaica on the long term consequences of severe malnutrition during the 1st 2 years of life. All the I.Q. measurements were significantly lower for malnourished children. They further confirmed that malnourished children have a higher probability of showing poor performance in intelligence tests as well as in other type of tests related to basic mechanisms of learning. Guzman et al (1976) made assessments of dietary intake, intelligence, physical growth and clinical signs of malnutrition of 600 children from 5 Philippine communities. The children from both the sexes aging 8 to 10 years old were from socially deprived families with rice, fish, maize, coconut and sweet potatoes as their respective foods. There were considerable differences amongst communities in nutrient intake based on 24 hour recall in intellectual and anthropometric measures. There were slight positive correlation between intake of energy, carbohydrates and intelligence.

Chaudhary and Rao (1984) studied 215 children aging 4 to 5 years to see the existence of association if any from nutrition between growth retardation and mental function.
Height, weight, arm, head and chest circumference were taken and mental function in terms of IQ was assessed using Binet Kamat test of Intelligence and Seguin form board. The results showed that growth retardation in chronic cases was higher, and males, urban children and taller children have higher IQ than females, rural children and shorter children.

Cremer et al (1977) studied the effect of food supplementation and psychological stimulation on mental development wherein psychological situation meant an hourly visit twice a week by health visitor till the child is three years old. One group was given only supplementary nutrition, another only psychological stimulation and another both, differing from period to period. Results reported that among families given supplementary food from before the infants birth, there was clearly a lower incidence of still birth. Stimulation alone had no effect on growth but it interacted with supplementary food to bring about standard growth. Stimulation had a greater effect than supplements in increasing the rate of the infants psychological development.

Christiansen et al (1977) studied 87 infants (16 to 20 month old) and 143 pre-school children (3 to 5 year old) from slum areas, half of them slightly to moderately below normal in length and weight. On controlling social variables, significant relations between standard length and results on tests of mental ability and spatial relations among the infants, and between length and a test of mental ability and one of vocabulary among the pre-school children were seen.
Nwuga (1977) tried to see the effect of kwashiorkor on intelligence. One index group i.e. urban kwashiorkor and four control groups i.e. siblings, a lower class group, an upper class group and a rural kwashiorkor group were given different psychological tests to measure specific intellectual abilities. The index group had lower levels of certain types of intellectual skills, specifically the higher cognitive skills, than their sibling, lower class group and upper class group. The upper class group was clearly better in performance on all the tests and in weight and head measurements than all other groups.

Evans et al. (1980) studied the relationship between intellectual development and nutrition by taking one new born child from each of the 14 families in which kwashiorkor had occurred. Undernutrition in that test group was prevented for the first 2 years of life by supplementary feeding. Controls who were the siblings received no supplementary feeding but received medical attention and management. Other two groups compared with were an older child who previously had kwashiorkor and the nearest sibling who had neither received extra feeding nor medical management. Psychological tests were given when the mean age of the test group was 8.9 year. The results show that the mean I.Q. of the supplementarily fed group was significantly higher than any of the other 3 groups.

Hoorweg et al (1976) studied 3 groups of Uganda children and 1 comparison group between 11 to 17 years of age. First 3 group had been admitted in hospital for PEM between the ages
8 to 15, 16 to 21, 22 to 27 months respectively. All the children came from one tribe and were matched for sex, age, education and home environment. Results show that all the three groups fell significantly below the comparison group in anthropometric measures and in tests of intellectual and motor abilities. Further they showed that a general improvement of intellectual abilities with reasoning and spatial abilities most affected, memory and role learning intermediated and language ability least of all affected was observed. Arellano et al (1977) supplemented calories and protein to four communities. The supplement significantly improved the physical development of children up to 7 years old. In girls there was a consistent relation between height and result of psychological tests, used to assess mental development. In boys there was a similar relation at three to five years but not at six to seven years.

According to Gopalan (1975) children suffering from malnutrition show a higher probability of poor performance in intelligence tests and other types of tests related to learning than their well-nourished counterparts. Jaya (1977) reports, children who had poorer clinical and nutritional status achieved low scores in tests of mental abilities.

If we consider the specific abilities affected adversely by malnutrition many studies of infants hospitalised with severe malnutrition (Kwashiorkor or Marasmus), report of greater deficit in language than in other areas of development, although all areas show a developmental deficit.
Such studies are numerous and all agree that PEM children exposed to the whole environment of disadvantage perform less well when compared to normal controls. (Monckeberg, 1968; Stoch and Smythe 1967; 1968; Chase et al, 1970).

Champakam et al (1968) remarked that there was significant retardation in perceptual and abstract abilities in the children suffering from malnutrition.

Shneour (1974) contends that malnutrition in early life severely and permanently changes the brain and hence mental capacity is the chief cause of low I.Q. factor. Gussow (1970) confirms these results by showing a relationship between psychological development and nutrition. Malnutrition and poor learning ability were also significantly related.

Proper food intervention in the form of breakfast and lunch supplantations, improved the nutritional and psychological condition of the children which also proves that although malnutrition and poor learning go hand in hand, supplementary food at the right time can improve both the nutritional status as well as the psychological functioning of the child.

Several other group of workers in different parts of the world have carried out studies to determine the impact of childhood malnutrition on mental development and intellectual performance in later life. All of them have unequivocally demonstrated experimentally the ill effects of PEM in a variety of ways by which human health and well being is affected by PEM.
2. Malnutrition and Emotional Maladjustment:

While affecting the intelligence of an individual adversely, malnutrition also brings about emotional maladjustment which reflects on the total behaviour of the person. Malnutrition affects reflexes like startle, grasp, visual placing etc. along with certain physiological characteristic like eye opening etc. This retardation results in delayed development of behaviour that depends on the maturation of these reflexes and physical characteristics. Many studies in man and animal which have observed the effect of malnutrition resulting in emotional instability and changes in behaviour are mentioned herewith.

To see the effect of malnutrition on emotional stability Barnes, et al (1970) and Zimmermann, et al (1972) carried out studies of rats, pigs and monkeys emotional patterns. Their results conclude that the malnourished rats showed decreased exploratory activity and high emotionality. Pigs on being fed low protein diet during the first eleven weeks revealed less sexual behaviour, less grooming and more aggressiveness. Similarly monkeys on a low protein diet also showed less curiosity and puzzle solving activity. On being given food reward they would perform better but would become apathetic on withdrawal. In tests of social dominance the monkeys on a low protein diet were submissive.

Read (1973) finds that severe malnutrition during prenatal life and infancy is accompanied by apathy, irritability.
maladaptions in social situations, low attention span and reduced exploratory behaviour. Other changes in behaviour that have been reported to be associated with severe early malnutrition are hyper-excitability to aversive stimuli and phobic reactions instead of normal curiosity towards new objects (Barnes, 1971) as well as decreased ability to focus on tasks and increased emotional sensitivity (Liggio, 1969; Thorp, 1975).

In another study Richardson et al (1972) studied the long term consequences of severe malnutrition on behaviour of children in Jamaica and West Indies. Subjects were 74 male school children who had been malnourished during the first 2 years of life. (Index cases). Each index subject was compared with the male sibling nearest in age (when he had one); and a male classmate nearest his age. Each male sibling selected was also matched with a male classmate nearest his age. Assessment of the subject's behaviour in school was then obtained from the teacher of each child. Index subjects were found to differ from their classroom comparisons both in behaviour related to class work and to social functioning at school. In contrast, the siblings differed from their classmate comparisons only in being more distractable. No association was found between behavioural impairment and the age during the first two years of life at which hospitalizations for severe malnutrition occurred.

Reporting on the Tulane study, Jefferson et al (1973) observe that the major behavioural sign of current malnutrition
is, reduced attentiveness, motivation or resistance to fatigue.

In National Institute of Nutrition, India a study was conducted (Champakam et al, 1968) to see whether school children treated for kwashiorkor some years before, were retarded in comparison to other children attending same school. They compared these children with others belonging to same religion, caste, socio-economic condition, but still significant behavioural changes in malnourished childrens were found,

M. Valensuela (1988) did assessment of the social and emotional development of 85 infants 17 to 21 month old of normal birth weight, well nourished or with moderate malnutrition (85% or less of expected weight for age) in Santiago, Chile. All nutritionally healthy infants were considered to be within normal limits of weight for height whereas only 71.4% of the undernourished infants fell in that category. The undernourished infants had variety of a typical patterns of attachment to their mothers which was also observed in abused and neglected infants. Their mothers were significantly less sensitive, less available, less accepting and less involved with their children.

Wurgaft et al (1987) while studying paternal behaviour and infant malnutrition collected information by structured interview to assess 78 chilean fathers. It included fathers of healthy (controls) and malnourished infants on basis of weight for age. Fathers of malnourished infants had a
significant more negative image of their own father and tended to imitate their behaviour and punishment patterns. Such fathers took less interest in physical and educational development, or health of their child. All these factors effect the emotional stability of the child.

Winick (1976) has shown with evidence that behaviour abnormalities may be more common in older children and adults who were malnourished in uterus, than in those whose mothers were adequately nourished.

Smith and Conger (1944) studied the effects of PEM on activity level of rats, on whom diet of equal calorie was maintained but varied the content of fat and protein. It was seen that when protein was reduced, activity was greatly depressed, whereas on reduction of fat, little activity was reduced.

Desbuquois G., (1979) recorded that children with less height, weight and low protein were listless and seemed to be victims of both under nourishment and maternal deprivation and indifference.

Richardson et al (1975) felt the lack of information about effect of malnutrition on behaviour and thus studied the social behaviour of 71 Jamaican boys, who were malnourished in infancy (index subjects) and compared them with classmates of the same age and sex and also with the sibling of same sex when available. The child's behaviour in his home setting was assessed by interview with the child's parent.
The index children differed significantly from their comparisons. They were less liked by siblings and more unhappy at school. They more often behaved immaturity, were more clumsy and were either highly active or lethargic. No relation was found between age when admitted to hospital for malnutrition and later behaviour.

Barrett et al (1981) explored the effects of early nutrition deprivation on later behaviour in two populations; (1) Guatemala and (2) California. Children were 6 to 8 year old. Results of this study showed social withdrawal and adult dependency in undernourished children and after supplementation at an early age they showed the highest social responsiveness and positive effect at school age.

In another study of his, Barrett et al (1985) examined the effects of calorie supplementation for pregnant women and children from malnourished population on children's school age behaviour. The child's abilities to respond to routinely stressful problem solving situations and to interact appropriately with peers were the dependent variables. 78 boys and 60 girls in rural Guatemala received different amounts of food supplementation both pre and post natally, as part of the longitudinal study. When measured at 6 to 8 year, highly supplemented children showed more interest in exploration of a novel environment, more involvement in a competitive game, greater persistence on a frustrating task, better motor impulse control and greater initiative across several group tasks, than did low supplemented children. In free play with
peers, high supplemented children showed more frequent happy effect, social involvement and moderate activity level and were less frequently timid or anxious. These results are consistent with findings from studies on the effects of early malnutrition on infant behaviour and suggest that behaviour impairments associated with early undernutrition have long term consequences for the child's development.

Barrera Moncada has explored the psychological test behaviour of severely malnourished children by means of the Gesell technique. Performance in all the fields of behaviour tested showed lower developmental scores than the standard calculated for children of similar age and ethnic group (Cravioto, 1964).

Joaquin Cravioto (1964) further sought to assess the psychological test performance of severely malnourished children during three different age periods (1) below six months of age, (2) between 6 and 30 months, and (3) after 30 months. The psychological test behaviour of the children was explored through the application of the Gesell method. The results confirmed once more the previous reports of lower scores in all fields of behaviour. As recovery from malnutrition took place, development quotients increased in most patients and the gap between the theoretical normal and the actual performance of the child progressively diminished except in the group whose age on admission was below six months.

The accounts given by several authors from different
countries show that apathy probably constitutes the most common finding in undernourished children. It can also be elicited as a sequel to emotional deprivation and loss produced by separation from the mother, which is customary at weaning in some societies, plus the separation that accompanies hospitalization (Wilson 1964; Platt et al., 1964).

Cravioto (1964) noted the observations made by Geber and Dean that recovery is more rapid among infants whose mothers show the greatest interest and solicitude, which suggests that separation anxiety plays an important role in emotional adjustment of a malnourished child.

Bowlby (1960) has described the psychological behaviour of the malnourished infants to be similar to the behaviour of a healthy child who has been separated from his mother by hospitalization.

The kwashiorkor patients seem to lose all the normal curiosity and desire for exploration that is natural to a child. This condition is so marked that renewal of interest has been considered as one of the most obvious signs of improvement – the child who smiles is well on the way to recovery (Cravioto, 1964).

Lester (1976) studied the cry sounds of 12 well-nourished and 12 malnourished male infants by using behavioural measures. The similarity between the cry of the malnourished infant and the cry of the brain damaged infant suggested that malnutrition may affect the regularity of the CNS. With these
findings, it was hypothesized that malnutrition is most likely to effect these regions of CNS which are responsible for the activation and modulation of behaviour.

Undernourished children have been reported to exhibit behavioural alterations including apathy, lethargy, inability to pay attention and perhaps over concern about food, so that responses to educational stimulation did not occur. Arellano-Carandang (1971) investigated whether a relationship existed between nutritional status and motor and exploratory behaviours, using 87 public school first graders. Results showed low correlation between nutritional measure and behavioural task.

3. Intelligence and Emotional Maladjustment:

With a view to study the effects of PEM on both intelligence and emotional maladjustment, it will be desirable to have knowledge of correspondence between intelligence and emotion. It is indispensable, to know the status of the mental development in order to make a correct diagnosis of actual behaviour.

Cravioto (1964) has briefed the influence of certain variables on the prediction of later intelligence as put up by Knobloch and Pasamanick "If intelligence is defined as the mental adjustment to new circumstances and is characterized by increasing complexity in the channels through which the subject acts on objects, it can be seen that the adaptive
sphere, as explored by the Gessell method is precisely the area of the behaviour that can best serve as an analogue to the later intelligence, since it is concerned with the organization of stimuli, the perception of interrelationships and the separation of the whole into its component parts with subsequent resynthesis in a manner adequate to solve a new problem.*

During the chronic development of severe malnutrition, from the mild moderate to the severe case, failure to respond appropriately to changing stimuli is reflected by a progressive withdrawal from the environment. It confirms that although the physical signs of body wasting are more noticeable, the behavioural changes have a greater importance because of their possible interference with cognitive development. Some studies mentioned here give a clear picture of the extent of interaction between intelligence and emotion.

The relationship between early socio-emotional functioning and intellectual achievement has been documented in a longitudinal study of school readings (Kohn and Rosman, 1972). Their findings suggest that the child who is curious, alert and assertive will learn more from his environment and child who is passive, apathetic and withdrawn will learn less about his environment.

Birns and Golden (1972) found that an index of pleasure or enjoyment in the tasks on the Cattell Infant Intelligence Scale at 18 month was significantly correlated with I.Q. on Binet Intelligence Scale at 3 years. Similarly Cicchetti and
Sroufe (1970) found a strong relationship between Bayley Mental Scale scores and emotional expression in severely retarded group.

Dimitrovsky (1964) found a positive correlation between verbal ability and emotional sensitivity significant for younger children. Davitz (1964) also found low but positive correlation between emotional sensitivity and both verbal and non-verbal intelligence and has concluded that a minimum amount of intellectual ability is necessary but not sufficient for recognition of emotional meaning from vocal cries only.

Cheyne and Jahoda (1971) matched 80 orphanage children, 6 to 10 year old with children in normal homes and tested them for recognition of emotion in speech. Recognition scores were higher for (a) negative than positive emotion (b) female than male voices and (c) educated than uneducated speech, though these effects interacted with age. Orphanage children showed no consistent differences from their controls apart from an inferiority in recognition of emotion in male voices. Recognition scores correlated with both verbal and non-verbal ability and correlations decreased with age. It was concluded that the development of emotional sensitivity is related more to general perceptual and intellectual factors than to specific experience with emotion.

Simpson and Izard (1972) found that institutionalized mental retardates, when matched with normals on the basis of intelligence, obtained significantly lower scores on the
Emotion Recognition test. Flavell (1977) also believes that the social behaviour of the infant is partly dependent on the developmental level or quality of mental abilities.

The findings of Simpson & Izard suggest that there is a developmental retardation in both the cognitive and the emotion system of mentally retarded individuals, and that there is some deficiency in the integration of emotion and cognitive development. The equal intellectual development and unequal emotion responsiveness of different aged normal and mentally retarded groups suggest some developmental independence of the emotion and cognitive systems (Izard, 1971).

Kagan (1971, 1976, 1978a) has investigated the overall mental development of infants as a factor in emotional and social development but found it difficult to study in these areas due to scarcity of reliably identified behavioural continuities related to attentional, perceptual and cognitive variables.

There are other studies which have been carried out to study the relationship between mental development, social development and emotional variables in infancy with mixed results (Lewis and Lee Painter, 1974, Sostek and Auders, 1977).

Lund (1939) states that "A complete description of an emotional behaviour includes mental, somatic and visceral variables. To be content with anything less would not do severe some of these factors may be identical in different types of emotional behaviour and all may occur under non-emotional as well as emotional conditions."
According to a WHO report (1977) observations regarding children showing different behaviour in different situations indicate that childhood mental health problems are in a more direct way linked with the interaction with understanding of their environment which is important in evaluating child's mental health. Moreover in all literate societies emotional and conduct problems have been found to be relatively common in both mentally feeble children and children with special disorders of learning or language development. Children's intellectual development is influenced by the quality of experiences in families but family care as such may not be cognitively damaging whereas it can damage social and emotional development.

Honzik et al (1948) stressed on effect of social and emotional factors on individuals deviations on cognitive test scores. Their findings showed that these factors exceeding more than mere day to day fluctuations in feeling, base a substantial relation to test score variation.

Bayley and Schaeffer (1964) found that the emotional atmosphere at the home had definite influence on I.Q. level in boys with loving and warm mothering being associated with high ability and maternal hostility being associated with low ability. It was also proved that children who showed more gain in I.Q. were more independent, competitive and self initiating in activities (Sontag, Baker and Nelson, 1958) and showed higher need for achievement (Kagan, Sontag, Baker and Nelson, 1958).
Munn (1954) and Russell (1940) have emphasized that excessive emotionality narrows the cognitive field and promotes rigidity and perseveration. Baldwin, Kalhorn and Breeze (1945) demonstrated that children reared in warm, democratic homes gained 8 points in mean I.Q. over a three year interval, whereas the mean I.Q. of children from rejecting, indulgent and less emotionally gratifying homes either fell or remained constant.

4. Malnutrition, Intelligence and Emotional Maladjustment

It has been known by the studies measuring the effect of malnutrition separately on intelligence and emotion (behaviour) that malnutrition in early life distorts the chemical composition of the brain which effects on certain structural components and damages the CNS sufficiently to lead to permanent intellectual impairment and other disorders related to behaviour. There are also numerous studies done both on man and animals that show the combine association of malnutrition with alterations in behaviour and intelligence (Dickerson et al, 1982).

Barnes (1969) has described the causal chain between malnutrition and mental retardation as: malnutrition - apathy - retreat even from the minimal stimuli offered - mental retardation, instead of the commonly believed: malnutrition - biochemical brain damage mental retardation. His animal experiments show that early malnutrition severely effects the learning ability and emotionality of the animals but the
Barnes et al (1967) created kwashiorkor and marasmic conditions in experimental animals by using restricted diets. Rehabilitation was then achieved by normal diet and the behavioural development of the animals observed. The results indicate that the malnourished animals had a poorer learning behaviour in classical and operant conditioning and in discrimination learning than a control group of normally fed animals. The retarded learning behaviour was long lasting but not permanent and was probably due to the observed decrease in the motivational drive.

Winick et al (1972) reviewed the animal studies and observed that in animals early nutrition is associated with impaired learning ability, heightened emotionality and reduced exploratory activity. Barnes (1971) also noted in animal studies as well as man studies, the changes in behavioural development caused by early malnutrition. These changes like extreme apathy, hyper excitability to aversive stimuli and phobic reactions instead of normal curiosity towards new objects, lead to a poor learning performance.

Reviewing the research presented at the International Conference on Malnutrition, Learning and Behaviour in Massachusetts, Scrimshaw (1968) observed that, in animals, severe malnutrition during the post weaning period has shown to impair permanently the development of the brain and subsequent learning and behaviour. Sensory deprivation also may
have the same effect. In humans, malnutrition interacts with infections, heredity and social factors and also impairs both physical and mental growth and development.

Liggio (1969) observed for one year, subjects with I.Q.s from 70 to 90 who were sent by their teachers for neuropsychiatric help because of their notable distractability in school. It was found that the most disturbed subjects had no animal protein in their diets, not even in the form of dairy products. As a result they were restless, often demonstrating an impulsing tendency to touch every thing; their attention span was very low and they demonstrated an inefficiency in memory test. Later it was also observed that those subjects whose family followed the dietary advice, their motor ability, attention span and memory improved considerably.

According to the study by Banik et al (1972) adaptive components of behaviour of the malnourished children is more affected. The adaptive development as designed by the Gesell method for young children can be regarded as an analogue to intelligence.

In 1972, Devadas, et al, investigated the impact of nutritional status on emotional expressions and mental abilities. On the basis of clinical findings, 16 well nourished and 16 malnourished pre school children were selected. Their emotional expression were recorded through observation and their mental abilities were assessed through specially constructed test items. It was found that the well-
nourished exhibited positive emotions with more frequency, duration and intensity and less behaviour problems, when compared to the malnourished. Also the former did better in the test on mental abilities.

According to Cravioto and Robles (1965) "Taking into account all the previous considerations, the persistence of low score of performance in adaptive behaviour during rehabilitation in the group of infants that suffered PEM before six months of age seems to indicate a probable loss in intellectual potential."

Caputo et al (1970) observed that deviant behaviour i.e., hyperkinesis, autism and involvement in childhood accidents, appear to be relatively common among premature and undernourished children, as are difficulties in language development and in various areas of academic achievement. Physical growth, motor behaviour and neurological functioning are adversely affected as well.

Cravioto (1964) quotes Robles et al wherein in his study of children with severe PEM in Mexico, he found that the general psychomotor behaviour was nearly normal but greater deficit was observed in mental development, especially in the field of language.

Galler et al (1984) evaluated soft neurological signs in 101 school children, 4 to 11 year old, who were malnourished in the first year of life and 101 comparison children matched for age and sex but who had no history of malnutrition.
Previously malnourished children performed significantly more slowly than comparison children on several timed motor tasks. A model is presented which shows interrelations among previously malnutrition, soft neurological signs, classroom behaviour, intelligence and physical growth. Slow motor performance was associated with lower verbal and performance I.Q. and the presence of attention deficit disorder, as assessed by the child's teacher.

In another study of his Galler et al (1984) studied the academic performance of 77 boys and 52 girls, who were 5 to 11 year old and had moderate to severe PEM in the first year of life. They were compared with the performance of matched children who had no history of malnutrition. It was seen that poorer school performance in the previously malnourished children can be largely accounted for by deficits in classroom behaviour and to less extent by a lower I.Q.

Brozek (1980), made the impression that malnourished children of school age compared with their well nourished counterparts are smaller in height, have smaller head circumference, fall behind intellectually and are more closely attached to their parents.

Dasen et al (1977), selected 5 to 21 months old children for his study to form two samples matched for age but differing in nutritional status. The stages of psychological development was assessed every three months with sensory motor intelligence scale. Videotapes of behaviour with a fixed set of objects were used. Significant differences
occurred between the two samples on some but not all of the dependent variables. One aspect of both sensory-motor intelligence and behaviour which appeared to be particularly adversely affected by poor nutritional status was the exploration of the environment and active experimentation.

Hales et al (1980) studied rats to see the effect of malnutrition on behaviour and learning abilities. Results showed that performance differed significantly between rehabilitated malnourished rats and normal rats. Difference in motivation and not learning ability was the explanation for the difference in performance between the malnourished and normal rats.

In another study the behavioural styles of response to cognitive demands were determined in a group of children who had survived early malnutrition. These behavioural styles in this group were compared with those in two groups of children who did not suffer from malnutrition. At birth the two groups differed significantly from the survivors but after 5 years when the survivors had been given enough stimulation, both the groups matched in performance. But it was not known whether the difference at birth was due to malnutrition or lack of stimulation (WHO Chronicle, 1974).

Lebedev et al (1969) treated 36 children with protein and found a certain improvement in mental development, speech and motor activity. Behaviour of these subjects became more regulated, convulsive attacks appeared much less frequently, and EEG data gradually took a normal character.
Klein, et al (1969), Latham, et al (1971) and Kaplan (1973) maintained that the relationship between early malnutrition and mental retardation need not be one of cause and effect. Malnutrition is found in areas which include deficiency of intellectual stimulation which could per se cause poor psychological development. The authors also offer a new hypothesis that early malnutrition is associated with mental retardation not because of pathological changes in the central nervous system, but because it leads to apathy which restricts the activities and learning opportunities of the child.

These studies lead us to a debatable question whether the effect of malnutrition of the psychomotor development of pre-school children is a transient phenomenon or a permanent irreversible process. The study of Keys et al, (1950) demonstrated that the effect of malnutrition on psychological performance is of transient nature. Cravioto (1962) however, observed that the effect of malnutrition on mental development varies according to the functional period of life at which malnutrition is experienced. On the other hand, a study carried out at National Institute of Nutrition, Hyderabad (Champakam et al, 1968) concludes that malnutrition might produce irreversible retarded mental development.

Studies supporting or rejecting these above mentioned three conclusions are many. Barnes (1966) showed that the nutritional deprivation in early life of rats, could cause a long lasting probably permanent retardation in visual
discrimination. Winick (1976) contradicts these findings while stating "Contrary to what had been thought, the chances for recovery from malnutrition are good. Even a child who was severely malnourished in the first year is capable of recovery to an average intelligence, stable behaviour and average achievement in school."

Lonsdale et al (1970) had also earlier reported similar thoughts, while studying 10 subjects with hyper phenylketonuria. Another study supporting this results earlier (Poser, 1967) concludes that subjects showing a typical manifestation of phenylketonuria, improved in many mental abilities after receiving low phenyl-alanine diet for five years. Hoorweg and Stanfield (1976) studied children between 11 and 17 years of age who had suffered from an acute attack of malnutrition between 9 months and 2 years of age. They showed no significant differences in the extent of the deficit in the malnourished and concluded that no catchup was likely to occur.

Stein et al (1972) conclude on the same lines while studying the relationship between maternal starvation during pregnancy and the mental status of the offspring in adult life. The results indicate that neither starvation during pregnancy nor the decline in mean birth weight had any effect on the adult mental performance and behaviour of the surviving offspring.

On the other hand there are many studies (Birch et al, 1963, Birch, 1970, 1971, 1972) and also Brockman et al.,(1971) who have observed different results while observing the effects
of severe PEM on cognitive development. They indicate that although malnourished children's cognitive development was significantly poorer than their malnourished counterparts, but after treatment, they improve gradually.

Kc Greger, et al (1987) studied the development of 16 children who were admitted to hospital for severe malnutrition and took part in a home visiting programme of psychosocial stimulation, which was compared with that of two other groups who were also admitted to hospital but received standard medical care only, a severely malnourished group of 18 and an adequately nourished group of 20. All groups were assessed regularly on Griffiths Mental Development Scale and the Stanford Binet Scale. Both groups of malnourished children were behind the adequately nourished group on admission to hospital and after a certain period the group which received no intervention showed little sign of catching up whereas the intervention group caught up to the adequately nourished group in two years. Again after the three year gap in intervention, the intervention group showed decline in three of the five Griffiths subscales, although they retained advantage over the non intervention group on the Stanford Binet test.

This study clearly proves that intervention or some rehabilitation for a specific period brings definite improvement in the malnourished child. Contrary to this are the results of another study (NARS 1986) wherein mothers of one group of malnourished children were given six sessions
of nutrition at home. But no difference between the two
groups of malnourished children was noticed in psychological
performance.

According to Dayton (1969) Early malnutrition is
related to low results on intelligence tests and behavioural
changes, and refeeding results in mental recovery except in
those children who were less than six months when malnourished.

Physiological Aspects of PEM, Intelligence and Emotion:

Every action or behaviour of an organism has a physiolo-
gical explanation or aspect behind it which gives a clear
picture of interaction between internal and external vari-
ables. As discussed, malnutrition in early life effects
certain structural components and damages the CNS suffi-
ciently leading to permanent intellectual impairment and
alterations in behaviour. This effect of PEM on intelligence
and behaviour can also be studied and explained through
their physiological aspects. An attempt of the same is made
here by the investigator, with a view to explore a physiolo-
gical basis of the interaction between PEM intelligence and
emotional reactions.

Eichenwald and Fry (1969), and Kaplan (1972) have
pointed out that in malnutrition both physical and bio-
chemical maturation such as ability to metabolize certain
amino acids is retarded. It also results in fewer brain
cells and lower brain weight due to which permanent deficit
in height, weight, head circumference as well as resistance to stress and intellectual functioning deficits.

Similarly many other reductions take place which tend to effect the cerebellum more than the rest of the brain in post natal malnutrition in rats, perhaps because the cerebellum is the most rapidly growing part of the brain at this time (Culley and Lineberger, 1968; Chase, Lindsley and O'Brien, 1969).

Brown (1965) studied the weights of brains taken from autopsies of over 1000 children during 12 years in Uganda. The mean brain weight of malnourished and well nourished children were compared. The mean body and brain weight were significantly lower in the malnourished group and both were lower than the measurement of a published standard reference.

Winick and Rosso (1969) have analysed brains from marasmic infants dying in there first year of life. DNA, RNA, protein content and cell counts were reduced. Fishman, Prensky and Dodge (1969) have found reductions of lipids, cholesterol and neuraminic acid in brains of infants dying of malnutrition between 2 and 22 months of age. The effect of PEM on hypothalamic stimulation is also reported by Alleyne and Young (1967). Similarly impairments in liver (Patrick et al, 1973) Pancreas (Shaper, 1964; Olurin and Olurin, 1969) Kidneys, (Dayal et al, 1970), muscles (Holmes et al, 1956; Check et al, 1970) heart (Piza et al, 1971) and skeletal system (Garrow and Fletener, 1964; Engsner et al, 1974) are reported as the result of malnutrition.
The involvement of PEM in CNS is apparent from the studies conducted in different parts of the world. Similar to this is the involvement of intellect whose identification is done with "Cerebral cortex" which is the highest set of integrating centres of the human brain. Through millions of synaptic connections in the grey matter of the cerebral cortex, any stimulus input can cause any response output.

Assuming that capacity to learn and retain the maze habit is symptomatic of the intellectual capacity of the rat, Lashley (1929) has said that quality and quantity of functional cerebral tissue is positively related to intelligence. Balton (1914) had shown intimate relationship of intelligence and brain by doing microscopic examination of a large number of brains. He showed that the receptive cortical layer is undeveloped in the idiot and in the imbecile.

Studies regarding testing intelligence of psychosurgery patients suggest that the operation has little effect on performance in intelligence for otherwise normal patients. (Leukel, 1968). Freeman (1948) had also found negligible correlation between tested intelligence and physiological malfunctioning like enlarged glands etc, although there is no clear cut evidence that cerebellar function is specifically impaired. Hoorweg and Stanfield (1976) found a significant deficit in the performance on a motor development test, suggesting a parallel with the clumsiness reported in previously malnourished animals (Platt, 1963).

Gall, believes that there is an intimate relation between
intellectual capacity and size and shape of the skull. According to the study, the heads of idiots, unless otherwise diseased, are characterized by deformity or smallness; the heads of eminent men by their magnitude. But contrary to this Alleyne (1978) has noted Paterson's results which show slight correlation between morphological development and intellectual development.

Electroencephalographic studies have been few in regard to the physiological aspect of PEM and mental development. Taori and Pereira (1974) found normal readings in a group of 20 children who had been admitted to hospital with kwashiorkor 6 to 8 years before. Slowing of patterns, particularly over the temporal lobes has been reported in acute PEM by Nelson and Dean (1959) and many others (Alleyne 1978) showed EEG patterns recovering to normal after treatment.

Besides the brain being considered the unquestioned seat of intellectual operations and the principles of brain function and automical and functional aspects being related to intelligence there is another physical factor heredity, which effects intelligence to a great extent. The most faithful approach to see the relation of heredity to composite measures of intelligence, is through intercorrelations between unrelated individuals, with special attention to one egg or identical twins (Guilford, 1967). Guilford further reviews, the study by Vandenberg on the Thurstone PMA test scores of identical and fraternal pairs of twins and found evidence of hereditary determination in case of scores for Number, Space, Verbal and Word fluency.
As the identification of intellect is with cortex, identification of emotion is with sub-cortical structures. These two structures have different set of values and two different ways of integrating experience. The opposition between two systems of mental functioning has been put forward in terms of abstract and concrete behaviour, ego and id and also directed and deistic thinking (Hillman, 1960). The explanation of emotion does not rest upon its identification or location in one member of the conceptual pairs. It rests upon the way in which these two systems, fields, regions, or structures relate. Thus emotion is a result of intracortical conflict.

According to Gray, (1935) Emotion was explained as the intense but temporary bodily behaviour initiated by some stimulation sufficient to bring about action of endocrines, heightened muscle tones, increased sensitivity etc. These physiological changes then stimulate the internal receptors and the organism feels emotional (Hillman, 1960).

Emotion gives birth to many autonomic reactions. In fear blood tends to leave the head. In fainting there are severe circulatory changes which lead to unconsciousness and changes in bodily posture. Secretions of various glands increases or decreases which changes the metabolism of the body. James Lange also states that an emotional stimulus sets off autonomic responses in our blood vessels, glands and in skeletal effectors, which act as stimuli for internal receptors, which inturn send impulses back into the nervous
system. Such impulses give rise to emotional experience.

(Morgan and Stellar, 1950).

There are different autonomic response patterns for rage, fear, sexual arousal etc. Studies show that predominant autonomic pattern of psychotic patients influence their reported "mood" as well as their behaviour. Pleasant emotions are accompanied by widespread but discreet parasympathetic responses, which are governed from the anterior and medial hypothalamus and include reaction like dilation of blood vessels supplying blood to the viscera and the skin. Rage and fear are accompanied by diffuse sympathetic discharge, reinforced by hormones from the adrenal medulla.

Going against this theory Cannon (1927) and Bard (1928) with co-workers prepared cats in which sympathetic system was sectioned along the whole length of the spinal cord. Such animals did not give the autonomic responses that are the part of normal animals emotional behaviour, but were able to give the hisses, snarls and facial expressions of an angry or fearful cat. Thus they criticized the theory by proving the fact that sympathectomized cats show all the outward signs of anger, yet cannot 'feel' it, at least in their autonomic system.

Stressing on the importance of sympathetic responses Hall (1934) states that in strange surroundings, for an organism, when sympathetic effects have a rapid outset there is a brief compensatory outflow of parasympathetic impulses.
It is taken as a measure of emotionality. According to Fulton et al (Morgan and Stellar, 1950) changes in the chemical and endocrine balance of the blood too, are sympathetic reactions during emotional experience like release of adrenaline from the medulla of the adrenal glands.

Experiments done by a group of workers, Hall, Yerkel and Rhoades (Morgan and Stellar, 1950) show that there is a close connection between the glandular make up of the organism, its genetic constitution and emotional expression. Lund (1939) has shown that circulation of blood to head often changes in emotional experience. In shame or embarrassment circulation is more due to dilation of the blood vessels leading to the face and head. In fainting its opposite occurs, due to general dilation of blood vessels in the body, and hence blood leaves the head, depriving it of oxygen.

With his experiments on dogs and cats, Bard (1928) has considered hypothalamus as the seat of emotion. He removed cerebral cortical in some animals while the thalamus and all lower structures were left intact. In other animals the thalamus as well as the cortex was sectioned, but the hypothalamus and midbrain structures were left alone. Finally, in other animals, the section of the brain stem was made below the hypothalamus. Results showed that there is some mechanism in the hypothalamus for organizing the somatic patterns of emotional response. Bard and Mountcastle (1947), also strongly supported the influence of hypothalamus on emotional responses.
Other evidence also show that the hypothalamus is an integrating centre for rage responses. Ross (1976) has pointed out the support of Grossman 1967, Maclean, 1967, by reporting that electrical stimulation in the posterior hypothalamus can produce rage like behaviour and that lesions may produce some suppression of emotional reaction.

Finally, it can be concluded that the psychological function (emotional consciousness) depends on the physiological function (processes) which take place in anatomical structures (Cerebral cortex and Hypothalamus). Hillman, (1960).

(B) Studies on other Related Variables:

Along with nutritional status, sex difference and educational status were other variables to be studied in regard to effect of malnutrition on level of intelligence and emotional maladjustment.

1. Sex Difference:

There is a common attitude of preference for boys in our Indian society. It is commonly believed that parents will prefer to fulfill the needs of their son than their daughter and be partial to him in all respects, even in the distribution of food. Girls who get lesser opportunities to develop their overall abilities are further burdened by extra responsibilities of the housework and younger siblings which brings in emotional maladjustment in most of the cases.
Individual differences which influence psycho-social development, comprise factors as diverse as the child's temperamental characteristics, sex, physical appearance and rate of development.

Boys and girls in our culture typically differ in certain temperamental traits, emotional expression and conformity to social controls, but whether these differences are innate biological or environmental is a desparitable proposition.

Scott, as quoted by Buck (1976) emphasized that sex difference are not only due to socialization but are innate too. He found male animals more aggressive than females. He further reported that male sex hormones are often associated with increased aggressive behaviour. Contrary to Scott, Bandura (Ross 1976) gives more importance to the role of sex role socialization in sex differences while conforming the results of animals in human, as boys were found to be more attentive to display of aggression that the girls.

A WHO report (1977) states that emotional disorders like fear, anxiety, depression, obsessions, hypochondriasis etc, occur with the same frequency in boys and girls while conduct disorders like poor peer relationships and destructiveness are significantly more common in boys. It was also reported that impairments or delays in development are markedly more common in boys.

Sex differences in general intelligence tend to be
negligible in magnitude and inconsistent in direction. Most of the obtained difference can be attributed to differential weighting of the particular tests used with various component aspects of intelligence in which boys and girls differ in opposite direction, for example vocabulary, verbal fluency, rote memory, spatial and numerical abilities (Tyler, 1954). Although the incidence of intellectual eminence is indisputably higher among males than females, differential conditions of cultural expectation, motivation and opportunity cannot be ignored.

Difference between sexes on particular cognitive abilities tend to be larger and more significant than on tests of general intelligence. In regard to the studies on sex differences, results vary to a great extent whereas some investigators report a difference in favour of boys (Hobson, 1947; Koch, 1954) and some report a difference in favour of girls (Freeman et al 1944) and also earlier Bryan et al. (1935) others find no difference at all (Havighurst et al, 1947). It is also reported that with the exception of verbal fluency, most sex differences in cognitive abilities are not evident at the younger age levels (Tyler, 1954).

When boys and girls are compared on primary mental abilities clear differences in favour of girls are found in word fluency, rote memory and reasoning (Havighurst et al 1947, Hobson, 1947). Same authors along with Lord (1941) have found that boys are superior in spatial abilities. Koch (1954) failed to find significant sex difference at the ages of five
and six years. Sex differences in verbal problem solving and casual thinking were not found to be significant but boys tend to surpass girls in mechanical puzzle problems and in arithmetical reasoning. (Munn, 1954 and Russell, 1940).

In studies by Me Carthy, where boys and girls were reasonably well matched with respect to I.Q. and socio-economic status, girls proved to be superior on almost every conceivable criterion of language proficiency. School achievement tests also show that girls excel boys in language skills but that their superiority is relatively much greater in speed of reading and verbal fluency than in vocabulary and verbal comprehension (Ausubel, 1958).

Maccoby (1967) observed that although generally there are no sex difference in general intelligence but somewhat girls tend to test higher on tests of general intelligence during the pre-school years and boys during high school years. Sontag et al (1958) and Maccoby et al, (1974) both report that in longitudinal studies, in which the same children have been tested repeatedly through their growth cycle, show greater gains for boys than girls.

Maccoby (1967) studied the sex difference in specific abilities and reports: Verbal Ability - In pre-school and early school years girls exceed boys in verbal performance but by age of 10, and number of studies show that boys catch-up in their reading skills. Numerical Ability - During school years some studies show boys ahead of girls, although number of other studies reveal no sex difference. In a longitudinal
study, Haan found men accelerating more than women in arithmetical ability during early adulthood. Spatial Ability - By the early school years boys consistently did better on spatial tests and this difference continued.

It was seen that girls got better results during school years, even in subjects in which boys had scored higher on standard achievement test.

Ames and Frances (1964) matched the subjects in boy girl pairs according to WISC, I.Q., age in months and socio-economic status. Following tests were administered to subjects for three consecutive years: the Gesell Incomplete Man, the Lowenfeld Mosaic test, the Rorscharch and Monroes Visual III. Results reported that for all three groups of subjects (Kindergarden, first grade class and second grade class) at every age, girls were superior to boys in terms of maturity of response and performance. Results of another study (Balow 1963) support the previous ones while reporting that girls were significantly better in both reading readiness and reading achievement. The reading readiness differences appeared to be a function of the ability to see similarities and differences between words.

In another attempt to study the extent of sex differences Garner John et al (1971) examined interrelationships between intellectual and behavioural impulsivity separately for boys and girls. It was done so in an attempt to confirm that impulsivity is differently related to attainment for the two sexes. The first hypothesis that boys are more active and
impulsive than girls was tested by comparing the respective mean scores. Difference was found to be significant. For second hypothesis that children with high and low scores on behavioural input would perform less efficiently than those with intermediate score, only significant effect was the interaction between sex and behavioural input.

Maxwell (1984) analyzed the Structure of Intellect Learning Abilities Test (SCI-LA) for sex differences. It was found that significant mean differences favouring females in memory ability do exist. No sex difference in true variance, error variance or in factor intercorrelations were identified. Cunnion (1981) took 30 boys and 30 girls for problem solving task. It was proposed that girls utilize an exhaustive approach, utilizing all the problems variables in order to reach an ideal situation, whereas boys seek the most expedient solution, streamlining the problem and using little information to reach an answer. These sex differences were significantly shown in the results.

Chaudhary et al (1984) in their study found that boys had higher I.Q. than girls. Nwuga (1977) took five groups to measure specific intellectual abilities and found that boys tended to be more affected by severe kwashiorkor with regard to mental development than girls. In another study Arellano et al (1977) gave a supplement of calories and protein to four communities, which improved the physical development of the children. In girls, he found, there was a consistent relation between height psychological tests to assess mental
development. In boys there was a similar relation at 3 to 5 years but not at 6 to 7 years.

2. Educational Status:

School exerts a sobering influence on the child since it also makes greater demands for mature behaviour. Hence there is an improvement in such attributes of ego maturity as independence and reliability. The satellizer tends to react to the teacher as a parent substitute. The primary status a child earns at school plays a relatively peripheral role in comparison to the derived status provided by his home. School not only participates in the transmission of our particular cultural ideology and psychological traits, but also plays an important role in the development of ego status and ego maturity goals, and in the acquisition of acceptable standards of social behaviour.

Studies on educational status as an independent variable are scanty. However, it is well known and established that education is training the mind for understanding, performance and achievement. It is therefore easily deduceable that educational status must cause profound improvements in total personality and development. Some of the otherwise interesting studies deserve mention.

Galler et al (1984) studied the academic performance of barbarian children who were 5 to 11 year of age and had a moderate to severe PEM in the first year of life. Their
performance was compared with children who had no history of malnutrition. Inter-relations of malnutrition, socio-economic status and school performance were studied. Poorer school performance in the malnourished children can be largely accounted for by deficits in classroom behaviour and to less extent by a lower I.Q. Current socio-economic status is not directly involved in changing academic performance whereas the early history of malnutrition and the accompanying conditions at the time of illness are leading contributors to changed behaviour outcome and school performance.

Gravioto and De Licardie (1970) compared children of different stature but matched for age, height of parents, ethnic background, housing and sanitary conditions. They concluded that the data led to a prediction that, the shorter children, whose height is a reflection of earlier and sometimes continuing malnutrition, risk school failures stemming from an incapacity to master primary school subjects.

The poor health of the disadvantaged is a primary variable in his educational failure. An extensive review of health studies show that Negroes and Indians suffer from the greatest health problems. The health factors which these studies found to relate specifically to intellectual and educational deficits are prematurity, obstetrical and prenatal complications, birth weight, maternal physical characteristics and nutrition (Hemlatha 1979). Pandey et al (1987) also reported that poverty and lack of education were both responsible for nutritional state of the child.
Along with the educational status of the child, the educational level of the parents, especially the mother, also contribute to the intellectual development of the child. Knobloch and Pasamanick, and also Kagan and Moss have shown the variation of the developmental quotients according to the level of maternal education and how this influence is progressively more manifested as the child grows older. (Cravioto, 1964).

Medinuss et al (1976) states that low reading achievements tend to be associated with school withdrawal, but the significant factor here is the low self concept that accompanies reading failure. In a comparison of 60 poor readers who dropped out of school and 60 who graduated Penty (1956) found that the former group held more negative attitude towards themselves.

An interesting relationship was found by Kohn and Rosman (1972) in a longitudinal study, between a dimension labeled Interest - Participation versus Apathy - Withdrawal and Intellectual ability and academic achievement.

3. Other Variables:

From above discussion it can be concluded that malnutrition in early life distorts the chemical composition of the brain which effects on certain structural components and damages the CNS sufficiently to lead to serious intellectual and emotional impairment. Simultaneously it is also
observed that if other factors like environment and poverty also join hands with malnutritional then the impairment becomes irreversible, thus making a permanent damage in a child overall development.

It is believed that in the impoverished circumstances in which so many children in poor countries are raised, there is a complex interaction of multiple environmental factors which cannot be ignored. (Pollitt & Thompson, 1977; Cravioto and Delicardie 1979).

Here we would discuss studies which gives us a clear picture about the involvement of these factors to some extent in brining the alterations in behaviour and intelligence.

Richardson (1976) studied severely malnourished boys aging six to ten years who were treated for malnutrition during first two years of life. Classmates and neighbours were taken for comparison. The results show that effect of malnutrition in first two years of life has different consequences for intellectual impairment depending on the back ground history, the economic condition of the household and child's social environment. If the general circumstances are unfavourable, then severe malnutrition is clearly related to later intellectual impairment.

Winick et al (1972) reviewed the animal and human studies that have attempted to isolate the effect of early malnutrition on brain structure and function, from the effects of other factors in a poverty environment. In animals
both early malnutrition per se and early environmental deprivation per se are associated with impaired learning ability, heightened emotionality and reduced exploratory activity. Taken together, the two factors interact to increased the severity of the behavioural changes. It was also reported that both enrichment of environment and providing of food leads to an improvement in mental performance in previously malnourished children.

Winick et al (1975) did study on Korean Orphans in three groups who were taken care (fostered) by middle class U.S. families at the age of two to three years, and who had thereby undergone a total change in environment. Results showed that all the three groups had surpassed the expected mean (50th percentile) for Korean children in both height and weight. Although all the three groups (malnourished, moderately malnourished and well nourished) were heavier and taller than would be expected if they had remained in Korea, their mean fell below the 50th percentile of the American standards. The tremendous psycho-motor development observed during infancy depends largely on the balance between nutrition and environmental forces.

Guthrie et al (1976) tested 56, 6 to 36 month old children in a mountain village in Philippines, out of which 16 were too sick to respond to the mental scale (Bayley Scales of Infant Development), and 15 with histories of severe malnutrition obtained very low scores. It was specifically noted that vigorous efforts are made to avoid a
child from crying by giving them heavily sugared food, carrying them most of the time and providing very little verbal stimulation. Because of this children had little opportunity to acquire self supporting verbal or manipulative skills. Furthermore generally poor sanitation predisposes to high prevalence of the diarrhoea malabsorption malnutrition sequence which exaggerates already existing dietary differences. This clearly indicates that the poor performance resulting from malnutrition due to faulty food habits, is aggravated by lack of verbal stimulation and poor environmental conditions.

Eichenwald et al (1969) reviewed studies suggesting that inadequate nutrition in infancy might result in permanent stunting of mental, physical and neural growth. They are not clear whether in humans these impairments are caused by malnutrition alone of whether they are complexly combined with other factors, i.e. infection and a poor social and emotional environment.

Smith et al (1967) studied a group of sick children who were severely under nourished from the first few months of life and who belonged to a privilaged socio-economic environment. When compared with normally nourished children of the same age, they were found to have mediocre intellectual and psycho-motor performances and social adjustment during the first years of life but after the age of five years, the satisfactory socio-economic level reigning in their families caused the undernourished children's mental retardation to
disappear, thus, indicating that malnutrition in itself may retard mental development but under favourable environmental conditions, this disorder is reversible.

Giugliani, et al (1987) did a case control study of under-nourished children in a squatter community and identified a number of proximate determinants of malnutrition. It was found that along with the low birth weight and absence of breast feeding, social factors were equally significant as antecedent of malnutrition.

Kata L. (1986) studied the environmental factors affecting nutrition and growth and found that concurrent infection or deficient diet are the main contributors to the malnutrition, growth retardation and premature deaths, commonly observed among children in impoverished societies.

Hanson (1975) tested several propositions about the relationships between and among environmental variables of relevance to I.Q., and hypothesized variables relating to I.Q. were measured longitudinally across 3 times in children (0 to 3, 4 to 6, 7 to 10 years) on a sample of 110 subjects. The results indicate that environment variables (1) were significantly related to measures of I.Q., (2) displayed high relationships within a given time period (3) and were extremely stable across the childhood years. These characteristics suggest that the relationships observed between I.Q. scores may be the result of a cumulative environmental effect.

Victora, et al (1986) studied the effects of socio-
economic and environmental indicators on nutritional state of a sample of 802 12 to 35 months old children in urban and rural area. Family income and father's intelligence level were risk factors which showed the strongest association with nutritional state. Mother's education, employment status of head of the family, and number of siblings showed some degree of association. Environmental variables particularly, the type of housing, degree of crowding and type of sewage disposal were also found to be associated with the child's nutritional state.

Many other empirical and theoretical studies conducted over the past 40 years have clearly indicated that a positive relationship exists between measures of children's home environment and their performance on I.Q. (Van Alstyne, 1929; Hunt, 1961; Kagan and Moss 1962; Wolf, 1964; Coleman, et al, 1966 and Marjoribanks, 1972; Echevarria, 1986).

These studies make it seem probable that there is an interaction between malnutrition and other environmental factors, specially social stimulation and that the child's ultimate intellectual status is the result of this interaction.

Besides social and home environment poverty plays a vital role for the incidence of malnutrition in children. In India two to three percent of the pre-school children belonging to poor communities suffer from severe forms of PEM, while 60 to 70% suffer from mild to moderate forms (Gopalan and Vijayaraghavan 1971). Deo and Paul (1975) report that under privileged communities, especially in the developing
countries are more prone to nutritional disorders or malnutrition and developmental retardation of mental abilities and physical manipulations are commonly observed among the children of these communities. Studies confirming the interaction between poverty and malnutrition are mentioned here.

Pollitt in 1972, as quoted by Hemlatha (1979) has shown a general relationship between low intellectual performance and low social class. Social factors that is the behavioural characteristics of low income families affect adversely the mental development of the child as to biological factors like closely spaced pregnancies and infections. Therefore, it is probable that the intellectual growth of malnourished children in poverty areas suffer from the effects of social and biological factors as well as from nutritional deficiency per se.

Stein et al (1972) studied the relationship between maternal starvation during pregnancy and the mental status of the offspring in adult life. The results of this study indicate that neither starvation during pregnancy nor the decline in mean birth weight had any effect on the adult mental performance of the surviving male offspring. In contrast, the association of social class with mental performance was strong. In poverty areas, there is mental retardation in combination with both severe malnutrition and serious deprivation of environmental stimulation. The latter itself could cause mental retardation per se (Barnes, 1969).
Peres Gil, et al (1987) studied the relation of socio-economic and environmental indices to the nutritional state of preschool children in rural community in Mexico and found positive correlation of the degree of malnutrition with housing condition, father's occupation and family income. Similar results are reported by Campino (1986) who found that income is the most important factor which determines nutritional state. When this variable is fixed other factors like health service, educational level, food and nutrition programme are shown to play an important role.

Pandey et al (1987) too found the size of family universally related to the intake of protein and energy, and also found poverty to be directly responsible for nutritional deficits. Srinivasan (1987) has considered poverty as the principle cause of undernutrition.

A report in WHO chronicle (1974) states that malnutrition in children living in developing countries is consistently associated with other environmental factors, particularly lack of sensory stimulation as a result of poor, socio-economic and cultural conditions and various kinds of infections - factors that may also interfere with the development of the brain. The interaction between these factors is very well explained in the following diagram:
Causative Factors of Malnutrition (W.H.O. 1974)

Poor Sanitary Conditions → High Disease Level

Low Unstable Income → Inadequate Nutrition

Over Crowding → Low Parental Attention and Decreased Social Stimulation

Large Families → Emotional problems of Mother (Arising from Family Instability)

Closely placed Pregnancies → Poor Physical Growth (Malnutrition)

Low level of Education → Overall Mental Development
Cravioto et al (1970) maintain that the environment in which children live at risk of malnutrition has negative effects on mental development of all children, malnourished or well fed living there, as measured with I.Q. tests and tests related to learning ability in reading and writing. He also proposed a "spiral" of malnutrition, learning deficits and poverty. A similar trend can be seen in the present investigation where mean I.Q. of the children belonging to low socio economic strata is 71.41, which is below average.

It has been known that due to intimate association between nutritional status and income levels children who are at the highest risk for malnutrition will be clustered in the poorest and socially deprived society (Cravioto et al 1966, 1967). Malnutrition generally occurs in a milieu where low socio economic status, limited education, poor sanitary conditions and recurrent infections are common (Winick, 1976).

The National Institute of Nutrition (India) has investigated this problem of malnutrition and mental development intensively during the last ten years. The intellectual performance of children who had been treated earlier for severe forms of malnutrition have been evaluated by employing specially developed battery of tests suitable for Indian children. Their performance was compared with that of a group of children who had not suffered from malnutrition. The normal children were matched for a number of variables like age, sex, socio-economic status, educational level of parents...
and schooling, all of which are known to influence mental performance. It was found that, the performance of children who had earlier suffered from malnutrition was clearly inferior to that of children who had not gone through an episode of severe malnutrition. This data, at first sight, appear to support strongly the view that childhood malnutrition leads to impaired mental functioning. But it must be remembered that there are other factors such as the less learning time because of severe illness, the traumatic experience of prolonged hospitalization and medical care, the level of parental intelligence and most importantly the mother child relationship, which are also involved in this interaction. Just as physical environment is necessary for satisfactory physical growth, psychological environment is necessary for satisfactory mental development. Malnutrition co-exists with poverty, illiteracy and both factors can independently influence mental function. Thus a number of factors operate in the proper intellectual and emotional development of children. While the importance of nutrition can not be minimized, it is necessary to realise that a number of non-nutritional factors, amongst which psychological environment is an important one, are additional contributory factors. Attempts at improving the mental development of children belonging to the poor socio-economic group should therefore take into consideration both nutritional and non-nutritional factors (Srikantia, 1975).
Besides environmental and socio-economic factors, factors arising within family also play a vital role in the development of a child. The requirement for normal psychosocial development in addition to an interact nervous system, includes in warm and accepting environment with stable parents or parent's substitutes, who are sensitive to the child's emotional needs and who provide appropriate conversational interchange and opportunities for play and consistent dispassion, supervision and support.

It has been shown that the social position of the family effects both the nutritional status of the child and the family characterizing, that are relevant to intellectual functioning. The quality of experiences a child goes through in his family may not be cognitively damaging but can damage his social and emotional development (WHO, Chronicle 1974).

Family break down has increased in urban areas in developing countries. Divorce rates are rising and thus more and more children belong to broken families which lead to emotional maladjustment. Employment in women has also increased, which has resulted in a larger proportion of children experiencing substitute during the day. This maternal deprivation leads to certain emotional changes which effect other mental abilities. Maternal deprivation also decreases breast feeding at a very early age which also is directly responsible for the onset of malnutrition.
Thus, numerous studies, conducted in different countries have demonstrated that malnutrition during the first two years of life, when coupled with all the other socio-economic deprivations that generally accompany, is associated with retarded brain growth and mental development which persist into adult life. What is not clear is the contribution of malnutrition relative to that of other social and cultural deprivations.