The effects of a cognitively-oriented intervention programme on the development of severely malnourished children

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ABSTRACT

18 severely malnourished Jamaican children (the Non-Intervention group), admitted to hospital between 6 and 24 months of age, were compared with a group of 21 well-nourished (Comparison) children of similar ages and social backgrounds, admitted during the same period. The malnourished children received the standard medical care and nutritional rehabilitation. Both groups were assessed at intervals on the Griffiths test and it was found that although they showed a similar pattern of change in developmental quotients (DQ) during the period of the study, the malnourished children obtained significantly lower scores than the well-nourished children at each test. The malnourished children developed at similar rates to the well-nourished children and therefore showed little sign of catching up in DQ.

In behaviour observation sessions on admission to hospital, the malnourished children were more likely to be apathetic than the well-nourished children and the well-nourished children were more likely to cry and show acute distress when they were unattended in their cots. When given a set of toys, the groups were significantly different in the quality of their play, with the well-nourished children using more of a wider range of actions on more of the toys. Most of these differences had disappeared by discharge.

A second group of 21 malnourished children (the Intervention group) participated in a structured programme of play activities in hospital, followed by weekly visits after discharge involving the mothers. 6 months after discharge, the Intervention group were significantly different from the Non-Intervention and the Comparison groups in general DQ on the Griffiths test. The Intervention children had caught up with the Comparison children on the Hearing and Speech and Hand-Eye Co-ordination subscales of the test, and were significantly ahead of the Non-Intervention children on the Performance subscale, but showed no significant advantage in Locomotor development. The interpretation and implications of these findings are discussed.

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ACKNOWLEDGEMENTS

The research reported in this thesis forms part of a longitudinal study of the development of severely malnourished Jamaican children at the University of the West Indies, Mona. I would like to express my thanks to the staff of the Tropical Metabolism Research Unit and the Paediatrics Department of the University Hospital. I would particularly like to thank Dr. Sally McGregor, the director of the study, who taught me so much about field research. The Staff Nurses, Mrs. Buchanan and Mrs. James, and the Community Health Aides, Miss Hamilton, Miss Halstead and Mrs. Burke, visited the children in their homes and maintained contact with the families in difficult circumstances. The "crash programme" workers made the toys from scrap material. During the course of the study we also had the support of the late Professor Jack Tizard, Professor John Waterlow, Dr. Kiernan, Mrs. Desai and Mr. Schofield. Ms. Christine Powell joined the research team during the last months of my stay at TMRU. I am very grateful to everyone connected with the Jamaican Malnutrition Study for their contribution to the research reported here.

At Bedford College, my supervisor, Dr. Kate Loewenthal, advised and helped me with patience and good humour, and I am very grateful. Mr. Ray Matthews provided needed advice in my negotiations with the computers. Dave Waddell at the computer unit also provided invaluable assistance.

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Chapter 1 INTRODUCTION

1.1 MALNUTRITION

Malnutrition, which has been described as "an impairment of health and physiological function resulting from failure of an individual to obtain all the essential nutrients in the proper amounts and balance" (Schaefer, 1969a), may take many forms. In the relatively affluent developed world, various degrees of overnutrition and the accompanying obesity are important health problems. A United Nations Food and Agriculture Organisation (FAO) report (FAO, 1975) calculated that in the early 1970s the average inhabitant of the developed world received 131% of his daily requirements of calories. However, in the developing countries of the Third World, undernutrition or inadequate nutrition are major problems. By the same FAO estimates, on average, a resident of the Third World obtained only 96% of his daily calorie requirements. Specific cases of regional famines are reported periodically with stark pictures of starving people, but as Harrison (1979) stated, "the everyday reality of malnutrition in the Third World is less dramatic". Malnutrition, in the form of undernutrition, is recognised to be the largest preventable health problem facing the world. The World Health Organisation (WHO) estimates that more than 100,000,000 children suffer from this type of malnutrition (Bengoa, 1974). FAO reported that in the 2 years to 1974, 55% of 128 Third World countries surveyed were getting less than their dietary needs (FAO , 1976).

In addition to the international inequalities of food distribution, food is usually unevenly distributed within countries, so that the adults and children in the most socially deprived groups in Third World countries suffer chronic malnutrition. Moreover, due in part to the vigorous marketing practices of the transnational baby food manufacturing companies (Chetley, 1979), breast feeding has declined in popularity (Grantham-McGregor and Back, 1970; Landman and Shaw-Lyon, 1976), being replaced with expensive powdered baby milks. This is a report on research with children from the most socioeconomically deprived families in one developing country, Jamaica.

Malnutrition in this report therefore refers to the failure of an individual to obtain essential nutrients in sufficient amounts. This type of malnutrition can take several forms ranging from diseases such as anaemia, which is due to the specific deficiency of iron, to the more generalised types of protein-energy malnutrition which are the subject of this investigation.

Protein-energy malnutrition (PEM) refers in fact to a group of pathological conditions usually occuring in infants and young children. The aetiology of PEM is complex. The changes in the names given to these syndromes over the years (previously 'protein malnutrition', 'protein-calorie malnutrition' and now occasionally 'energy-protein malnutrition') reflect changes in the emphasis placed on the relative importance of dietary energy (i.e. calories) and protein. In general, it is thought that the children's protein intake would probably be adequate if the total amount of calories in their diets was sufficient. If inadequate quantities

Table 1.1 Classification of protein-energy mulnutrition after Wellcome Classification. Lancet, 1970

% of expected weight for age	Oedema	Type
80 - 60	O	Moderate
	+	Kwashiorkor
60	O	Marasmus
	+	Marasmic-kwashiorkor

of food which is high in protein content are given to children, the protein will be used to provide energy rather than for its more usual role in the building of body tissue. These protein-energy deficits are usually also accompanied by deficiencies in many vitamins and trace elements which are important for the proper functioning of the body.

PEM in children is usually diagnosed on the basis of an individual's anthropometric measurements with reference to international standards for their age and sex. An early widely-used classification was proposed by Gomez et al (1956) and had three categories - first, second and third degree malnutrition - based on weight for age using the Boston standards (Stuart and Stevenson, 1959). A more sensitive classification system was developed by a Wellcome working party (Lancet, 1970) and this has superceded that of Gomez. Also using the Boston standards of weight for age, children are classified as adequately nourished or moderately or severely malnourished according to the degree of deficit shown and the presence or absence of nutritional oedema (Table 1.1). This classification system has been criticised particularly because it does not take height into account (Waterlow, 1974; McLaren and Read, 1975). A child with a deficit in weight for age may be below normal height though the correct weight for that height (stunted), or of normal height, but underweight for that height (wasted), but this classification does not discriminate between these types. Other systems have been proposed (McLaren and Read, 1975), but at present the Wellcome classification is in general use and this is the system that is employed in this study.

Table 1.2 Prevalence of protein-energy malnutrition in community studies (1963 - 1972)

From Bengoa, 1974

Region	No. of communities	No. of surveys	No. of children examined	Protein-calorie malnutrition (%)		
				Severe	Moderate	Severe & moderate
Latin America	20	29	116,179	0-12.0	3.5-32.0	4.6-36.0
Africa	16	32	34,184	0-9.8	5.6-66.0	7.3-73.0
Asia	10	16	43,326	0-20.0	13.0-73.8	14.8-80.3
Total	46	77	193,689	0-20.0	3.5-73.8	4.6-80.3

The prevalence of moderate and severe malnutrition is difficult to assess (Bengoa, 1975). Bengoa (1974) summarised the results of 77 community studies in 46 developing countries between 1963 and 1972. Table 1.2 shows the ranges and medians of percent prevalence of PEM in studies in Latin America, Africa and Asia. These studies have shown up to 20% of the children examined to be severely malnourished and up to 74% moderately so.

Three syndromes of severe protein-energy malnutrition have been identified. These are 'kwashiorkor', 'marasmus' and 'marasmic-kwashiorkor'. (Table 1.1).

Kwashiorkor

Plates 1.1 and 1.2

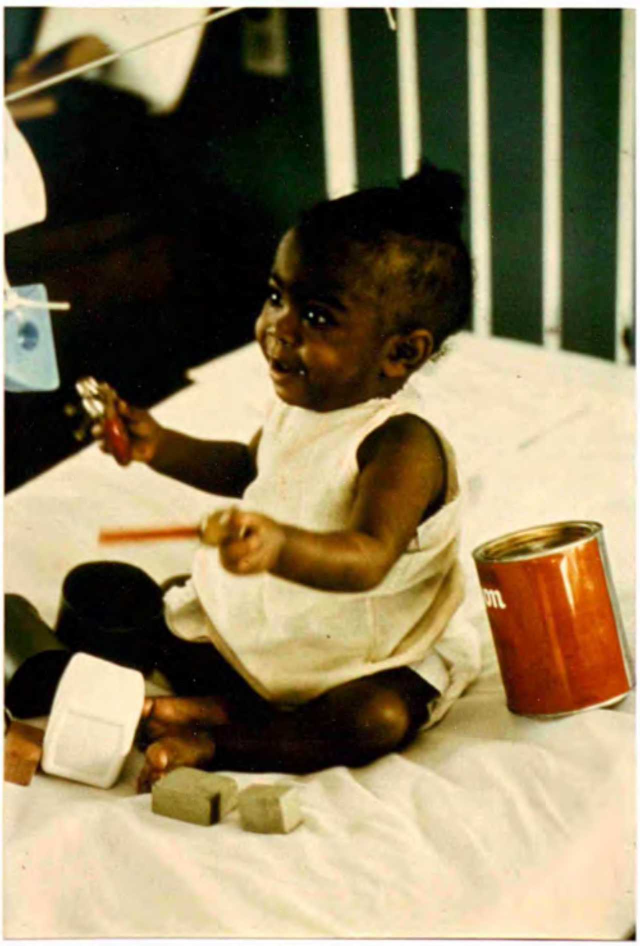
Kwashiorkor was described by Dr. Cecily Williams who worked in the Gold Coast in the 1930s (Williams, 1933, 1935). The presence of oedema (puffiness of the face, limbs and body, a manifestation of excess total body water involving extra-cellular fluid space) is *sine qua non* for the diagnosis of kwashiorkor (Alleyne *et al*, 1977). Alleyne *et al* describe some of the clinical features in the following extracts from their book on the diagnosis and treatment of PEM:

"Characteristically these children are apathetic, irritable, weak and inactive, and have oedema and a fatty liver. Weight deficit is almost always present. Though not universally found, changes in hair and skin, hepatomegaly and hypothermia (rectal temperature 35°C) are frequently seen.

"The severity of the pitting oedema varies widely from a mild degree of puffiness around the eyes and swelling

Plate 1.1 Child with kwashiorkor (aged 13 months) - on admission to hospital.

Plate 1.2 Same child - ready for discharge, 2 months later.



of the feet and hands, to generalised oedema.

"Some of the most striking clinical features of kwashiorkor are the skin and hair changes. They are not present in all cases and are reversible on recovery.

"The skin changes include hypopigmentation, either diffuse or patchy, with areas of hyperpigmentation. In 'flaky paint' dermatosis, more common on the extremeties than the trunk, these hyperpigmented patches desquamate to expose either raw area or thin, hypopigmented skin. In other cases the thin, shiny skin is tautly stretched on the oedematous limb or trunk.

"In Jamaica the deficit in height is less in kwashiorkor than in marasmus and marasmic-kwashiorkor, suggesting that the duration of illness was shorter in kwashiorkor than in the other two clinical types." (pp2-4)

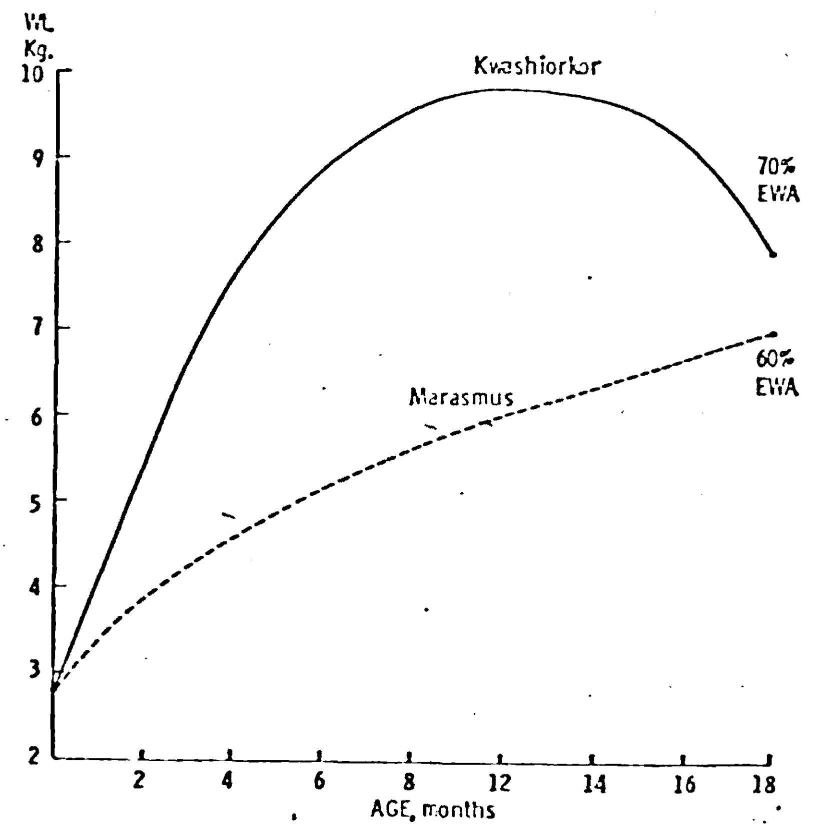
Different natural histories have been suggested for marasmus and kwashiorkor (Waterlow and Rutishauser, 1974). Figure 1.1 shows these hypothetical patterns of weight gain.

The role of diet in the development of the different conditions has also been the subject of controversy (James, 1977; Alleyne <u>et al</u>, 1977). It has been recognised for some time ("for thousands of years" state Alleyne <u>et al</u>, 1977) that marasus was due to an inadequate intake of energy. It has been recently proposed that kwashiorkor, for some time thought to be due to a different kind of diet, a high energy/ low protein diet, may in fact be the result of particular individuals' pattern of metabolic adaptation to deficient diets rather than to the diets themselves (Whitehead and Alleyne, 1972).

Figure 1.1 Hypothetical pattern of weight gain showing the natural histories of kwashiorkor and marasmus.

EWA = expected weight for age, Boston standards
100%EWA at 18 months of age is approx. 10.9 kg.

from Waterlow and Rutishauser, 1974



Marasmus

Plates 1.3 and 1.4

The clinical picture of marasmus has been described by James (1977) thus:

> "when compared with a normal child the marasmic infant has a marked deficit in both weight and height. Wasting of adipose tissue and muscle occurs to an extraordinary degree. Yet, despite these severe changes, hepatomegaly and oedema are absent, the skin usually appears normal and there are few hair changes." (p611)

The marasmic child is literally skin and bones because of the wasting of subcutaneous adipose tissue and muscle. Alleyne and colleagues state that

> "wasting is most striking around the neck and buttocks, and over the shoulders, the upper arms and legs and rib cage....Muscle atrophy gives rise to atony with intestinal distension, abdominal protrusion and rectal prolapse."
> (Alleyne et al, 1977, p25)

Marasmic-kwashiorkor

Children with this diagnosis show clinical features of both marasmus and kwashiorkor. Marasmic-kwashiorkor is regarded as an intermediate form of severe malnutrition, but as the degree of stunting of height is often significantly greater than in kwashiorkor, is thought to reflect a longer illness than is usually thought to be the case with kwashiorkor.

Infection often plays an important role in the development of PEM. The reciprocal relationship between poor nutrition and infection often contributes to the development

Two views of a child with marasmus

Plate 1.3

Plate 1.4

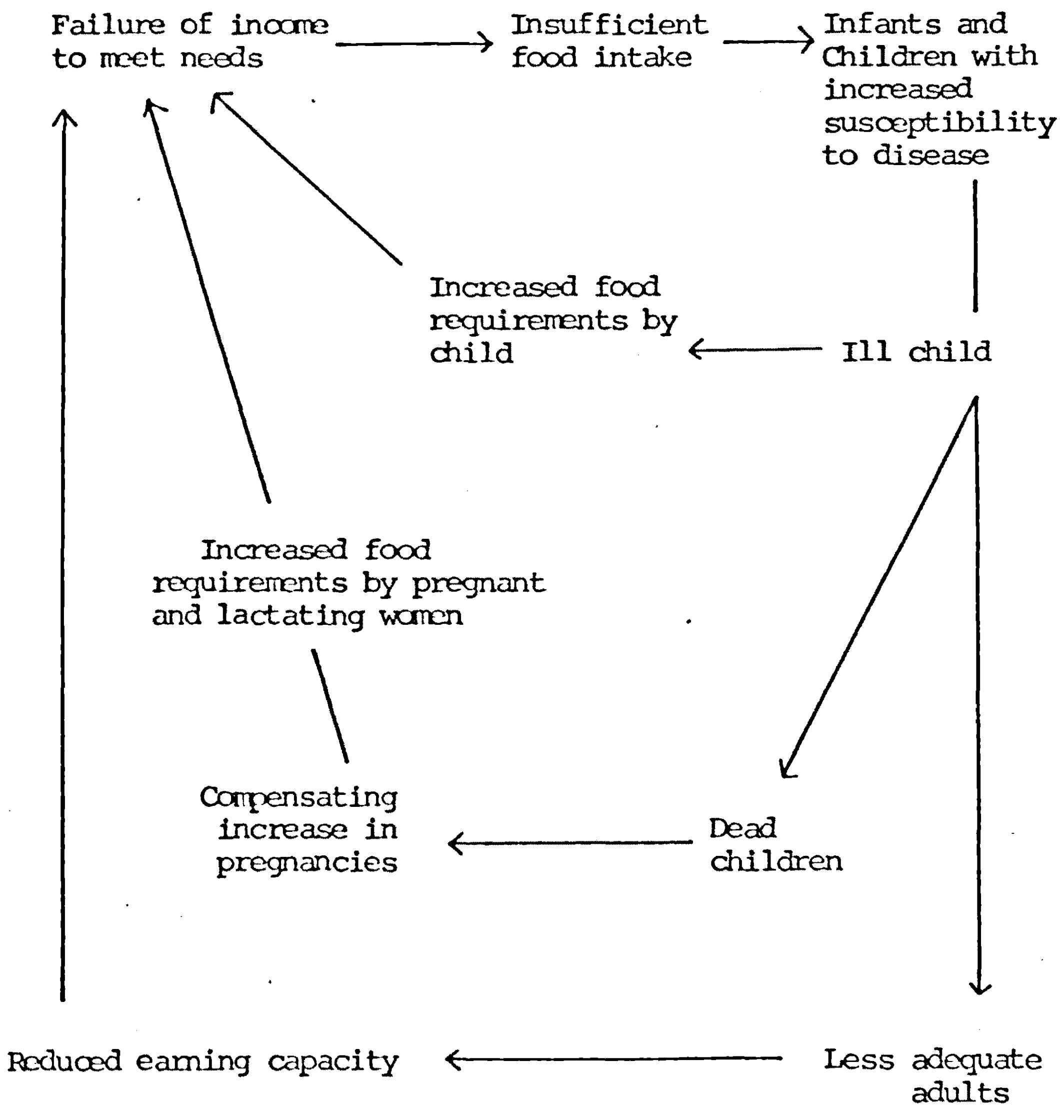
of severe malnutrition. The prevention of severe PEM depends to a great extent on the improvement of public health standards in developing countries (Suskind, 1975; Alleyne et al, 1977; Bengoa, 1974). Bronchitis, pneumonia and upper respiratory tract infections, impetigo, malaria, measles, ear and eye infections and above all gastroenteritis are often associated with poor growth and PEM.

PEM in young children is due to a variety of factors. Increasingly, clinicians discuss the "ecology of malnutrition" (Richardson, 1972). Hay (1979) has proposed a conceptual framework for the identification of children at risk which places the individual at the centre of concentric circles of influence representing (a) the household, (b) the community, (c) the economic and political environment and (d) the physical environment.

Poverty is certainly the basic reason for protein-energy malnutrition. In reality, PEM is neither a medical nor a psychological problem, it is a political problem. The British Government's Overseas Development Agency's Advisory Committee on Protein (1974) proposed one model of the interrelationships between factors in the development of PEM which stressed the role of poverty (Figure 1.2). Alleyne et al (1977) added other factors in their discussion of the ecology of PEM: Poor farmers, forced to sell their land, move from a rural to an urban existence. Food, which they can no longer grow themselves, is only available for cash which they do not have. Overcrowded living conditions cause the spread of infections, which interact with poor diets to accentuate the development of malnutrition. Disturbed

Figure 1.2 Interrelationships between factors leading to malnutrition suggested by O.D.A. Advisory Committee on Protein, 1974

from Alleyne, Hay, Picou, Stanfield and Whitehead, 1977



family life, wars and civil unrest as well as natural disasters such as floods, droughts and earthquakes all play their part.

These factors have a complex interrelationship and as Hernandez et al (1974) found in one Mexican community, the introduction of successful development programmes without accompanying specific nutrition education programmes, even over a 13 year period, may not improve the nutritional status of the children.

The long-term intergenerational relationships of poverty and nutrition have also been highlighted (Birch and Gussow, 1970; Birch, 1971, 1972). For example, a chain has been suggested leading from poor nutrition of a female child, through her inadequate pelvic development and consequent poor reproductive efficiency to her becoming the mother of a child whose development is at risk, continuing the chain into the second generation.

The fact that differences in nutritional status are often associated with differences in the social environments of the children has (often unintentionally) been demonstrated in studies of the development of malnourished children (Stoch and Smythe, 1963; Cravioto and DeLicardie, 1976, 1974a, 1975a; Muñoz et al, 1974).

Muñoz et al, (1974) set out to investigate what they termed "the epidemiology of good nutrition in a population with a high prevalence of malnutrition" in Mexico. In an attempt to detect those social environmental factors which were associated with different levels of nutrition, the families of 36 well-nourished children and 37 malnourished ones were selected from within a community of poor farmers. The socioeconomic differences between the two groups were minimal, but the authors state that

> "This is not meant to infer a denial of the role of poverty in the etiology of malnutrition, but rather that it is very possible that the mere fact of being a part of this social stratum creates a greater susceptibility to malnutrition and that there exist other factors that precipitate it to a greater or lesser degree." (p227)

Unexpectedly, neither size, integration, nor total income of the families distinguished the groups. Of the 15 aspects of child care examined, 3 were significantly different between the groups. These were the amount of contact mother and child had outside the home and town, the modernity of mothers' ideas regarding child health and the degree of restrictiveness in mother-child interaction. The families were not different on such aspects as their attitudes to their children and their possessions, their participation in teaching and stimulating the development of the children and in habits of cleanliness. Many indices of feeding habits were also similar, including breast feeding practices and beliefs. However, the causes and form of weaning, and the variety of subsequent foods were very different between the groups.

The difficulties in interpretation of data relating to nutritional and non-nutritional factors in child development are highlighted in this study. The authors concluded that it was difficult to make positive interpretations of the results because differences between the groups cannot be clearly identified as causes or consequences of malnutrition. Moreover, although they were sometimes able to detect differences in modernity of concepts and ideas (e.g. towards health and feeding of children), they were not necessarily able to measure concomitant differences in habits and practices. In this community of Solis, malnutrition was found to be predominant in females, while good nutrition was predominant in males. Was this due to the status traditionally given to the sexes or was it due to the selective survival of females due to their greater physical resilence? And furthermore, how far can these findings be generalised? Other studies (e.g. Christiansen et al, 1975) produce different associations.

Muñoz's, study, which proved unsuccessful in the attempt to clarify the issue of the causes of the better nutritional status of some children despite the general context of poverty and ignorance in the community highlights many of the problems which arise in this area. These will be discussed in Chapter 2.2 with reference to studies of malnutrition and psychological development.

The complexity of the relationship between nutritional and environmental or developmental factors in communities where poor nutrition is endemic is further demonstrated by the observation by Rutishauser and Whitehead (1972) in Uganda that African children during the second and third years of life could have energy intakes 30% below recommended levels and still gain weight at rates similar to those of healthy English children. It was found that, in general, the Ugandan children between the ages of 18 months and 3 years spent less time in high energy consuming activities such as running than European children of the same age living in the same tropical environment.

Differences in energy consumption were apparently due to differences in the type of food eaten by the two groups. On the African children's high carbohydrate diets, one would have to eat twice the weight of food eaten by the European child on a diet which was lower in carbohydrates and contained more milk to achieve the same energy intakes. It was calculated that the differences in activity could account for a difference in energy expenditure in the order of 84kJ (20cal)/kg body weight per day.

The relationship between nutrition and child development cannot therefore be fully understood without reference to the behaviour of the children.

1.2 TREATMENT OF PROTEIN-ENERGY MALNUTRITION

Moderate malnutrition *per se* does not require hospital treatment. In most countries, when a child is identified as underweight, advice on improved nutrition (and possibly food supplements) would be provided for the family according to the community's resources, but unless some other medical problem coexisted with subclinical malnutrition, hospitalisation would not be required.

In contrast, severe malnutrition does require hospital treatment. In some centres, many children die within the first few days of admission to hospital, but this mortality is often due to the associated complications of electrolyte and fluid imbalance, infection, parasitic infestation and anaemia rather than to malnutrition *per se*. Children are most at risk in the early stages of treatment. Mortality can vary from 5 to 50% between centres although the severity of the malnutrition may be comparable (Ashworth, 1979). Many centres have reported marked improvement in the success of treatment for severe malnutrition in recent years. This has been the case with the Tropical Metabolism Research Unit and the Department of Child Health at the University of the West Indies Mona campus in Jamaica.

The treatment has been summarised by Alleyne *et al* (1977) as "the use of therapeutic diets high in energy and protein, the careful attention to the correction of fluid and electrolyte imbalance, and the control of infections".

The therapeutic diets, which may have to be administered by nasogastric tube are introduced as soon as the intital acute problems have been treated. At the University of the West Indies, the high energy milk diet for 'catch-up' growth is made from a full cream powdered milk fortified with arachis oil (Table 1.3.) This energy dense food is fed ad libitum, 4-hourly night and day, so that energy intakes of 840kJ/kg per day are achieved, producing growth rates 20 times faster than normal. Rapid catch up-growth in hospital is desirable for medical reasons (reduced risk of cross-infection) and economic reasons (shorter, cheaper hospital stay for each child) as well as for psychological considerations (reducing the duration of separation from the family for children at a particularly vulnerable age). Ashworth (1979) reports that periods up to 6 weeks may be adequate, but some centres report hospital stays of up to 1 year.

Reaching the ideal weight for height has been recommended as the criterion for recovery and discharge from hospital (Ashworth, 1979), though individual centres adopt criteria applicable to their particular circumstances. Invariably, when a child reaches his expected weight for his height, children fed ad libitum spontaneously cut their food intake resulting in a drop in growth rate. Once the deficit in weight for height has been corrected, children frequently show a spurt in height growth (Ashworth, 1975, 1974).

Table 1.3 Formula for therapeutic diet used in the treatment of protein-energy malnutrition in Jamaica.

from Picou et al (1975).

Full cream milk powder + added carbohydrate (eg. 'Pelargon')	190g
Arachis oil	55g

This mixture is made up to 1 litre.

It contains 564 kJ (135 kcal) and 3.14g protein in each 100ml of fluid.

It is fed to provide approx. 920kJ (220 kcal)/kg per day in feeds spread throughout the day.

1.3 MALNUTRITION AND PSYCHOLOGICAL DEVELOPMENT

With the improvement in the physical treatment and rehabilitation of even quite severely malnourished children, there has been an extension of interest from the saving of lives to the assessment of the quality of the lives of the survivors. Few put it as bluntly as Manocha(1972) who wrote:

> A significant number of children who are severely malnourished in their early infancy die due to a variety of reasons, which may include simple exhaustion or inability to combat a minor infection. The dead may be more fortunate in a certain sense compared to the survivors, who experience physical and mental retardation and loss of learning ability during the most critical years of mental development." (p.93)

Champakam et al (1968) summarised the situation thus:

> "Until recently in the fight against malnutrition, survival was the main concern. Awareness and knowledge of the biochemical pathology of malnutrition and the availability of more efficient means for prompt diagnosis and treatment have reduced the immediate mortality among malnourished children. In direct proportion to our success in this regard is the grim possibility of an increasing pool of survivors who may be handicapped in a variety of ways and for variable periods of time". (p. 844)

In 1970, Frisch quoted Birch's hope that

> "..we shall have a body of detailed information which will convert our surmises about the relation of

malnutrition to mental development into strongly based facts" (Birch, 1968), and made the plea that "Until that time, surmises should not be treated as facts and millions of malnourished children should not be condemned as permanently retarded mentally". (p 194)

Since the 1950s, interest in the development of individuals who were malnourished in infancy has grown, incorporating studies of animals and humans. The close interrelation of poverty and malnutrition, and the association between poverty and poor psychological functioning (Birch and Gussow, 1970; Wedge and Prosser, 1973; Rutter and Madge, 1976) makes the investigation of the development of malnourished children particularly difficult.

With respect to the issue of the subsequent development of children malnourished in infancy, several alternative models may be proposed (figs.1.3a,b,c,d). At its simplest, the nutritional status and the psychological development of an individual may be directly and independently influenced by the circumstances of social deprivation and poverty (Fig. 1.3a). A more likely model is proposed in Fig. 1.3d. With such a complex interaction between the elements, and the impossibility of researchers setting up true experiments in which one or more of the elements can be manipulated, these models may never be completely tested.

Studies have been carried out in communities where malnutrition is endemic which have investigated the development of children who have been malnourished in infancy. The many ethical restrictions and methodological problems inherent in these attempts to identify the effects

Figure 1.3 Possible relationships between poverty, nutritional status and psychological development.

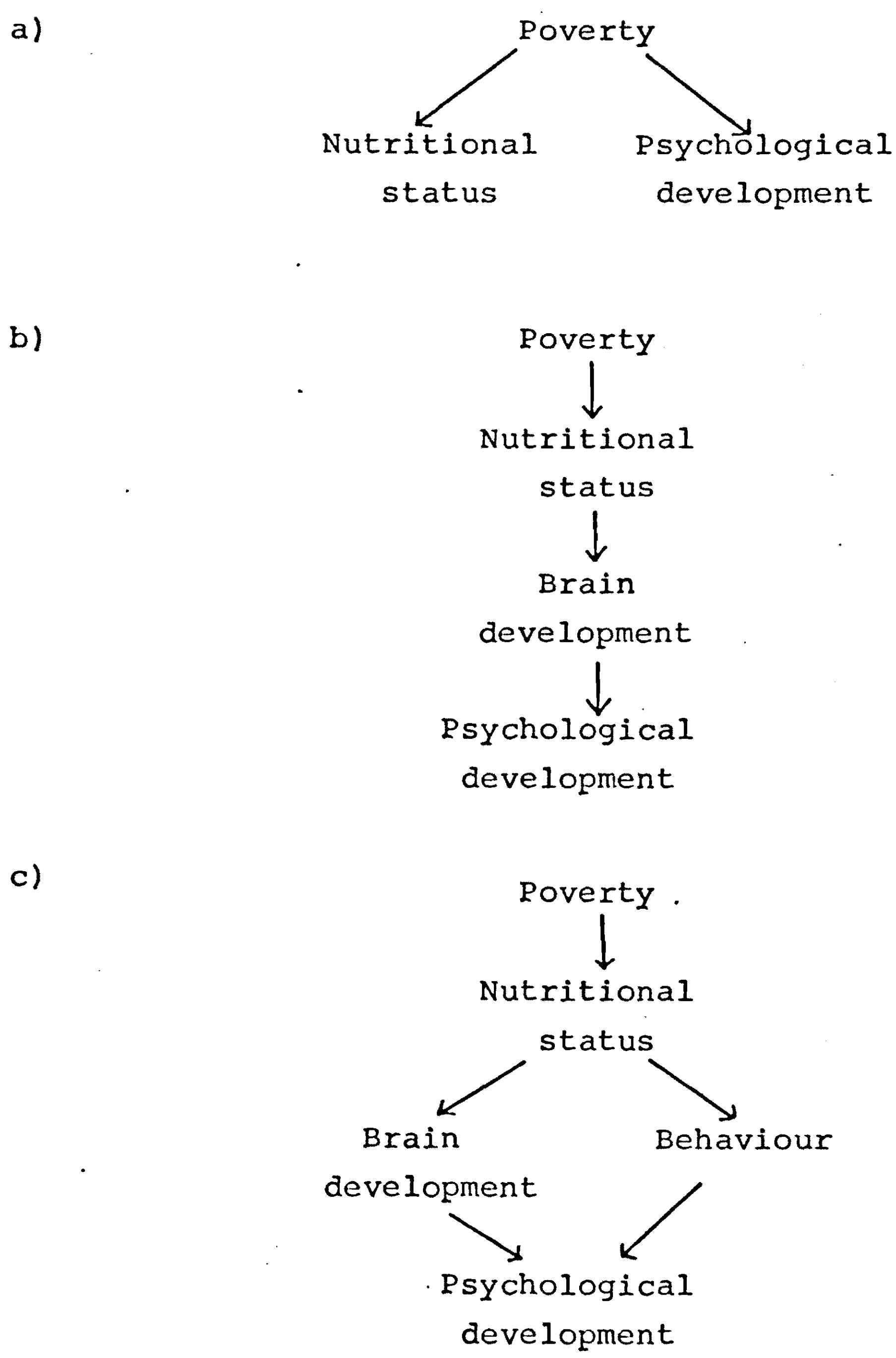
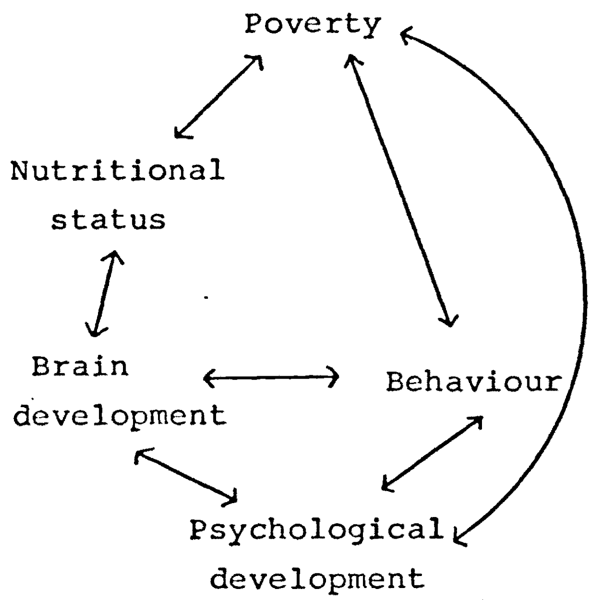


Figure 1.3d


Poverty
Nutritional
status
Brain
development
Behaviour
Psychological
development

of malnutrition in human populations have led to the attempts to develop animal models.

A generally held view of animal studies in the field of malnutrition is clearly articulated by Winick and Coombs (1972):

> "Animal models provide several advantages when compared to human field studies. The diets can be closely controlled and frequently analyzed to ensure uniform composition. Furthermore, the extreme and extended effects of severe malnutrition can be studied, the study of these being excluded from human studies for obvious ethical reasons. The laboratory also provides a setting in which environmental and social conditions can be made uniform and constant during both the period of malnutrition and subsequent recovery."

This optimisim has not proved wholly justified.

Levine and Wiener (1976) comment on "the sweeping generalisations about the effects of early malnutrition that have been made from animal models". In general, it has been easier to develop experimental models to investigate the effects on CNS development and physiology than in other areas, although even these have not been without their problems. In human populations, interest has been in whether early malnutrition affects the development of cognitive processes and there are obvious limitations to the usefulness of models employing the laboratory rat or even sub-human primates.

In Chapter 2, research on malnutrition and development is reviewed. The findings of studies of human populations and those using animal models which are relevant to the present study will be discussed. Data collection for the present study began in June, 1975. Many of the reports that are included in this review were published after that date and these data therefore, though not available at the time of the initial design of the Jamaican study, contribute to the interpretation of the results.

CHAPTER 2. LITERATURE REVIEW

2.1 MALNUTRITION AND THE DEVELOPMENT OF THE CENTRAL NERVOUS SYSTEM

The development of the central nervous system (CNS) involves a precise sequence of morphological, biochemical and functional events with each stage depending on the orderly progression of the previous developmental stages (Winick, 1973). Different regions of the system show sequential periods of cell proliferation (hyperplasia), migration and enlargement (hypertrophy) during the pre- and post-natal period, often showing patterns of chemical and morphological change which are as yet not fully understood. With a constant rate of protein synthesis, but changing rates of cell division, cellular growth can take the form of either periods of hyperplasia or of hypertrophy or both occurring simultaneously. Nutritional deprivation in any one of these periods can therefore be expected to have different effects (Dobbing, 1973).

The brain goes through the most rapid development in the period termed the 'brain growth spurt' when total brain weight change is maximal. However, different areas of the brain show their most rapid growth at different times, developing at different rates for different periods of time. In the development of systems, periods of rapid development are considered 'critical periods' or 'vulnerable periods' when noxious insult is likely to have maximum impact. In the brain therefore, different stages of the development process may be considered 'critical periods' for specific areas and functions (Dobbing and Sands, 1973).

The experimental work on nutrition and CNS development has, of necessity, employed animal models. A further complication is that interspecies comparisons can only be made with difficulty (Lloyd-Still, 1976a). Individual animal species and humans follow individual patterns of development. For example, the 'brain growth spurt' occurs in different animals at different times relative to birth - as shown in Fig. 2.1 (Davison and Dobbing, 1968; Dobbing, 1973). The human growth spurt is perinatal (mid-pregnancy to approximately 2 years after birth), while in the rat it is largely postnatal, with the effect that as far as relative level of CNS development is concerned, a newborn rat is the equivalent of an 18 week human foetus.

The measures of brain development used in studies of the effects of nutrition initially measured total brain size and weight (e.g. Brown, 1965). Extensions of this work involved the quantification of certain biochemical constituents of the CNS. Morphological changes have therefore been inferred from alterations in biochemical indices (Holt et al, 1975). One such index is the measurement of cholesterol as an index of the development of myelin. This has been somewhat controversial because cholesterol, though a major constituent of myelin, is not exclusive to it (Chase, 1976). Total DNA has been used to estimate total cell number. This also is not without its problems because it is based on the assumption that the amount of nucleic acid is constant in a stable nucleus. There are some CNS cells which are polyploid (Lentz and Lapham, 1969, 1970), but as these are few in number the errors in estimates

Figure 2.1 Rate curves of brain growth in relation to birth in different species.

Values are calculated at different time intervals for each species.

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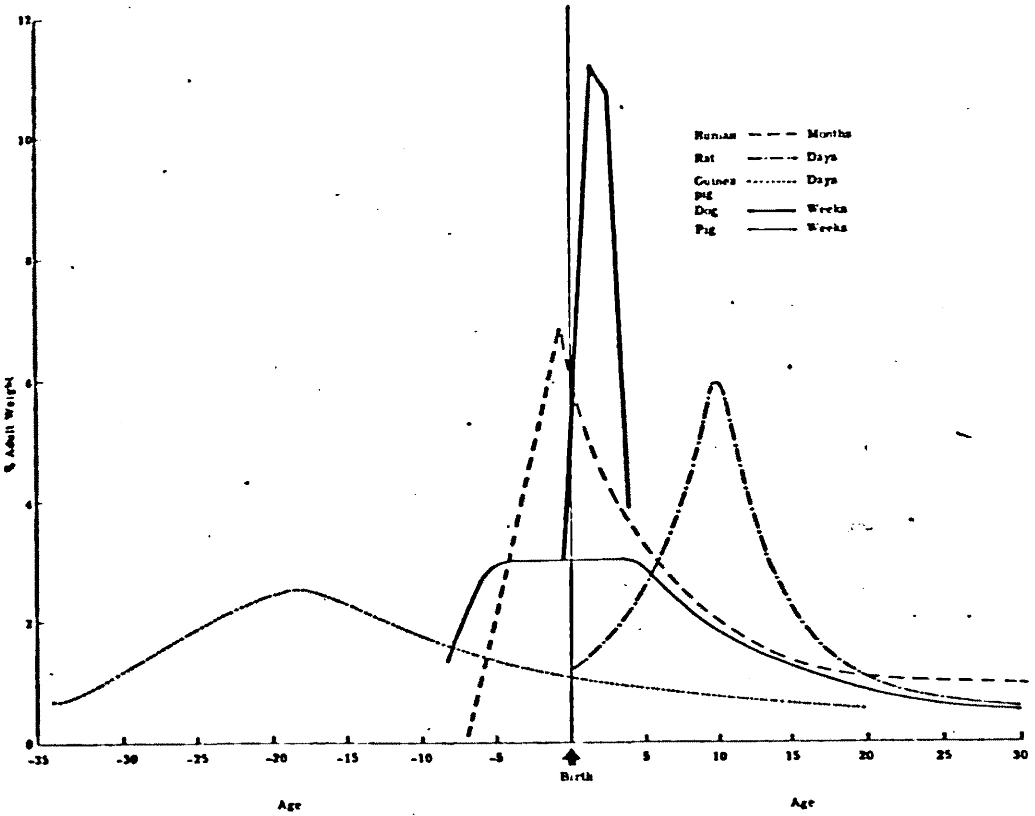
from Davison and Dobbing, 1968



are considered minimal. The ratio of RNA to DNA is regarded as an estimate of cell size.

In the human brain, neurones are formed primarily <u>in utero</u>, with proliferation of glial cells in the first postnatal year and the most rapid accumulation of myelin in the second posnatal year. The rate of DNA accumulation shows two maxima in humans, one prenatal (coinciding with neuronal proliferation) and one postnatal (glial proliferation). See Fig. 2.2. The rat follows a similar sequence of acquisition of neurons and glial cells though, as mentioned earlier, at different relative rates (Fig. 2.3).

In the human brain, approximately 25% of the mature adult number of cells are present at birth. By 6 months, the proportion has increased to 66% with 90% present by the end of the first year. Differential regional development is demonstrated by the fact that 54% of the cortex and brain stem cells are present at birth in comparison with 29% of the cerebellum. This latter area,however, has a shorter, more rapid period of cell multiplication in the first 4 postnatal months.

The difficulties of inter-species comparisions is further demonstrated by the differences in regional distribution of cells in the mature brains of rats and humans. In man, by far the largest proportion of cells is in the cerebrum (68%). In the rat, the cerebrum has 43% of the cells with marginally more (46%) in the cerebellum. In man, the cerebellum accounts for 30% of the total number of cells. The brain stem has the remaining 2% in man and 11% of cells in the rat.

Figure 2.2 Rate curves for increases in brain weight, DNA and cholesterol in humans.

from Dobbing and Sands, 1970

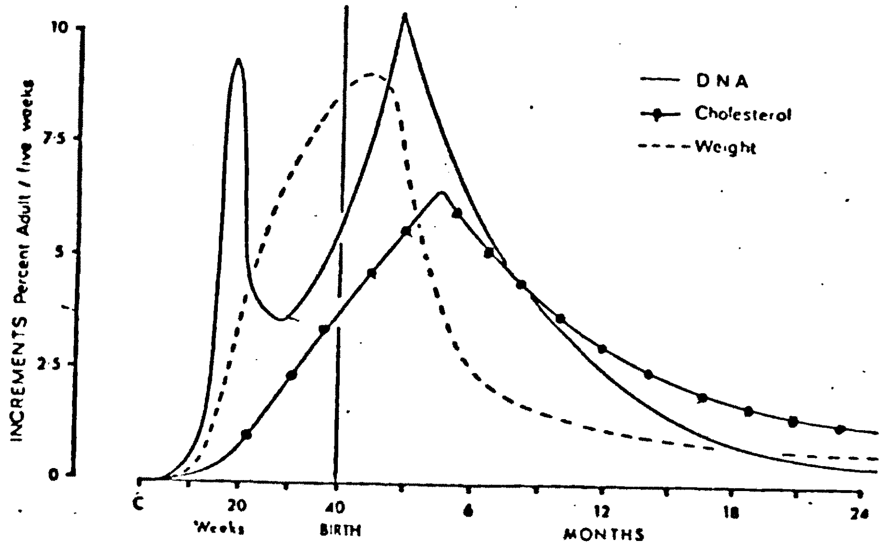
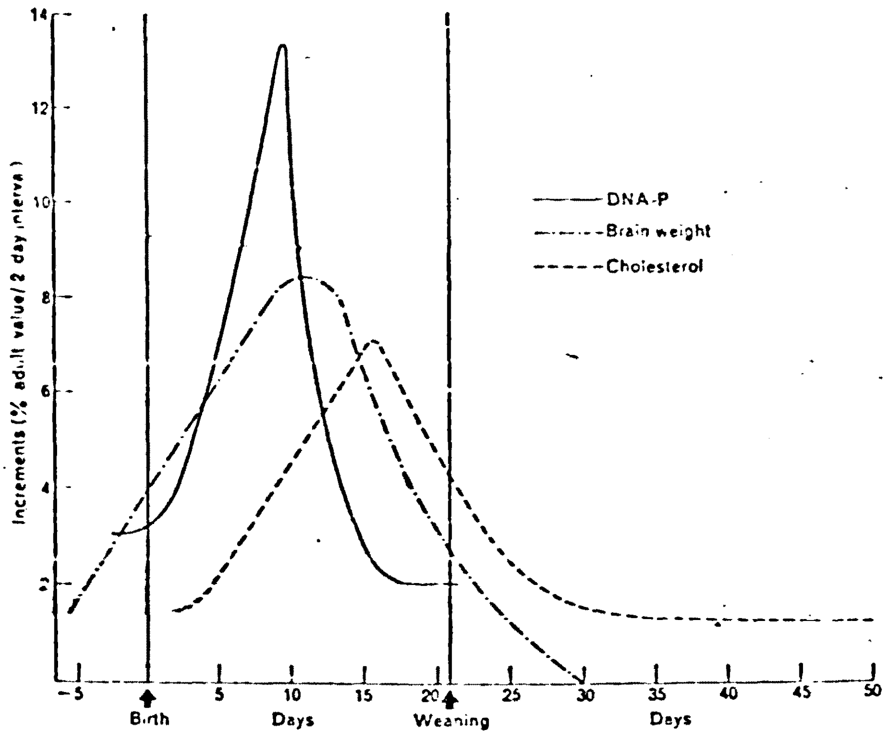


Figure 2.3 Rate curve for increase in brain weight, DNA and cholesterol in the rat

from Davison and Dobbing, 1968



A large proportion of total brain weight in humans (more than 25%) is accounted for by the myelin sheaths on the axons of nerve cells. Myelin insulates the fibres, influencing the speed of transmission of nerve impulses; its deposition being responsible for the 'white matter' of the brain. More than 50% of the total amount of myelin is deposited between 12 and 24 months of age, but different regions myelinate at different rates. So that nutritional insult in the period between 2 and 4 months of age, for example, can be expected to affect the myelin of the sensory root and corticospinal tract of the cerebral hemisphere, but to have little effect on the motor roots where myelination would be almost complete and the frontal areas where it would have barely begun (Dodge et al, 1975).

2.1.1. MALNUTRITION AND CNS DEVELOPMENT IN ANIMALS

There is evidence of a certain amount of 'sparing' of the brain of mature animals even when there is a considerable reduction of body size due to malnutrition (Platt and Stewart, 1971). Post-weaning malnutrition produces reversible changes in cell size (Winick and Noble, 1966, 1967). However, perinatal malnutrition has been shown to produce permanent changes in gross measures of brain development. For example, Zamenhof et al (1968) produced reduction in both cell size and number in the offspring by malnourishing pregnant rats through protein reduction. Moreover, a combination of pre- and post-natal malnutrition produces a much greater deficit in brain cell number than would be expected from the summation of the effects of solely prenatal and postnatal malnutrition (Winick, 1973, 1975) suggesting the importance of both the timing and the duration of malnutrition. There is also evidence of intergenerational effects in that prenatally malnourished rats, normally fed from birth or weaning and mated to normal animals, produce offspring with reduced cell number (Zamenhof et al, 1971).

In rats, malnutrition begun from birth produces measurable deficits in cell number in the cerebellum by 8 days of age, while the cerebral cortex is not affected until 14 days (Winick, 1973). The sensitivity of the rat's cerebellum to postnatal malnutrition has also been confirmed by other studies (Chase et al, 1969; Neville and Chase, 1971; Sobotka et al, 1974). Similar regional differential sensitivity has also been demonstrated in utero.

Perinatal malnutrition has been shown to affect brain growth in mice (Howard and Granoff, 1968), pigs (Dickerson et al, 1966) and monkeys (Kerr et al, 1973) as well as rats.

Early postnatal malnutrition also appears to reduce dendritic growth (Bass, 1971; Salas et al, 1974). Salas, Diaz and Nieto (1974) report reduced total number of dendritic spines, with thinner dendrites and reduced network density. However, as Shoemaker and Bloom (1977) point out, dendritic morphology can be affected by non-nutritional environmental characteristics such as complexity (Greenough and Volkman, 1973; Greenough et al, 1973), so these findings must be interpreted with care. There have been other comparable findings in experiments with non-nutritional influences on brain morphology. Gross changes in brain weight have also been produced by rearing rats in 'stimulating' environments (Rosenzweig and Bennett, 1978).

Dobbing and Widdowson (1965) found distortions in lipid synthesis in rats malnourished early in the suckling period. Reduced cholesterol concentrations persist after long periods of rehabilitation. Demonstrations of the effects of early malnutrition on the deposition of lipids has similarly been reported in the pig (Dickerson et al, 1971) and the rhesus monkey (Kerr and Helmuth, 1973). The permanent deficits in brain myelin content have been attributed to the permanent reduction in the population of myelinating glial cells (Nowak and Munro, 1977). In addition, in some studies, the composition of the myelin isolated from malnourished animals indicate retarded development (Krigman and Hogan, 1976).

The data on the effects of malnutrition on brain enzymes are difficult to interpret because of the variety of ways in which they are reported (Shoemaker and Bloom, 1977). There are, in fact, many apparent contradictions in the reports which need further clarification (e.g. in the effects of intrauterine malnutrition on levels of noradrenaline dopamine and seratonin: Shoemaker and Wurtman, 1973; Ramanamurthy, 1977). Moreover, brain enzymes have also been shown to be affected by stimulation, and handling and nutrition have been shown to interact in their effects on cholinergic enzyme activity (Eckert _et al_, 1975).

In summary, there is considerable evidence that malnutrition prenatally and in the period of rapid CNS development early in postnatal life can produce distortion and deficit in brain anatomy and biochemistry. Certainly, reduced brain size (reduced cell number and/or cell size) as well as distortion in myelination have been demonstrated in malnourished animals of many species. However, the mechanisms for many of the changes and their functional significance are still far from being understood. In fact, Dobbing and Smart (1974), who have themselves carried out important work in this area, question the importance of relatively minor reductions in brain size in the context of the known functional reserve and plasticity of function.

2.1.2. MALNUTRITION AND CNS DEVELOPMENT IN HUMANS

There have, understandably, been few studies of the effects of malnutrition on the structure and function of the human brain. The studies which have been carried out are frequently difficult to interpret, not only because they typically involve very small numbers of children (frequently less than 10), occasionally from more than one country, but also because the methods of data presentation vary greatly (Chase, 1976) and frequently local reference values for the populations sampled are not available.

The growth and composition of the brains of children who died of malnutrition have been investigated in a few studies. In interpreting the data from such studies, however, one must be mindful of the possibility that the fact that these children did not survive their illness implies that they were in significant ways different from children who do survive.

Brown (1965, 1966) reported that the brains of Baganda children dying of moderate and severe malnutrition weighed less than the brains of adequately nourished children of the same age. In this study the deficits could not be fully evaluated. The only available norms were European or North American and even the well nourished African children appeared to be different from these standards.

Winick and Rosso (1969a) examined the brains of 9 marasmic children who died before the age of 12 months. The 10 comparison children had been well nourished and had died as a result of acute conditions such as accidents. The brains of the children who had been severely malnourished were relatively low in DNA, RNA and protein. The 3 most severely affected (DNA reduction of more than 50%) had had small birth weights and had possibly been premature or prenatally malnourished, a factor often ignored in these studies. It was not stated which areas of the brain were most affected. In addition, Lloyd-Still (1976b) points out that when DNA content (i.e. cell number) is related to weight rather than the age of the child, the DNA reduction is proportional to the weight reduction. Chase (1976) argues that as the reduction of DNA in the 3 most severely affected children is "considerably greater than occurs in the laboratory animal under-nourished to the greatest extreme possible" other environmental insults might have been present. Chilean and Jamaican children who had severe malnutrition before 24 months were found post mortem to have reduced DNA in equal proportions in the cerebrum, cerebellum and brain stem (Winick et al, 1970).

In another study, the birth weights of 4 of the 6 study children were known to be normal (Chase et al, 1974). All the children had been breastfed for a limited period after birth. The children died of severe malnutrition (marasmic-kwashiorkor) when aged between 12 and 24 months. Cerebellum DNA was unaltered, while cerebrum-brain stem DNA was reduced by 10%, but statistically significant differences were not found when compared to specimens from non-malnourished children.

Head circumference has been used as a gross measure of brain volume in living children. However, the value of this measure is a controversial issue. Some, like Winick (1973), argue for its usefulness while others, like Lloyd-Still

(1976b), argue for caution in the use of the head circumference in the study of the effects of malnutrition. There is evidence obtained from echo ventriculography of significant increases in the size of cerebral ventricles in children in hospital with kwashiorkor (Vahlquist et al, 1971; Engsner, 1974) as well as the suggestion of brain atrophy in the results of transillumination from a Chilean study (Monckeberg, 1969). In healthy individuals, head circumference and brain size closely correlate, but in PEM such factors as thinning of the scalp and skull bone may affect results. However, extremely depressed measurements, such as -2SD obtained in some marasmic children, are thought to truly reflect retarded brain growth (Engsner and Vahlquist, 1975; O'Connell et al, 1965).

Latham (1974) discusses the question of the significance of reduced brain size. Like Dobbing and Smart (1974) mentioned earlier, he asked "'so what' if brain size is smaller than average?" He quoted Dr. Louis Leakey, who pointed out that the Eskimos have much larger skulls than the Japanese though the Eskimos were not necessarily more intelligent, and added "it is well known that the head circumference and therefore the brain size of adult women is smaller than of adult men. In these days it would be a rash man who cited this as evidence of male intellectual superiority!" Chase (1976) also questions the possible importance to intelligence of the loss of glial cells in the cerebellum. Dobbing (1979) restates his view that total cell number "is without any functional meaning, at least within the range of variation we are concerned with here".

vonMuralt (1975) suggested that although the normal healthy young brain exhibits a marked degree of 'plasticity' in response to focal lesions, "malnutrition produces a generalised lesion, and seems doubtful that such brains still retain their 'plasticity'".

Chase (1976) argues that the nutritional effects on myelin would be particularly important for humans:

> "Because myelin develops almost entirely in the postnatal period, and it is one of the few brain parameters for which alterations is known to be associated with loss of neurological integrity...it is particularly important in postnatal malnutrition" (p.24).

Myelination appears to be more affected in children malnouri-hed in the second year of life than in younger children (Rosso et al, 1970 ; Chase et al, 1974) which corresponds with the period of most rapid myelin deposition.

Motor nerve conduction velocity reduction, one possible consequence of deficits in myelination, has been reported for children with kwashiorkor though not with marasmic children (Engsner and Vahlquist, 1975). Taori and Perreira (1974) found non-significant differences favouring the well-nourished children in an Indian study.

Abnormal brain function following severe malnutrition has been reported from studies of auditory evoked potentials by Barnet and her colleagues working in Mexico (Barnet et al, 1978). Compared with those of other children of the same ages, the evoked potentials of marasmic children were deviant when the children were admitted to hospital. Although there was some improvement as the children's nutritional rehabilitation progressed, abnormalities remained at post-discharge follow-up sessions. However, once again, these data are difficult to interpret as, for example, attentional differences are thought to be related to evoked potential differences (Dodge et al, 1975).

Abnormal electroencephalograms (EEGs) have been reported for malnourished children for some years (Nelson, 1959; Karyadi, 1975; Coursin, 1975). Nelson (1959) found that 36% of the EEGs from children with kwashiorkor were abnormal, though local reference norms were not available. Similarly, Karyadi (1975) reports that in one study in Indonesia, 64.5% and in another, 30% of formerly malnourished children had abnormal results, with the usual qualifications about local standards.

Electrophysical studies of malnourished children are at a relatively early stage, but there is, in general, evidence of prolongation in conduction times, increased latencies and abnormal response patterms (Coursin, 1975). Children with kwashiorkor show deficits more often than children with marasmus, but this may only be a reflection of the ages of the children - kwashiorkor children often being slightly older than the marasmic children in these studies (e.g. Montelli et al, 1974).

In general, from the few studies that have been carried out with human subjects to investigate the effects of malnutrition on CNS anatomy and function, there is some evidence of distortion and deficit. Unfortunately, these data are often difficult to evaluate. Moreover, the 'state of the art' of human neuropsychology does not allow precise [illegible] of the functional significance of some of these anatomical and biochemical distortions. However, the investigations of behavioural development have to be viewed against the background of these suggestions of abnormal structure and functioning of the CNS.

2.2 MALNUTRITION AND BEHAVIOUR IN ANIMALS

The evidence of distortion and deficit in brain tissue led to the emergence on the 1960s of what Levitsky (1979 describes as a "mechanistic" conception of the relationship between early malnutrition and subsequent behaviour. It was thought that reduced cell number and size - "damage to the neural hardware" (Levitsky, 1979a) – was producing mental retardation.

Increasingly however, this view has been challenged in studies of humans and animals. In the area of animal research, the validity of conclusions about impaired learning ability were questioned (Levitsky and Barnes, 1972; Winick and Coombs, 1972) and in addition, the importance of direct effects of non-nutritional factors and indirect effects of nutritional ones were stressed.

In order to evaluate the relationship between early malnutrition and subsequent behaviour it is necessary to examine two major aspects of the animal studies. The early non-nutritional experiences of the malnourished animals must be examined. The methods used to produce the malnutrition may themselves produce behavioural sequelae. Moreover, the tests and the test situations may also influence the results obtained.

2.2.1 Rodents

There have been a large number of studies of the behaviour of rodents during and after periods of malnutrition. These have involved animals being fed meals deficient in quality and/or quantity and the periods of deprivation have extended for varying lengths of time through pregnancy, the suckling period and after weaning. A few studies have included amimals malnourished over several generations.

Many different procedures have been adopted to produce malnutrition in rodents, but the method used to produce malnutrition in the young animal may itself have non-nutritional components which are of some importance in the pup's development. An important aspect of the neonatal environment is the behaviour of the dam towards the developing animal. There is evidence of altered maternal behaviour in many studies of malnourished rats. One method of producing early post-natal malnutrition involves the periodic separation of mothers and pups (e.g. Eayrs and Horn, 1955). It is clear that such dramatic deprivation of maternal care, which not only removes the source of nutrition, but also the source of social as well as thermal and sensory stimulation, is likely to have a major effect on the development of the young (Plaut, 1970). Mindful of this, Slob et al, (1973) introduced virgin females providing maternal care with the exception of lactation for the neonatally under-nourished rats - so called "aunts". The fact that these malnourished animals subsequently failed to show deficits in open field behaviour, a test of motor co-ordination and two learning tasks when compared with well nourished controls suggests that maternal behaviour is an important factor in the functional development of malnourished animals.

Restricting the amount of (good quality) food to the dam also produces altered maternal behaviour. The daily pattern of nest occupation and desertion as well as the efficiency of retrieval and the amount of licking of the young have been shown to the altered in underfed dams (Smart and Preece, 1973), regardless of the nutritional status of the pups (Smart, 1976). Simonson et al, (1969) report that underfed dams were "preoccupied by the search for food" and "highly irritable". Restricting the quality of the food to the dam (but not the quantity) produces a similarly altered pattern of maternal behaviour (Massaro et al, 1974; Levine and Wiener, 1976).

The stimulus characteristics of the pup also appear to influence maternal behaviour, as in the case of growth-stunted pups produced by adrenalectomization (Wiener et al, 1977; Massaro et al, 1974). The pups' abnormal pattern of sucking has also been implicated in the alteration of the dams' behaviour (Galler and Turkewitz, 1977).

A commonly used method of inducing perinatal malnutrition is the increase of litter size. Here again we find alterations in maternal behaviour associated with the experimental manipulation (Seitz, 1954). The presence of large numbers of animals in a litter or the reduction in the number of nipples (by partial mastectomy of the dam) produces competition between the animals for the available nipples. This often results in pups of widely varying weights and the altered pattern of early interaction may also have long-term behavioural sequelae (Levine and Wiener, 1976).

It is apparent therefore that Winick and Coombs' (1972) confidence in the clarity of animal models has not been supported in the case of the control of non-nutritional elements of the early experience of malnourished rats. Altered mother-infant environments are known to produce significant behavioural changes in the adult rat (Denenberg, 1969; Levine and Thoman, 1969; Thoman and Levine, 1969). Moreover, malnutrition produced by different means may have different behavioural consequences, even when weaning weights are similar (Leathwood, 1979). In addition to these confounding variables, an important element in the early development of the perinatally malnourished animal relates to the state and behaviour of the animal itself.

Levitsky and Barnes (1972) proposed that the malnutrition acts indirectly on behavioural development by "functionally isolating" the animal from its environment. To quote Levitsky (1979b):

> "the effects of malnutrition on cognitive development may be indirect rather than direct. That is, malnutrition may not have to physically damage the brain in such a way as to impair its funtion. It may instead alter what an organism learns about its environment and what it does". (p39)

This hypothesis proposes that the quality and quantity of the young animal's interaction with its environment are reduced, thereby restricting its range of experiences.

Differences in the behaviour of malnourished and well-nourished rat pups may be due to differences in the rate of development or in motivation. Retardation of spontaneous motor activity has been reported in malnourished rat pups (Smart and Dobbing, 1971a). The appearance of reflexes and the maturation of physical features are delayed (Cowley and Griesel, 1966; Simonson et al, 1969; Smart and Dobbing, 1971b). In addition, dispersal of the pups throughout the housing area in the first days of life and climbing behaviour are delayed in pre-natally deprived (Levitsky et al, 1975) and postnatally deprived animals (Massaro et al, 1977). Thus, the quantity and the course of the physical contact of the malnourished pup with its surroundings can be reduced.

Rats malnourished pre-or post-weaning have been observed to avoid, or at least not to approach, novel objects in their environment (Barnes et al, 1976). Levitsky and Barnes (1975), utilizing the 'latent learning' paradigm, demonstrated that rats malnourished at the time of the original (unrewarded) exposure to a maze, performed less well than the adequately nourished comparison animals when they were returned to the maze and had to learn to find food. Further developing this line of investigation, Levitsky (1979a) showed that malnourished rats were less likely than well-nourished animals to learn information incidental to the initial solution of a discrimination problem.

A more complex picture now emerges of the elements in the aetiology of any behavioural deficits which may be observed in rats which experienced perinatal malnutrition. To evaluate the behaviour of malnourished rats it is necessary to examine the procedures used to assess the developmental status of the animals, and the animal models that have been developed to investigate the influence of malnutrition on cognitive ability.

The first distinction that needs to be made is between animals that were tested while still experiencing chronic malnutrition and animals that were tested after a period of nutritional rehabilitation. There seems to be little doubt that markedly abnormal behaviour is demonstrated by animals tested while chronically malnourished (Cowley and Griesel, 1959, 1962, 1963, 1964; Baird et al, 1971). An area of controversy surrounds the long-term effect of early malnutrition, and the test behaviour of animals who had experienced some degree of nutritional rehabilitation with some time on a normal high protein diet ad libitum.

Many of the experimental procedures involved stimulus-response (S-R) learning. Deficits in S-R learning are hypothesised to reflect deficits in cognitive ability, but this may not necessarily be the case. In addition, differences in performance in standard S-R learning tasks, which include food or water reinforcement (e.g. Cowley and Griesel, 1959) may not represent differences in learning ability. Levitsky and Barnes (1969) found that the feeding and drinking behaviour of rats was affected by earlier periods of malnutrition. The rewards are therefore likely to be inappropriate as they may have different incentive values for groups of malnourished and control animals.

Differences in learning performance may not truly reflect the animals' ability to learn. The proposition that differences in the performance may be due merely to differences in motivation is supported by the experiments of Levitsky and Barnes (1975). These investigators found that when the level of motivation was controlled for, by selecting rats on the basis of the rate of bar-pressing in a Skinner box during the training period, there were no differences in the ability of malnourished and control rats to learn a visual discrimination problem or a reversal learning problem. Any behavioural differences observed were generally interpreted as a demonstration of increased reactivity of the previously malnourished animals.

Heightened 'emotional reactivity' has been a frequent finding in malnourished animals. Increased emotionality in open field experiments has been demonstrated in rats malnourished during gestation, the suckling period and post-weaning, or post-weaning only. This has been assessed from the animals' decreased horizontal movement with frequent freezing, decreased vertical activity and increased excretion of urine and faeces (Winick and Coombs, 1972; Sobotka <u>et al</u>, 1974).

The view that heightened emotional reactivity is a consequence of early malnutrition in rats has been challenged by Levine and Wiener (1976) in their detailed analysis of the data on these animals' behaviour in the open field. They highlight inconsistencies in the data from studies which produced malnutrition by a variety of methods (Simonson <u>et al</u>, 1971; Hsueh <u>et al</u>, 1973, 1974; Ottinger and Tanabe, 1968; Frankova and Barnes, 1968; Seitz, 1954; Guthrie, 1968), and concluded:

> "Many investigators in the field of malnutrition appear to be unaware of the sensitivity of the open field to the specifics of the testing situation".

Listing such variables as the relative size of the arena, the time of day, illumination and noise levels and length and number of trials, Levine and Wiener proposed that

> "It is possible that the influences attributed to early malnutrition may be more directly related to other environmental determinants or to an interaction of the malnutrition with these nonspecified environmental variables."

There is evidence of a greater sensitivity to aversive stimuli in malnourished animals. Previously malnourished rats respond to stimuli of lower intensities than normals (Stern et al, 1974; Smart et al, 1975) and give a more exaggerated response (Stern et al, 1974; Levitsky and Barnes, 1970). There does not appear to be a relationship between this behaviour and the timing of the malnutrition, but there does appear to be evidence of a neurohumoral component in its development (Stern et al, 1974; Sobotka et al, 1974). But once again non-nutritional early experience is a possible cause of this behaviour (Porter and Wehmer, 1969; Masterpasqua et al, 1975).

An excessive reaction to stress is likely to interfere with the learning ability of the previously malnourished rat. Reducing the stressfulness of the test situation could therefore improve performance. By providing a period of familiarisation with the test-box, thus reducing fear behaviour, it was possible to demonstrate avoidance learning of previously malnourished rats was equivalent to that of well-nourished animals (Frankova, 1973). Similarly, Cowley and Griesel (1966) found that the performance of malnourished rats in a water-maze was improved by raising the temperature of the water, producing a less stressful situation.

In the study of the development of rats which experienced perinatal malnutrition of some kind, the findings are inconsistent. Behavioural deficits have been demonstrated (Tsukada et al, 1979), but behavioural advantages can also be found in the literature on malnourished rodents (Hanson and Simonson, 1971; Rider and Simonson, 1974; Baird et al, 1971; Slob et al, 1973). In general, it would appear that differences in the performance of malnourished and well-nourished rats can be explained by factors other than differences in their capacity to learn. There is some evidence of motivational differences between animals with current or past malnutrition and well-nourished animals. This, combined with their apparently different sensitivity to environmental stimuli, could affect the performance of malnourished rodents on behavioural tests.

Intergenerational malnutrition may be a better model for the situation in humans populations with endemic malnutrition than short, precisely timed periods of nutritional deprivation. Cowley and Griesel (1959) were among the first to raise the issue of the effects of low-protein diets over successive generations on the behaviour of rats. Later, a colony of rats with experience of several generations of protein deficient diets was instituted by Stewart (1975) and studied longitudinally over several generations. Turkewitz (1975) reported on the performance of some of Stewart's colony (after 6 to 8 generations of malnutrition) on visual discrimination tasks at 3 levels of difficulty. Deficits were demonstrated in this group when compared with well-nourished controls on the two more difficult tasks, although the groups did not differ on the easiest task with regard to either the percentage of animals reaching the criterion level (8 consecutive correct responses) or the number of trials needed to reach this level. He concluded that these results reflected the effects of the intergenerational history of poor nutrition, suggesting that the pursuit of this type of model was important as much of human malnutrition was of this type.

Galler and Rosenthal (1979) report that when malnutrition has been present for more than one generation, the behavioural outcome is generally more severe and less responsive to dietary rehabilitation than in first generation malnutrition. Their data suggested that altered maternal behaviour in the animals with the history of intergenerational malnutrition may play a part in the causation of these more marked disturbances.

Galler (1979), reporting on a variety of measures on well-nourished, postnatally malnourished and intergenerationally malnourished rats, showed that the consequences on intergenerational malnutrition and postnatal malnutrition can be similar under some conditions and different under others, depending on the behavioural measure utilised as well as on the age at which the test is carried out. There were also sex differences in performance on some tests. Galler is, so far, unable to explain the differences she found, but suggests genetic factors related to the survival of the intergenerationally malnourished animals as well as adaptation to chronic malnutrition. This study confirmed that intergenerational effects take several generations of nutritional rehabilitation to disappear.

2.2.2 Sub-human Primates

The use of the laboratory rat in animal models to investigate the relationship between early malnutrition and cognitive development may be questioned. As Galler (1979) comments, "despite similarities in behavioural patterns observed in rats and humans, the mechanisms underlying such behaviour may be quite disparate". Certainly it seems clear that there are significant differences between the pregnancies of rodents and primates which are relevant to the issue of possible behavioural consequences of perinatal malnutrition (Riopelle, 1979; Neuringer, 1979). There is some evidence that primates may be more tolerant of low protein intake than rodents (Riopelle, 1979).

However, the primate studies are not necessarily more successful in disentangling the nutritional and non-nutritional elements in the development of behaviour. A major series of studies on primates (in this case, rhesus monkeys *Macaca mulatta*) has been carried out by Robert Zimmermann and his colleagues (Zimmermann, 1969, 1973; Zimmermann *et al*, 1976, Aarke *et al*, 1973; Strobel, 1979). Unfortunately, a variety of criticisms may be levelled at these studies. Their test schedules with the animals may have been too short (Strobel, 1979; Zimmermann *et al*, 1975a). An even more basic criticism of their work relates to their use of food reinforcement in many of their studies (Zimmermann *et al*, 1974, Zimmermann, 1969). These researchers have commented that many of their results, including their finding of superior performance by malnourished animals on discrimination tasks (Zimmermann, 1969), may have been "a function of the heightened value of the food incentives for the malnourished monkey" (Zimmermann et al, 1976).

The use of primates in research on the effects of malnutrition has facilitated the investigation of the issues raised by Levitsky and Barnes (1972) in their hypothesis of the "functional isolation" of the malnourished infant - the suggestion that malnutrition depressed exploratory behaviour and curiosity. The neophobic reaction that has been reported in rats (Levitsky, 1975) has also been demonstrated in malnourished pigs (Levitsky, 1975). Even when malnourished pigs do not show the neophobic reaction, they appear to be indifferent to new objects in their environment (Barnes et al, 1976). These types of motivational changes however, are best demonstrated in protein-malnourished monkeys. When nutritionally deprived, behaviours that are not orientated to obtaining food, such as visual curiosity, manipulative puzzle-solving and social behaviour, are reduced (Zimmermann et al, 1975a, b). Malnourished animals can solve mechanical puzzles at a level at least equal to control animals, but only in the presence of extrinsic motivation. If the reward is manipulation itself (i.e. intrinsic motivation), the interest in puzzle-solving is uncharacteristically low (Aarke et al, 1973).

There has also been evidence from the primate studies of deficits in selective attention mechanisms (Zimmermann et al, 1974). In a series of experiments designed to test the ability of malnourished animals "to localize and select the critical cue" in a visual display, monkeys on low protein diets performed at a level significantly below those of well-nourished animals. The authors comment that "the depressed performance of the malnourished monkeys on these series of tasks, all of which require some type of attention, detection or scanning response, stands in sharp contrast to the performances achieved on other learning tasks" by malnourished monkeys. Comparing their results with some obtained by Klein and colleagues (Klein et al, 1969) with children, Zimmermann et al, (1974)conclude that malnutrition may not produce deficiencies on cognitive or learning tasks per se, but that if these tasks require selective attentional mechanisms, the performance of malnourished individuals would probably be inferior to that of other individuals who had been reared on adequate diets.

These studies with sub-human primates and particularly those which have investigated the areas of motivation and attention provide evidence in support of a model of the relationship between nutrition and development and learning which is mediated through altered responsiveness to the environment.

2.3 THE EFFECTS OF ENVIRONMENTAL ENRICHMENT OF MALNOURISHED ANIMALS

The interaction between the malnourished animal and its environment has been further investigated in studies which have manipulated environmental as well as nutritional variables.

In studies of the rat, structural changes in the brain induced by perinatal malnutrition are remarkably similar to the structural changes induced by stimulus deprivation in infancy (Rosenzweig, 1966). In addition, many areas of development that are retarded in malnourished animals are enhanced or accelerated in animals reared with increased stimulation. For example, retardation in body growth and development as well as the structural and functional development of the CNS have been reported in malnourished animals, while acceleration of somatic growth and enhanced development of motor and sensory funtions have resulted in animals reared in enriched environments (Frankova, 1974, 1977). Table 2.1 shows these similarities in brain structure and behaviour.

The many similarities in the behaviour of previously malnourished rats and rats reared in experimental isolation suggest that the distortion in the behaviour of the malnourished animals could be due, in part, to some kind of stimulus deprivation - e.g. Levitsky and Barnes' (1972) "functional isolation". If this were in fact the case, the effects of malnutrition could possibly be ameliorated by enriching the environment of the malnourished animals.

In animal studies, increased stimulation is often

Table 2.1 Some effects of early malnutrition and stimulation in animals. adapted from Fraňková, 1974.

Malnutrition	Stimulation
A. Growth and development of tissues and functions:	
Marked retardation of growth.	Acceleration of growth.
Retardation in development of spontaneous motor activity.	Enhanced development of motor and sensory functions and their coordination.
Delayed appearance of reflexes and maturation of physical features.	Earlier eye opening and more rapid development of response to sound.
B. Structural and functional development of the CNS:	
Lower brain weight, total DNA, RNA, lipid and protein in brain.	Increased brain weight. Increased weight and depth of cortex.
Retardation of myelination processes.	More rapid myelination.
Disturbance in EEG activity.	Accelerated development of adult EEG.
C. Influence on neurohumoral system:	
Smaller pituitaries containing a lower concentration of growth hormone.	Earlier maturation of hypothalamo-pituitary system.
D. Behaviour:	
Decreased exploratory behaviour.	Increased exploratory behaviour.
Increased emotional reactivity.	Lower emotionality, less emotional response to stress situations.
E. Resistance to stress and disease:	
Disturbance in ability to respond to stress and disease.	Better adaptation to different pathogenic agents.
	Better survival from starvation and smaller gastrointestinal lesions in conflict situations.

provided by a variety of handling procedures. Handling influences the development of numerous physiological and behavioural functions (Frankova, 1974; Eckhert *et al*, 1975). Levitsky and Barnes (1972) investigated the effects of handling during the period of early nutritional deprivation on the subsequent behaviour of rats. Handling malnourished rats normalised total horizontal locomotor activity, their exploratory activity and decreased their fear responses. Conversely, environmental isolation exacerbated the effects of malnutrition on locomotor activity and other behaviours.

The provision of stimulation with the minimum of human contact with the developing rat, achieved through the introduction of an additional female into the home cage, enhances exploratory behaviour (Frankova, 1974). Pups raised with the 'aunts' did as well as the control animals in the behavioural tests.

In the primate studies, a similar interaction has been found between nutrition and environmental stimulation in the development of behaviour in cebus monkeys (Elias and Samonds, 1977; Boelkins and Hegsted, 1979), squirrel monkeys (Gold berger, 1979; Boelkins and Hegsted, 1979) and rhesus monkeys (Neuringer, 1979, Strobel, 1979).

In this area, one is again unable to identify precisely the behavioural consequences of perinatal malnutrition *per se*. Animals that have experienced malnutrition in the perinatal period demonstrate deficits in subsequent behaviour when compared with animals which did not experience malnutrition. However, the animal models developed so far have not permitted the separation of the effects of nutrition from the effects of non-nutritional factors such as the level of environmental stimulation.

These studies suggest that the relationship between early malnutrition and behaviour in animals follows a pattern similar to that shown in Figure 1.3d, which has been proposed for humans. It suggests that nutrition has a direct effect on both brain development and behaviour and these in turn interact with environmental stimulation and with each other to produce the test results that have been reported.

2.4 MALNUTRITION AND PSYCHOLOGICAL DEVELOPMENT IN HUMANS

The effects of nutrition on psychological development have been investigated in children with mild-moderate malnutrition and with the more severe forms.

A rigorous classification and comparison of the human studies is difficult because of the variety of experimental designs employed. Some studies have been confined to one syndrome, while others have included patients with different forms of PEM. In addition, samples of different ages and sexes have been selected according to a variety of criteria (e.g. medical histories or present anthropometry).

In general, however, the experimental designs in the human studies of malnutrition and psychological development fall into four main categories:

1. ex post facto cross-sectional.
   a. Comparison of tall and short children in 'at risk' populations
   b. Survivors of malnutrition compared with children without previous history of clinical malnutrition
2. ex post facto longitudinal
   Children studied from the time of diagnosis of malnutrition - followed up for varying lengths of time
3. Prospective longitudinal
   Regular observation of cohort from birth in 'at risk' community.
4. Intervention
   a. Behavioural intervention in hospital
   b. Nutritional and/or behavioural intervention in 'at risk' community.

These studies attempt to separate nutrition from the genetic and environmental factors which influence development. Implicit are questions about the pattern of development that the children would have followed if they had not experienced nutritional deprivation. These questions cannot be answered as in the majority of studies premorbid data on the children are not available.

An inherent weakness in research in this area is that true experiments are not possible. Many authors use the term "controls" when describing groups of children with whom the malnourished or formerly malnourished children are compared (e.g. Brockman and Ricciutti, 1971; Nwuga, 1977). These children are not in fact "controls" in the true experimental sense (Richardson, 1975) and throughout this report the term "comparison group" will be used.

Severe and mild-moderate (subclinical) malnutrition will be discussed separately. The experience of a period of hospitalisation in infancy may of itself have long-term consequences for psychological development (Douglas, 1975) and this must be considered an important difference between the two groups. The severely malnourished children that have been studied have been hospitalised for periods of up to one year and in some cases have been restrained for some of that time (e.g. in 'metabolic beds').

The studies in this review and the findings that are discussed have been selected because of their relevance to the research that is being reported. Some studies are reported in some detail when they have a direct bearing on the design or interpretation of the research that is reported in this thesis.

2.4.1 Malnutrition, brain development and behaviour

The effect of malnutrition on psychological development is difficult to assess in relation to the critical periods of brain development largely because few prospective studies exist in this area. As a result, the timing of the nutritional insult and the premorbid development of the infant often cannot be determined with certainty. Age of hospital admission does not necessarily bear a predictable relationship to the age of onset of nutritional deprivation. Possibly for this reason, attempts to relate age of hospital admission to subsequent development have produced inconsistent results. For example, Cravioto and Robles(1965) found that children admitted to hospital with kwashiorkor before the age of 6 months had a poorer prognosis for development than children admitted after this age. In contrast, Richardson and colleagues (Hertzig *et al*, 1972) were unable to find a consistent effect of age of admission on children's later performance in tests of psychological development, while Chase and Martin (1970) found that children diagnosed at a younger age had the best prognosis.

2.4.2. Severe protein-energy malnutrition in humans.

Studies of children who had at some time experienced severe protein-energy malnutrition have been carried out in many developing as well as developed countries. These include the following:

Africa

Uganda	Geber and Dean, 1955, 1956
	(Hoorweg and Stanfield, 1972,1976, 1979 (Hoorweg, 1976.
South Africa	Evans *et al*, 1971;
	Stoch and Smythe, 1964, 1967, 1976;
Nigeria	Nwuga, 1977
	Ashem and Janes, 1978

Asia

India	Champakam *et al*, 1965;
	Patel, 1975;
	Ghia *et al*, 1973;
	Parekh *et al*, 1974;
	Srikantia, 1979;
Philippines	Guthrie *et al*, 1976;
Indonesia	Liang *et al*, 1976
Lebanon	Botha-Antoun *et al*, 1968
	(Yaktin and McLaren, 1970 (McLaren 1975 (McLaren *et al*, 1973, 1975

Europe	
Holland	Stein *et al*, 1975
Yugoslavia	Cabak and Najdanvic, 1965
England	Valman, 1974
The Americas	
Peru	Brockman and Ricciuti, 1971
	Pollitt and Granoff, 1967
Chile	Monckeberg, 1968, 1979
Guatemala	Cravioto *et al*, 1966
	Lester, 1975, 1976
	Witkop *et al*, 1970
Mexico	Cravioto and Robles, 1965
	Cravioto and DeLicardie, 1968
	Cravioto *et al*, 1967
	DeLicardie and Cravioto, 1975
	Birch *et al*, 1971
	Cravioto, 1977
United States	Chase and Martin, 1970
	Lloyd-Still *et al*, 1975
Jamaica	(Birch and Richardson, 1972 (Richardson et al, 1973, 1975 (Hertzig *et al*, 1972.

2.4.3 Studies of development of severely malnourished Children

The development of severely malnourished children has been assessed while the children were being treated in hospital. In Mexico, Cravioto and Robles (1965) obtained Gesell DQs at fortnightly intervals during the hospitalisation of children being treated for kwashiorkor. There were six children admitted before the age of 6 months, nine children between 15 and 19 months and five between 37 and 42 months. The children's scores were compared to the norms for the test for Motor, Adaptive, Language and Personal-Social developmental quotients, and Cravioto and Robles report that

> "as recovery from malnutriton took place, developmental quotients increased in most patients and the gap between the theoretic normal and the actual performance of the child progressively diminished. Not all the fields of behaviour explored with the Gesell technique exibited the same speed of recovery. Language, which was in general the most affected sphere,also presented the lower velocity".

The youngest children were the most retarded. In these children the initial deficitremained constant during the entire period in hospital (in some cases, up to 6½ months). This study had no comparison group, but the authors comment that the scores obtained by the malnourished children were lower than those usually obtained by children "of the same chronological age and ethnic group not affected by severc malnutrition".

The lack of a comparison group in the Mexican study is a major weakness. However, this increase in DQs during rehabilitation in hospital has been reported in other studies of severely malnourished children. In Lebanon, Yaktin and McLaren (1970) found a similar pattern. Again using fortnightly tests, over a period of 16 weeks in this case, these investigators found that the Griffiths DQs of marasmic children increased by an average of about 20 points during recovery in hospital.

In follow-up studies, the IQs of children who had experienced earlier periods of severe malnutrition have also been measured. In Yugoslavia, Cabak and Najdanvic (1965) tested 36 children aged 7 to 14 years, who had been hospitalised with marasmus or marasmic-kwashiorkor before the age of 2. On the Binet test, only 18 children obtained scores within normal IQ limits (91-110). The rest of the children had scores of 90 or below. There was no comparison group in this study and no local norms for the test were available, so the distribution of scores was compared with norms for other Serbian children. In general, the formerly malnourished children scored lower than other Serbian children.

In another study which also employed a form of Binet test, Monckeberg (1968) in Chile found that 3 to 6 year old children who had been marasmic in the first year of life achieved very low scores.

These studies which have no comparison group are very difficult to interpret and more useful information comes from comparisons with intra-community groups.

The assessment of development in studies of human populations raises several methodological problems. In general, the studies are carried out in communities in which there are no indigenous tests standardised on the local population. In the majority of the studies, measures of development or intelligence such as the Bayley Scales, the Griffiths Mental Development Scales or the WISC have been used. These are tests which have been designed for North American and British populations.

This use of test norms is obviously unsatisfactory and raises questions about the validity of such norms for the populations being investigated. There have therefore been attempts to find appropriate intra-community comparison groups. Matching purely for social class proved inadequate (Stoch and Smythe, 1963, 1967; Pollitt, 1972) and attempts were made to match malnourished and non-malnourished children on the basis of a varied range of demographic, economic and social characteristics. Champakam, et al (1968), in a follow-up study of survivors of kwashiorkor selected for comparison children from the same locality and school class, age, sex, religion, caste, SES, family size, birth order and educational level (parents' and children's) as the malnourished children, but were forced to conclude that as personality and other inter-personal factors were not controlled for, the possibility still existed that the same unidentified factors which contributed to the development of kwashiorkor in particular children may have been the cause of any differences found between the groups. The problem is that is is not possible to match subjects for all possible characteristics and the probability of other unmeasured causal factors always remains (Mora et al, 1974).

In an effort to reduce genetic and environmental variability, the use of intra-familial comparison children has been advocated (Tizard, 1974; Latham, 1974). Older and/or younger siblings have been used to form comparison groups - for example in Peru (Pollitt and Granoff, 1967), in Mexico (Birch et al, 1971) and in Jamaica (Hertzig et al, 1972). In addition to the fact that in these societies apparent siblings may in fact have different parentage and not be as genetically similar as expected (Lloyd-Still, 1976b), other differential environmental effects such as those due to age, birth order and sex are often uncontrolled for (Belmont and Marolla, 1973). If one child has experienced severe undernutrition, it is likely that others may also have been at least moderately malnourished (Richardson, 1975b), such inequalities of food supply themselves suggesting inequalities in environmental conditions and relationships.

Christiansen and Herrera (1975) report on the problems encountered in a pilot study in Bogota,Columbia, utilizing a design of sibling matching to control social and health variables. They found that sibling pairs of dissimilar nutritional status were rare in the population surveyed (48 out of 12,000 families). Arguing that physical growth differences between siblings may represent not only differences in health and nutritional status, but also changes in family resources and environment over time, they show that the design is subject to bias between older and younger sibling groups who may have experienced different home conditions. Furthermore,because of the scarcity of sibling pairs, a large age range had to be accepted to achieve minimal sample size and this heterogeneity weakened the power of statistical adjustments. They established that there were differences between the malnourished children and their siblings in the relationship of social covariates to the development measures, concluding that sibling matching was only partially effective as a means of controlling non-nutritional factors.

It must be acknowledged however that the use of intra-community comparison groups, though useful in the interpretation of measures on the malnourished children and assisting to establish their normative validity, does not eradicate the problems caused by the cross-cultural application of standardised tests. Pollitt and Thomson (1977) question the assumption of construct validity implicit in the trans-cultural use of tests and put a strong case for the use of indigenous test material.

In one study concerned with the development of moderately malnourished children, the researchers have tried to assess the local or 'emic' validity as well as the North American construct validity of the measures of cognitive ability they selected for use. This is the Institute of Nutrition of Central America and Panama (INCAP) study in Guatemala (Klein, et al, 1977; Irwin et al, 1977, 1979), which is discussed in Chapter 2.4.6.

Stoch and Smythe (1963, 1967, 1976) have carried out a longitudinal study of 'Cape Coloured' children in South Africa in which severely malnourished and well-nourished children have been compared. The groups were matched for sex and age. In each of the groups, 18 children were aged between 10 and 24 months when taken into the study and the remaining 3 in each group were between 24 and 36 months. Selecting children according to broad characteristics of social class proved an inadequate method of matching and the initial disparity between the groups was marked. It was found that 'alcoholism, illegitimacy and broken homes were the rule in the undernourished group, whereas the control group lived under more stable home conditions' (Stoch and Smythe, 1967). Over the years there were changes in the homes so that at the 15-year follow-up, it was found that except for 5 of the formerly malnourished children, the home environments of the two groups were "barely distinguishable because of greater economic stability and foster placements".

The IQ test results are summarised in Table 2.2 The IQs of the two groups remained significantly different from each other over the 15 year period. In 1967, Stoch and Smythe reported deficits in visuo-motor development and pattern perception in the formerly malnourished children (the "index" group). There was little overlap in full scale IQs and there were significant differences between the groups in five subtests: Vocabulary, Problems, Pattern completion, Blocks and Form boards. This was accompanied by a relative retardation in achievement at school.

At the 15 year follow-up (Stoch and Smythe, 1976), the highly significant difference between the groups was more marked in the boys (with a mean difference of 24.55) than in the girls (10.55). The groups were significantly

Table 2.2 IQs in 15 year follow-up of severely malnourished South African children

from Stoch and Smythe, 1963, 1967, 1976

		Approx. number of years after hospitalisation		
		5	10	15
Group	Malnourished	70.9	61.2	56.0
	Well-nourished	93.5	76.7	72.9
Significance of difference				
	p	0.01	0.01	0.005
Tests		Gesell Merrill-Palmer	NSAIS	NSAIS

NSAIS = New South African Individual Scale different in seven of the nine subtests of the New South African Individual Scale (NSAIS) and, as in the earlier test, the greatest differences were in Vocabulary, Problems, Pattern completion and Blocks. There was no longer a significant difference in the Form boards subtest.

In this study, other psychological tests were given in addition to the IQ test. Stoch and Smythe (1967) report that the index children showed a poorer grasp of time than the comparison children, and that this could not be explained by the observed differences in IQ. In addition, the index children score significantly lower on tests of motivation and initiative. Scores for these tests are not reported for the children at the older stage, but other tests were given at this point. The Bender Visual-Motor Gestalt Test (a measure of maturity of visuo-motor perception) produced evidence of minimal brain dysfunction in both groups. In the Figure drawing test, there was evidence of organic deficits in 10 index children and 6 comparison children. The researchers report that there appeared to be a perceptual disability in the formerly malnourished children that was independent of their intellectual deficits. The 1967 and 1976 papers report EEG abnormalities in both groups of children. However, Stoch and Smythe argue that their data support the hypothesis that there were organic differences between the two groups.

As teenagers, the children were given the Columbus Test and the comparison children were found to be significantly ahead of the index children on the social-emotional maturity scale ($p=0.05$). However, from observations and interviews with parents, Stoch and Smythe concluded that the comparison children's parents "coped significantly better in handling their children (p=0.01)" and that the formerly malnourished children had "significantly less cultural learning opportunities (p=0.001)... and a greater number of taumatic life experiences (p 0.001)". Rather surprisingly, in spite of these data, the authors concluded that the social differences between the groups were minimal, arguing that the comparison group were themselves in many ways suboptimal.

Physically, there was a certain amount of catch-up in the growth of the malnourished children. Over the ten years between the first and third reports, the mean difference in height between the two groups decreased by 2.73 cms. However, the difference between the groups in head circumference increased over the period by 0.51 cms although skull thicknesses were not different between the two groups. The latter information is rare in these studies as it is not usually considered ethical to give X-rays (and certainly not skull X-rays) for research purposes.

In their third report, Stoch and Smythe (1976) argue thus :

"Undoubtably the index group suffered from environmental deprivation owing to the higher incidence of illegitimacy, deprivation of learning experience apart from school, poorer parental nurturance, and more personal traumatic experiences. The control group, however, also suffered real disadvantages and over the period of observation the early differences between the two groups have to a considerable extent been eliminated. Difficult as it is to separate environmental from nutritional factors in the poor performance of these children it does not seem possible that the significantly low head circumference of the index group, the errors in the Bender-Gestalt and the Human Figure Drawing, and the high incidence of abnormal EEGs in both groups can be explained on any other than an organic basis". (p335)

This organic brain dysfunction was hypothesised to be "dominantly at a central neurointegretive level".

This study reports the longest follow-up of children who experienced early severe malnutrition to date. Long-term follow-up of survivors of malnutrition is important as in studies monitoring individuals showing moderate mental retardation in childhood, there is some evidence of amelioration in the late teens and early twenties (Tizard, 1972). Unfortunately, doubts about the comparability of the groups in this study remain, and reports of apparent EEG abnormalities in both groups only serve to complicate the picture.

Another study (Hansen <u>et al</u>, 1971; Evans <u>et al</u>, 1971) also used the NSAIS for testing 'Cape coloured' children in South Africa. These children had previously been hospitalised with kwashiorkor. At between 10 and 11 years of age they were compared with a group of their siblings of similar ages. On the NSAIS, as well as on the Goodenough-Harris drawing test, the two groups obtained very similar scores (e.g. NSAIS: Malnourished 77, Comparison 78). The children were also very similar on anthropometric measures and it seems likely that although only the index children had experienced clinical malnutrition, their siblings had probably suffered chronic undernutrition which could have had the effect of minimising the difference between the groups (Latham, 1974).

Another follow-up study in Africa tested spatial-perceptual abilities as well as other areas of intellectual ability in teenage children.

Between 1970 and 1971, Hoorweg and Stanfield studied Baganda children aged 11 to 17 years who had been admitted to the Nutrition Research Unit in Kampala, Uganda, at least 10 years earlier because of PEM (Hoorweg and Stanfield, 1972, 1976, 1979; Hoorweg, 1976). They formed three groups of 20 individuals each, according to their ages at the time of admission to hospital (Group 1: 8-15 months, Group 2: 16-21 months, Group 3: 22-27 months). A comparison group of children who had not had clinical malnutrition was selected from the out-patient clinic attended by the formerly malnourished children. The children were matched for age, sex, education as well as such factors as scores on measures of traditional/modern characteristics of the home.

Some clinical data were available for the period of hospitalisation of the malnourished children, but there was only incomplete information about the children before and after the episode of malnutrition. A selection of standard tests of intellectual ability were given to the children as well as a test of incidental learning and the Lincoln-Oseretsky motor development scale. The children were tested for general reasoning (Raven matrices), verbal-educational abilities (WISC arithmetic test and a specially contructed vocabulary test), spatial-perceptual skills (WAIS block design, Porteus mazes, memory for design test), short term memory (Knox cubes) and rote learning.

The malnourished children were found to be significantly different from the comparison children on the Raven matrices, Block design, Memory for designs and incidental learning (Hoorweg and Stanfield, 1976, 1979; Hoorweg, 1976). They were also significantly different on the motor development scale. From analyses involving correlations between various indices of clinical status in hospital and intelligence test scores, it was concluded that the chronicity of the malnutrition, rather than its acute severity, was the most important factor in the production of the intellectual deficits. These indices, which in effect largely parallelled marasmus ("chronic under-nutrition") and kwashiorkor ("acute malnutrition"), were more useful in explaining the intellectual retardation found than the age of admission to hospital, although the authors note that no child was admitted to hospital before 6 months. Incidental learning was the only test that failed to show a correlation with "chronic undernutrition", but there is the suggestion that the incidental learning scores were an artifact of the matching procedure.

Contrary to the findings of Stoch and Smythe (1976) in

South Africa, Hoorweg and Stanfield (1976) concluded that there were no overall indicators of brain damage in the malnourished Ugandan children such as shown by acute or chronically brain-disordered patients. However, Hoorweg and Stanfield argue that "the chances are small" that the differences in intellectual performance between the groups do not result from malnutrition but from other aspects of the home environment. It appears that there was a generalised impairment of intellectual abilities with reasoning and spatial abilities most affected, at an intermediate level and language ability least affected (Hoorweg, 1976).

In Nigeria, Nwuga (1977) was able to trace 15% of the children presumed alive after treatment for kwashiorkor at the University College Hospital, Ibadan, and formed a group of 52 9-10 year old urban children who had been treated before the age of 3. He used 4 comparison groups comprising siblings within 2 years of the index child (n=34), matched lower class controls (n=32), upper class controls (n=38) and rural kwashiorkor survivors (n=9) respectively.

The previously malnourished children were found to be poorer than their siblings, the lower class classmates and the upper class comparison group on tasks requiring short term visual memory, logical reasoning (picture arrangement), perceptual organisation (block design) and analytic thinking (Progressive matrices). Boys tended to be more adversely affected than girls.

Apart from the statement that the lower class comparison group were matched with the index cases for age, sex, family size, birth order, religion and socioeconomic status, little detail is given about the selection process. However, the unequal numbers in the groups suggest limits to the matching process and therefore makes the evaluation of these results difficult.

Significant differences in measured IQ have been demonstrated in other studies of school age children who had been malnourished in early life, notably in India (Champakan et al, 1968), Mexico (Birch et al, 1971) and Jamaica (Hertzig et al, 1972). One study of the subsequent development of marasmic children in rural India (Ghai et al, 1973) is unusual because these investigators found non-significant differences between these children and a group of well-nourished children matched for age, sex and socioeconomic status. However, although the differences were not statistically significant, the previously malnourished children had lower mean scores on the Wechsler tests than the comparison children (particularly on the performance scale).

Birch et al (1971) had sibling comparison children for their study of Mexican children admitted to hospital for the treatment of kwashiorkor between 6 and 30 months of age. After an interval of at least 3 years from discharge from hospital, 37 children with siblings within 3 years of age were tested on the WISC. The children were aged 5 to 13 years at the time of the follow-up test. The mean full scale IQ was 13 points lower for the previously malnourished children than their siblings ($p<0.01$), with slightly smaller deficits in the verbal IQ (11.2) and performance IQ (7.7).

Although there was a tendency for the siblings to be older than the malnourished children, there was no significant relationship between age and IQ. However the siblings were not matched for sex and there were sex differences in IQ in the comparison group, though not in the malnourished group.

Champakam et al (1968) matched for a variety of social variables in their study of 19 previously malnourished (kwashiorkor) Indian children. At ages of between 8 and 11 years, there were significant differences favouring the comparison group on an Indian IQ test. These were particularly marked in the younger group (8-9 year olds), but less so in the older group (10-11). Memory, abstract thinking, verbal and perceptual ability appeared to be affected in the malnourished group.

In this study, as in work by Cravioto and colleagues (Cravioto and Delicardie, 1968; Cravioto, et al, 1967) and Ghai et al (1973), the Birch and Lefford tests of intersensory integration were given to the children (Birch and Lefford, 1963, 1964). There has been the suggestion from studies using standard IQ tests that formerly malnourished children may show deficits in the integration of information from several sensory modalities (e.g. Stoch and Smythe, 1976). Auditory-visual integration is thought to be a factor in differentiating between good and poor readers (Birch and Belmont, 1964) and kinaesthetic-visual integration is thought to be important for writing. Champakam et al (1968) reported that the survivors of kwashiorkor demonstrated poorer intersensory organisation than the comparison group. There was the suggestion that there was improvement with age as the older age group performed better than the younger children.

Cravioto and colleagues report on a study of intersensory integration in Mexico (Cravioto and Delicardie, 1970; Cravioto, Gaona and Birch, 1967). This is a comparative study of previously malnourished children (i.e. before 30 months) and their closest siblings. The children, who were tested for IQs by Birch et al (1971), were aged between 5 and 10 at the time of the test. The expected improvement in competence in visuo-auditory integration with age was found, but the rate of improvement was different in the two groups and there was a marked lag in the malnourished group.

In the kinaesthetic-visual intersensory integration test, at each age, the previously malnourished Mexican children had significantly lower performance levels than the sibling group, with a similar relative level of performance on the visual recognition of two-dimensional forms.

Specific sensory integration skills have been examined by Witkop et al (1970) in Guatemalan subjects aged 4 to 15 years. These included 24 rural and 18 urban survivors of kwashiorkor, and 135 urban and 113 rural comparison children from the same social class and locality of the formerly malnourished group who had not previously been hospitalised. Because of the suggestion of abnormal enzyme activity in the brains of children recovered from malnutrition which would produce histidinemic-phenylketonuric-like behaviour (Whitehead and Milburn, 1964; Habicht and Witkop, 1967), these investigators examined whether the behaviour of formerly severely malnourished children was similar to the pattern that results from the absence of the enzyme histidase. They assessed the auditory ability, auditory memory span, oral stereognosis and visual tracking ability in the subjects.

The kwashiorkor group had normal audiograms, but depressed auditory tracking scores. Auditory tracking was tested by additive series of 5 phrases (e.g. 'El gato de Poli', 'El lindo gato de Poli', 'El lindo gato de Poli tiene una cola', etc). The errors made by the kwashiorkor group were quantitatively and qualitatively different from those made by the comparison children, with the kwashiorkor group making a higher proportion of more serious types of errors.

The kwashiorkor group also made more errors than the comparison group in the oral stereognosis tasks. After visually matching 20 geometric shapes, the subjects were required to identify each one when it was put into his mouth by pointing to its duplicate.

In the visual tracking task, the subjects were required to reproduce actions such as 'right hand pats chest twice' or 'left hand pats top of head twice' which were demonstrated by the examiner. The proportional number of errors made by the kwashiorkor group was not as great as in the other two areas, but the difference was not considered great enough for the researchers to be able to say that the visual modality was less affected than the others.

In all the measures, there was evidence of a greater deficit in the older members of the kwashiorkor group. The results were suggestive of specific enzyme deficits, but the authors add that "Kwashiorkor children made faster decisions than their control counterparts as did those controls in the upper twenty-fifth percentile of the error scores for stereognosis, this despite repeated instructions before and during the test to take all the time they needed." This raises the issue of the speed of response of the survivors of malnutrition. Klein and colleagues (1973) reported that what was initially thought to be a memory deficit in a group of survivors of PEM could also be interpreted as the result of attentional and motivational differences between these children and the comparision group. Referring to Witkop's study, they comment that some of the differences between malnourished and well-nourished children on cognitive tasks need to be demonstrated independently of individual differences in response style which may be important predictors of performance on difficult tasks.

Classificatory ability is another area of cognitive ability that has been assessed in severely malnourished children. Brockam and Ricciutti (1971) tested Peruvian children. 20 were marasmic when admitted to the British-American Hospital in Lima. The children were tested several months after they were first diagnosed as marasmic (after a mean interval of 8.7 months in the under twos and 19.6 months in the older children) and were between 11.8 and 43.5 months old when tested. At the time of the test, the children were apparently still in a convalescent unit staffed by medical personnel. No details are given of any involvement of parents in this unit. 19 comparision children, individually matched for age and sex with the malnourished children, were selected from day care centres serving slum areas socioeconomically comparable to the areas from which the malnourished children had come.

The children were tested on 10 sorting tasks with 8 simple objects. The tasks included categorisation by size, colour, texture, form and complexity, administered during two sessions on successive days. Serial ordering and spatial grouping of the objects were taken as evidence of discrimination of the objects. There were highly significant differences between the performance of the malnourished children and of the well-nourished comparison group, both in total scores and in measures of serial ordering and similar object grouping ($p<0.001$). A small comparison group ($n=7$) of children presumed to be chronically undernourished performed at an intermediate level.

When retested after a further 12 weeks of nutritional rehabilitation, the malnourished children showed no improvement in performance. Their mean score changed from 15.4 at the first test to 14.3 at the second. The level of test performance was found to be related to standardised anthropometry.

Brockman and Ricciutti stated that their data suggested that there was permanent cognitive retardation in the rehabilitated malnourished children, and they say that "the strikingly lower sorting task scores of the experimental subjects appeared to be due neither to a lack of maintained interest nor to less frequent contacts with the objects. Rather, their performance reflected a relative inability to discriminate the similarities and differences among the task objects....and to group or categorize on the basis of the discriminated differences". This judgement is based on the analysis of such features as time spent on the tasks and frequency of handling of objects. The deficits shown are therefore interpreted in terms of "deficiency of single modality sensory discrimination". However, data from research with sub-human primates (Zimmermann, 1979) and with rodents (Levitsky 1979) suggest another interpretation of these results, one which is not presented by Brockman and Ricciutti. These results may merely reflect attentional deficits in the malnourished children which affect their performance on a task which requires special attention to many characteristics of objects. Furthermore, the possible effects of prolonged periods of hospitalisation on the experimental group do not appear to have been taken into account.

There is evidence of attentional deficits in severely malnourished children from a study carried out in Guatemala. Lester (1975, 1976) set out "to test the hypothesis that the infant's ability to attend to and process information from the environment as seen in the elaboration of the orienting response... is affected by nutritional insult". Using magnitude of heart-rate deceleration as a measure of the orienting response to auditory stimuli, Lester found that malnourished one year olds showed an attenuation or complete absence of the orienting response to stimulus onset and no evidence of dishabituation to changes in tonal frequency (Lester, 1975). This deficit when compared with well-nourished Guatemalan 1 year olds was interpreted as "a fundamental attentional deficit associated with nutritional insult" and this behaviour, taken with differences in the cries of malnourished children (Lester, 1976), is seen as indication of possible dysfunction of CNS regulatory processes.

The presence of such attentional aberrations in malnourished children before and after nutritional rehabilitation could contribute to intellectual retardation through the "functional isolation" of the infant as has been suggested from work with animals (Levitsky and Barnes, 1972) or could contribute to poor test performance in such tasks as those requiring discrimination between properties of stimuli. These findings are comparable with the findings from sub-human primates (e.g. Zimmermann et al, 1974).

In general, these studies show deficits in intellectual performance in formerly severely malnourished children, but it is not possible from the data that they report to separate the effects of nutrition from the effects of non-nutritional environmental factors.

Two studies of children diagnosed as having severe malnutrition, in which particular attention was paid to social environmental factors, will be reported in some detail because of their importance to the research in this report. One was carried out in Mexico and the other was a study of the long-term sequelae of severe malnutrition in Jamaican boys.

<u>The work of Cravioto et al (Land of the White Dust)</u>

An important study in the field of severe malnutrition has been carried out by a team headed by Joaquin Cravioto in the Land of the White Dust, a rural village of approximately 6000 people in south west Mexico (Cravioto <u>et al</u>, 1969). A longitudinal study of all the children born in the village over a 13 month period in 1966-1967 involved the collection of regular, scheduled data from birth for 334 individuals. Of these, 22 children developed clinical severe malnutrition at ages between 4 and 53 months: 15 kwashiorkor and 7 marasmus. In the group that became malnourished, one child had been born at 34 weeks gestational age (weight: 2820g), but the others had been full-term infants. No systematic association was found between size at birth and either the development of severe malnutrition or the age at which malnutrition occured (Cravioto and DeLicardie, 1974b).

The prospective design of the research project is its great advantage over most of the research in this field. However, this very fact may limit the extent to which its findings may be generalised to other communities. To quote Cravioto and DeLicardie (1974b):

> "In the course of a longitudinal study beginning at birth of 334 infants, 22 developed severe malnutrition, despite the fact that all children were examined on a biweekly basis, growth failures identified, infectious illness treated, and the parents given advice (which they did not follow) on the appropriate feeding and care of the child."

It can be argued that in many countries where malnutrition is endemic, many children become severely malnourished because of the absence of medical personnel and the unavailability of health and nutrition advice. In Cravioto's small Mexican village, there was "a resident team of paediatricians, psychologists, social workers, nurses and nutritionists" (Cravioto and DeLicardie, 1974b). Nevertheless, the Land of the White Dust study offers a rare opportunity for the analysis of premorbid data on severely malnourished children and therefore must play an important part in the investigation of the interrelationships of social, psychological and nutritional factors in the development of children.

The index group of severely malnourished children was reduced to 18 by the death of 3 children after the diagnosis had been made. 11 of these children were treated in hospital for up to 60 days and 7 were kept at home. It is very unusual for severely malnourished children to remain at home during treatment, and it must be noted that all three deaths occurred in this group. The 19 survivors had all been diagnosed before the age of 39 months.

A comparison group of children from the same cohort who had not experienced severe malnutrition was matched to the index group on the basis of characteristics at birth (sex, gestational age, season of birth, body weight, body lengh and psychomotor development).

The language development of the two groups was studied longitudinally (DeLicardie and Cravioto, 1975; Cravioto and DeLicardie, 1975a). Mean language development (measured by the Gesell method) was very similar in malnourished and non-malnourished children in the first year of life, when only one case of severe malnutrition had been diagnosed. During the following two years however, a significant difference in language development emerged. Mean values were significantly lower in the malnourished children, whose distribution of scores was also significantly different from the non-malnourished children.

Concept development was tested in the whole cohort by the use of 22 bipolar concepts (e.g. 'big-little', 'long-short') from Palmer's curriculum (Palmer, 1971) at four points between 26 and 38 months of age to establish norms for the group. When the severely malnourished and the comparison children were assessed, the mean number of bipolar concepts present in the former group was significantly lower than for the latter group at all ages tested. When tested at 46 months when all the malnourished children had been rehabilitated, there was a marked increase in the malnourished group, but they still had a language development lag compared with the well-nourished comparison children.

At the age of 5, the children were tested on the Wechsler Preschool Primary Scale of Intelligence (WPPSI). (Table 2.3) In general, the survivors of severe malnutrition had lower scores than the well-nourished children matched at birth (DeLicardie and Cravioto, 1974).

The Land of the White Dust cohort offered a unique opportunity to investigate some of the macro- and microenvironmental correlates of PEM (Cravioto and DeLicardie, 1976, 1974a, 1975a). Three kinds of macroenvironmental factors were assessed: biological and social aspects of the parents (age, height and weight of either parent, mothers'number of previous pregnancies, as well as the parents' personal cleanliness, literacy, educational levels, newspaper reading and radio listening), family structure (nuclear or extended, number of children in household) and socioeconomic status (source of family income, percentage of income spent on food, annual per capita income). Of these, only one was found to be significantly different between the malnourished children and the comparison children matched at birth - mothers' radio listening. Similarly, these investigators (Cravioto *et al*, 1967) found in a previous study that children whose mothers used only the local dialect to address them had weight gains that were significantly lower than children whose mothers used the national language. Cravioto and DeLicardie (1976) suggest that both these behaviours are related to the parents' interest in events outside the home and reflect choices between traditional and modern cultures.

A second comparison group was constituted which comprised full-term children who were matched to the survivors of PEM on the basis of sex and IQ at 5 years of age. Each malnourished child could therefore be compared with either a child matched for characteristics at birth, who shall be termed the 'birth matched comparison group' or a child matched for characteristics at 5 years of age, termed the 'IQ matched comparison group'. In this way it was hoped to be able to separate characteristics associated with low performance on the IQ test from characteristics associated with severe malnutrition. Table 2.3 compares the WPPSI IQs of the three groups.

The IQ matched comparison group did not differ significantly from the survivors of severe malnutrition or the birth matched comparison group on the biological characteristics of their parents, but were slightly, though not statistically significantly, worse off on the socio-economic status measures (DeLicardie and Cravioto, 1974). However, this IQ matched group were significantly different from the other two groups on the proportion of literate mothers and, like the birth matched group, had a significantly higher proportion of radio listeners among the mothers than the malnutrition survivors.

Table 2.3

Distribution of IQ scores (WPPSI) at 5 years of age in survirors of PEM and comparison children.

Land of White Dust. Delicardie & Cravioto, 1974.

I.Q. total score	Number of children Survivors of malnu-trition	Controls for sex and IQ.	Controls matched at birth
60-64	1	2	
65-69	2	2	
70-74	5	4	
75-79	2	2	1
80-84	3	3	2
85-89	1	1	5
90-94			2
95-99			3
100-104			0
105-109			0
110-114			1

As only one case of severe malnutrition occurred before the child was 12 months old,Cravioto and DeLicardie concede that some of the maternal attributes (e.g. multiparity, closely spaced pregnancies) and infant characteristics (birth weight, early weaning) which were poor predictors of malnutrition in this group could possibly be important in predicting malnutrition which occured early in the first year of life (Cravioto and DeLicardie, 1974a).

On a micro-environmental level, assessments were made with modified versions of the Bettye Caldwell HOME Inventory (Caldwell, 1967) at regular intervals from the age of 6 months to the age of 5 years. At all ages but 18 months, the birth matched comparison children were significantly different from the malnourished children. Of particular significance is the fact that the children's home environments were assessed to be qualitatively different on two occasions up to the age of 12 months when only one child had become clinically malnourished. Moreover, the IQ matched children were not significantly different from the malnourished children on the HOME inventory.

To further investigate non-nutritional influences on the children's development, at the monthly developmental assessments, the mothers' behaviour during the test session was independently recorded on a form of the Bayley Maternal Behaviour Profile (Cravioto and Delicardie, 1974a). Twenty categories, representing a wide variety of the mothers' responses were recorded. In 12 of the categories, significant differences (at the 5% level or less) were obtained. These categories are shown in Table 2.4. Furthermore, not only did the average behaviour rating differ between the malnourished children and birth matched comparison children, but differences in the proportions of specific behaviours were also found. For example, in the category 'Mother's sensitivity to child', whereas $33\frac{1}{3}$% of the mothers of malnourished children were 'not aware of the child's need for attention, support and comforting', this only applied to 6% of the birth matched comparison children; while 10% of mothers of malnourished children were 'always aware of child's needs and

Table 2.4 Aspects of the test situation to which mothers of severely malnourished children and of birth matched comparison children showed significantly different behavioural responses

Land of the White Dust (Cravioto and DeLicardie, 1974a)

Behaviour during test	p
Reaction when child performs easily	0.000
Response to interview	0.001
Sensitivity to child	0.001
Interest in child's test performance	0.003
Responses to child's needs	0.004
Mother's view of her role	0.006
Emotional involvement with child	0.009
Amount of verbal communication with child	0.015
Expression of affection toward child	0.016
Reaction when child performs extremely well	0.027
Status consciousness	0.036
Cooperation with examiner during testing	0.042

and his presence', 40% of the mothers of birth matched comparison children were so aware.

The authors acknowledge that a monadic theoretical model of mother-child interaction is inadequate and that a unidirectional approach, emphasising the mother's role, often pays insufficient attention to the possible dependence of mother's behaviour on the constitutional and temperamental characteristics of the child. However, their analysis of the mothers' behaviour appears to adopt the same approach, although they argue that this has been avoided by their measurement of mothers' responses to the test situation. The work of Chávez (Chávez and Martínez, 1979) with moderately malnourished children and their families demonstrates the apparent importance of the stimulus and behavioural characteristics of the child in the development of mother-child interaction. With well-nourished children, there is also evidence of the importance of the infant's developmental status in the determination of his/her social environment (e.g. Green et al, 1980). Although maternal behavioural differences were demonstrated before children became clinically malnourished, relationships between maternal behaviour and nutritional status may not necessarily be undirectional.

In addition to the assessment of IQ at 5, DeLicardie and Cravioto (1974) report detailed observations of the children's behaviour and verbalisations which were made during the administration of the test by an independent observer. The observer described the child's overt behaviour including, as far as possible, a verbatim account of the child's verbalisations when confronted with a task, disregarding the correctness of the response. These responses were analysed, following the logic tree of Hertzig et al (1968), as 'work' or 'non-work', as 'verbal' or 'non-verbal' and as 'spontaneous extension', 'delimitation', 'competence', 'negation', 'substitution', 'request for aid' or as 'passive'. In this way, an attempt was made to "compare the behavioural styles of survivors of clinical severe malnutrition and control children in response to demands for cognitive functioning".

The survivors of malnutrition, the birth matched comparison children and the IQ matched children were significantly different from each other in the proportion of work responses (X^2=32.97; df=2; p<0.001), with the survivors being closest to the IQ matched comparison group (X^2=8.58; p<0.01). The differences between the groups was also highly significant in the proportion of their responses which were verbal (X^2=53.80; p<0.001). The general pattern that emerged was that while survivors of PEM and IQ matched comparison children have similar styles of initial response to cognitive tasks, the birth matched comparison children show a different style, with 'non-work/non-verbal' behaviour being more common in the malnourished children and the IQ matched comparison children ~~and 'work/verbal' behaviour being more common in the malnourished children and the IQ matched comparison children~~ and 'work/verbal' behaviour predominating in the children matched to the malnourished children on birth characteristics.

Delicardie and Cravioto (1974) suggested that as the main environmental differences between the malnutrition survivors and the IQ matched comparison children on one hand, and the birth matched comparison children on the other, was the quality of stimulation available in the home as measured by the Caldwell inventory, the response style of the survivors of PEM must largely be due to the level of stimulation. However, when the children in each group with similar HOME scores were compared (7 survivors, 6 birth matched comparison children and 10 IQ matched comparison children), it was clear that, as they put it, "the antecedent of severe malnutrition appears to be another influential factor".

In discussing the predominance of unresponsiveness as a style of behaviour by the formerly malnourished children when presented with a cognitive task, these authors suggest that this style may lead to "a quick answer without regard for its accuracy" or "low scores on tasks that require speed of response". This prediction appears to be supported by the findings of Witkop et al (1970) and Klein et al (1973) that formerly malnourished school age children tended to respond very rapidly even when advised to reflect on their answers.

In this study therefore marked similarities were found between the children who had low IQs at 5 and the survivors of severe malnutrition in both their home environments and their response styles to cognitive tasks. These data tend to support the social environment as an important causative factor in the mental retardation shown by the survivors of malnutrition. There are however sufficient differences between the group of formerly malnourished children and the IQ matched comparison group to suggest that the experience of malnutrition also had an important effect. The Jamaican study of Richardson and his colleagues (Richardson, 1974, 1976) further investigates these interactions of micro-environmental factors and nutritional status.

The Jamaican study of Richardson et al

The second study of severely malnourished children that will be discussed in detail is a study of the long-term sequelae of PEM in Jamaican children carried out by Birch, Richardson and others (e.g. Birch and Richardson, 1972; Richardson et al, 1972, 1975). Until the present study was undertaken, this provided the only available information about the psychological development of Jamaican children who had experienced severe malnutrition, and provided the impetus for the research which will be described in this report.

74 male children who had been treated for severe protein-energy malnutrition (kwashiorkor, marasmus and marasmic-kwashiorkor) at the Tropical Metabolism Research Unit and the Paediatric Department of the University of the West Indies in Jamaica before the age of 24 months were selected for study. The mean length of their hospital stay had been 8 weeks. At the time of the study, these "index" children were aged 5 years 11 months to 11 years.

Two comparison groups were also selected for study. The "classmate" or "neighbourhood" comparison group comprised unrelated children, the classmates of those index children who attended school and the neighbours of those who did not. This resulted in 71 matched pairs of index and comparison children. 8 of the comparison children were found to have been sick before the age of 2 years "either from malnutrition or with symptoms that could have been associated with malnutrition", but only one had been hospitalised during that time with gastroenteritis (Birch and Richardson, 1972).

The "sibling" comparison group of 38 children consisted of male children aged 6 to 12 years, described by Birch and Richardson (1972) as "having the same biologic mother as the index patient and having shared a home residence with the index child for most of his life". The child nearest in age to the index child was selected, but the siblings were somewhat older than the index children.

Physically, the rural index children were significantly different in weight, height and head circumference from both the neighbourhood comparison group and the sibling group at the time of the follow-up tests, but the index - sibling difference did not apply in the urban children (Richardson, 1975b).

The intellectual development of the children was assessed using the WISC and the verbal scale of the WPPSI (Birch and Richardson, 1972; Hertzig et al, 1972). All mean IQ measurements - Full scale, Verbal and Performance - were lower for the index children than for the two comparison groups, with the neighbourhood group having the highest scores. The difference between the index children and the neighbourhood children was significant at less than the 0.1% level of confidence in all three measures. The index children differed from their siblings on the full scale and verbal IQs ($p<0.025$). The siblings only differed from the neighbourhood group on Performance IQ. The researchers argue that these differences were not artifacts either of age differences between the groups or of differences in ordinal position. Age on admission to hospital, which ranged from 3 to 24 months, was not related to the level of school-age IQ.

In explaining their choice of the WISC, Hertzig et al (1972) state that "although this intelligence test has not been standardised for Jamaican children, its use in the present study is appropriate". However, one can argue that the inappropriateness of the test is demonstrated by the fact that many of the children in the study failed to answer any of the test items correctly. According to the WISC scoring convention, a child who had no correct answers would score a "floor value" of 46 for the full scale and the verbal scale IQ and 44 for the performance scale IQ. Table 2.5 shows the number of children in the index and comparison groups to score 46. In both the full scale IQ and the performance IQ, 23% of the index children could not answer any of the questions correctly. The percentages for the comparison group were 7% and 5% respectively.

Hertzig et al (1972) argue that "because the index cases have the lowest scores, the effect of this artifact of scoring is to provide an excessively conservative estimate of the size of the differences in intelligence between the index cases and the comparison children and between the index cases and the sibs". This may be true, but the fact that the distribution of the scores is distorted in this way does raise doubts about the validity of the scores. Pollitt and Thompson (1977), in their criticism of cross-cultural application of standardised tests, point to the use of the WISC in this Jamaican study as an example of researchers disregard of "indications from test data that the tests do not behave in the same manner as in the culture in which the test was developed". These authors also point to the discrepancy between the IQ scores and the school performance of the Jamaican children as further evidence for this.

Table 2.5 Children in index and comparison groups performing at or below the floor scoring level of the test scales.

From Hertzig, Birch, Richardson and Tizard, 1972.

	Full scale IQ		Verbal IQ		Performance IQ	
	Index	Comp	Index	Comp	Index	Comp
≤46	17	5	3	1	17	4
>46	57	69	71	73	57	70
X^2:p	0.01		N.S.		0.01	

Richardson et al (1973) report on the achievement test scores, class grades and teachers' evaluations of the boys who attended school. They state that in populations on whom IQ tests have been standardised, and in disadvantaged children in particular, the correlation between IQ tests and school achievement is about 0.5 or lower. The evaluation of school performance therefore "provides functionally relevant estimates of cognitive level and complements information provided by intelligence testing". Few studies other than Stoch and Smythe (1967, 1976) in South Africa have examined the educational achievement of formerly malnourished children.

Reading, spelling and arithmetic skills were measured on the Wide Range Achievement Test (WRAT; Jastak and Bijou, 1946). The index and sibling average quotients were almost identical. The index children had significantly lower scores than their classmates on all three tests, while the siblings only differed from their classmates on the reading test. Correlations between the WRAT and the full scale WISC scores ranged from 0.45 to 0.67.

The teachers were asked to evaluate the children's performance over a period of 2 or more weeks. Here again, index children scored lower than classmates, while the siblings and their classmates did not differ significantly. 24% of the index children, in contrast to 8% of their classmate comparison group, were rated in the lowest category "he is severely backward". When median grades across subjects were obtained for each child, the pattern was maintained: index children had a significantly lower median grade than their classmate comparison children, while their siblings and their classmates did not differ significantly. In a comparable pattern, index children were rated significantly more often than their classmate comparisons as having special problems in class work while siblings were not.

The suggestion from Richardson and his colleagues at this point therefore was that the levels of school achievement of formerly malnourished children and their siblings reflect common elements in their home environments contributing to their low functioning, but that the IQ test results suggest that an acute episode of malnutrition may have been "an additional factor contributing to the low cognitive funtioning of the index children beyond the influence of the general social, physical and biological background".

Teachers who did not know the children's medical histories were requested to rate the children's behaviour as well as their achievement at school (Richardson et al, 1972). 58 index children and matched classmate comparison children together with 31 of the sibling group and their classmates were included in this analysis. In the teachers' evaluation of children's behaviour related to classwork (e.g. ability to pay attention) and their social relationships with adults and children in school, as well as their frequency of behaviour problems, the general pattern was that the index children were significantly different from their classmates in a less favourable direction (in at least 5 out of 8 categories at less than the 0.1% level of confidence). On only one comparison was the sibling group different from their classmates. As far as behaviour or conduct problems were concerned, the formerly malnourished children were overrepresented in the categories of behaviour described as "shy, withdrawn, hard to reach" and "unresponsive, poor speech and lacking in communication". Siblings were also overrepresented in the former category, but not in the latter.

These judgements by the teachers were supported by the assessments of the children in sociometric studies in the index boys' classes. The index boys were less popular with their classmates than was the case for the comparison group.

This behaviour was apparently also typical of the children at home (Richardson et al, 1975). Mothers of formerly malnourished children assessed their children as different from other children at home more frequently than the mothers of the comparison children, the index boys being described more frequently than the comparison children as "backward, retarded, withdrawn, solitary or unsociable" and less often as "aggressive, stubborn or disobedient". The index children were also rated by the mothers as significantly less mature than the comparison children as well as more awkward and lacking in vitality.

Differences between the ratings of index children and their siblings were not statistically significant, but were in the same direction as index-comparison differences.

Richardson et al (1972) summarises the composite picture of the index boys' behaviour thus: "a passive, quiet and withdrawn child rather than one who is aggressive and tends to act out". They argue that factors contributing to the behavioural impairments are unique to the formerly malnourished child.

71 of the index children and their comparison children were included in the investigation of the background histories of children who experienced severe PEM (Richardson, 1974). From questionnaires, it was found that the past and present lives of the mothers (or guardians) of the index children were more disadvantaged than those of the comparison children, that the

economic and housing conditions of the index children were of a lower standard, that the index boys were more disadvantaged in respect of the stimulation in the home and that the rate of mortality of siblings of the study children was greater for the families of the index children than for families of the comparison children. The results of the questionnaire are summarised in Table 2.6.

In general, therefore, the index boys lived in families that were more isolated socially, with caretakers who had fewer human and material resources and were generally less capable than was the case for the neighbourhood comparison children. These findings are in line with those of Cravioto's study (Cravioto, et al 1967; Cravioto and DeLicardie, 1974a). Richardson (1974) argued that these data point to a "need to shift emphasis away from primary attention to malnutrition as a cause of functional impairment in later childhood to a broader concern for the ecology of child development where malnutrition is one of an array of variables that are hypothesised to influence the functional development of children".

In another stage of this study (Richardson, 1976), the relationship of presence/absence of malnutrition in infancy, height at follow-up (used as an "indication of children's overall life history of nutrition") and social background to school age IQ was examined in 71 matched pairs of index and neighbourhood comparison children. An early acute episode of severe malnutrition appeared to have markedly different consequences for IQ depending on the social background of the children.

With the two groups combined, the tallest boys (more than 0.5 standard deviations above the Jamaican standards) were found

Table 2.6 Differences in social background of formerly malnourished and comparison boys.

from Richardson, 1974

Background variable	X^2 P level
Caretaker variables	
Caretaker's upbringing and education	< 0.005
Mother's general reproductive history	< 0.01
Mother's pregnancy with study child	< 0.05
Caretaker's level of capability	< 0.01
Caretaker's contact with media	< 0.05
Caretaker's human resources	< 0.05
Economic and housing variables	
Structure and condition of house	< 0.05
Home furnishings and appliances	< 0.025
Amount of crowding in the house	< 0.005
Education and social variables (child)	
Extent of child's social relations	N S
Intellectual stimulation	< 0.05
Caretaker's child-rearing practices	N S
Amount of schooling	< 0.0005
Familial Mortality	
Mortality among siblings	< 0.005

to have significantly higher IQs than the shortest boys (more than 0.5 standard deviations below the Jamaican standards). In addition, in this combined group, boys with the most advantageous social background history scores(the highest 3 deciles of the scores)had significantly higher IQs than those with the most disadvantageous scores (the lowest 3 deciles). The 3 factors of malnutrition in infancy, height at follow-up and social background together were found to account for 46% of the variance in IQ, with the largest contribution being made by social background (29%) and the smallest by malnutrition(5%).

A further comparison was made between the IQs of a group of formerly malnourished boys with the shortest heights who had social background scores in the lowest 4 deciles and a group of the tallest well-nourished children with the highest social background scores. Only 2 boys of the latter group overlapped in IQ scores with the former group.

Under certain conditions however,the formerly malnourished index children had higher IQs than the comparison children. For example, tall index boys from favourable home backgrounds have an average IQ 11 points higher than short comparison boys from unfavourable homes. Under the most favourable conditions, there was only a difference of 2 points between the mean IQs of the two groups.

Richardson (1976) concludes:

"If severe malnutrition in infancy occurs in a context of a life history which is favorable for intellectual development, an early acute episode of malnutrition appears to have a negligible effect on intellectual functioning. If, however,the early acute episode of malnutrition occurs in an unfavourable set of circumstances for intellectual development, the early acute malnutrition has a clear relation to later intelectual impairment". Discussing the particular context of this study, Richardson continued,

"Whether different results would have been obtained using girls, different ages at follow-up, and poor conditions of medical care and nutrition during the acute episode and convalescence must be answered in other studies".

These studies have, in general, demonstrated deficits in intellectual development in children who have experienced an early episode of severe malnutrition requiring hospital treatment. However, none of the studies have been able to prove that malnutrition per se produced these effects. Apart from the general picture of physical and social deprivation that forms the background for malnutrition, there is the suggestion that the homes of the malnourished children are different from others within the same social stratum.

But, in spite of the inability to attribute causality, or even to make definite conclusions about associations, certain suggestions emerge from the large quantity of data that has been collected. Evidently the survivors of malnutrition perform poorly on intellectual tasks relative to intra- and extra-familial comparison groups. The findings on specific types of intelligence test items are inconsistent, often from inappropriate tests, but general IQ appears to be depressed in formerly malnourished schoolchildren. The ability to recognise forms presented across sensory modalities is also impaired, but the apparent differences in attention and response styles may be significant influences on performance on such tasks. Important mediating roles in the development of severely malnourished children may be attributable to different patterns of social interaction but a long period of hospitalisation in early childhood may itself be important for social development.

Moreover, the prognosis for the severely malnourished child appears to be largely dependent on the social milieu, as is known to be the case for children who have not experienced severe nutritional deprivation. It would therefore seem to be imperative to develop treatment regimes which include behavioural as well as nutritional components.

2.4.4. Behavioural intervention with severely malnourished children

Behavioural intervention programmes with severely malnourished children have been reported in Lebabon (McLaren, 1975, Yaktin and McLaren, 1970; McLaren et al, 1973, 1975), Mexico (Cravioto, 1977) and Chile (Monckeberg, 1979).

In the Lebanese study, 30 marasmic Arab children, admitted to hospital between the ages of 2½ and 16 months of age (mean = 8 weeks), were assigned to either a standard 5-bed hospital ward (the "unstimulated" group) or a similar room which had additional provisions (the "stimulated" group). The children stayed in hospital for a minimum of 4 months and the medical care was similar on the two wards.

The behavioural intervention appeared to be generalised rather than specific, as indicated by the following description by McLaren (1975):

> "The stimulated group was provided with a rich environment and a warm nurse-child relationship. They lived in a colourful 5-bed ward which was decorated with animal pictures, red patterned curtains, and a bright colored linoleum on the floor. A variety of toys, baby chairs, a pram, a play pen, and music were provided for the children. The nursing staff spent part of their time playing with, singing to, and nursing these children".

In hospital, the children were assessed on 8 occasions at fortnightly sessions on the Griffiths Mental Development Scales. The scores of both groups improved over this period, but the stimulated group did so to a significantly greater extent than the unstimulated group. Information about the children's performance on the subscales of the test are only provided for the two groups combined. Yaktin and McLaren (1970) do report, however, that the groups, which were not significantly different from each other on the subscales at the first test, reached significantly different levels on the Hearing and Speech and the Eye Hand Coordination Scales at tests 4 to 6, and on the Personal Social scale at test 4.

McLaren (1975) reported that a "comparable group of young children from the same low socio-economic class who were physically normal" obtained scores of between 106 and 111 over 8 tests. No further information is given about the comparison group, and although initially the two marasmic groups were reported to have been matched for age and sex, the size of groups changed throughout the study.

After discharge home, some of the formerly malnourished children were tested at 3-monthly intervals, as were the comparison group (Yaktin et al, 1971, McLaren, 1975). Unfortunately, there was a high rate of attrition, so that at the fourth test session (one year after discharge for the malnourished children), no group had more than 5 children. The mean DQs obtained by the three groups over these 12 tests are shown in Table 2.7, along with the mean Stanford-Binet IQs obtained approximately 1 year after the twelfth test (McLaren et al, 1973, 1975).

Little information is given about the homes of the children. They all came from "a low socio-economic class", with an income of the equivalent of twenty pounds per month or less, and "the majority of the fathers and almost all the mothers

Table 2.7 Griffiths DQs of Malnourished and Well-nourished children

from McLaren, 1975.

	Groups					
	Malnourished				Well-Nourished	
	Stimulated		Unstimulated			
Tests	DQ	N	DQ	N	DQ	N
1	52	20	49	20	106	20
2	63	20	56	20	107	20
3	69	20	61	20	108	20
4	71	20	63	20	109	20
5	76	20	63	20	109	20
6	78	20	65	20	109	20
7	78	20	68	20	111	20
8	79	20	69	20	109	20
Follow-up tests						
1	88	16	85	17	110	20
2	84	13	88	12	105	16
3	86	6	81	9	100	9
4	83	4	81	5	105	5
5	79	15	86	15	99	15

were illiterate" (Yaktin and McLaren, 1970). When visited at home, "there were no obvious differences between the home environmental conditions of the two groups" (McLaren et al, 1973).

When the children were tested on the Stanford-Binet, they were compared to four additional groups. Children who were "known to have been moderately undernourished for about three years" though "they had never been hospitalised or received nutritional treatment" formed the "undernourished" group, and in addition, groups were formed of the siblings of each of the malnourished groups. The children were aged between 37 and 60 months at the time of this test. The unstimulated group scored significantly higher than the stimulated group for IQ and Memory, while the undernourished group had higher scores than the stimulated group for IQ, language, memory and social intelligence. The healthy siblings of the malnourished children consistently obtained the higher scores and in the majority of instances, the sibling groups' scores were not different from those of the well-nourished comparison group.

McLaren (1975) concluded that "the apparent beneficial effects of stimulation during rehabilitation are evanescent". However, given the nature of the additional stimulation, its short duration and the apparent unsystematic nature of the follow-up, this study cannot be taken as a satisfactory test of the effects of behavioural intervention on the development of severely malnourished children.

Cravioto's behavioural intervention programme* was carried out with members of a group of 23 severely

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* Cravioto, 1977; Milán et al (undated).

malnourished children admitted to the Hospital Infantil de Mexico before the age of 6 months. 3 groups were formed: a "Non-stimulated" group who were given the standard treatment (7 infants), a "Stimulated" group who received "a programme of systematic cognitive, language and emotional stimulation" (13 infants), and a group termed the "Self-stimulation" group who "instead of showing the apathy, immobility and lack of expression characteristic of severe malnutrition were active, smiling, and frequently asking through facial, hand and body movements for interacting responses with any person nearby" (3 infants). For this last group, "the staff could not let down these charming infants who thus became stimulated although not in a systematic way and not for specific behaviours".

The programme for systematic stimulation is described as having the following elements (Cravioto, 1977):

1. "A reproducible model of mother-child interaction", based on the work of Ainsworth was applied by a psychologist and the nurses attending the children.

2. "The micro-environment of the stimulated infant was reconstructed and run so as to have a high rating when assessed by the Inventory of Home Stimulation devised by Bettye Caldwell (Caldwell, 1967)."

3. Based on the record of performance of each infant on the Gesell and Uzgiris-Hunt development scales, the child was taught the next behavioural step in each scale.

4. "Social reinforcement was the only type of reward given to the infants and staff. Non-desirable behaviours were not reinforced".

At the end of six months of this treatment, the stimulated group had made significantly greater gains in test scores than the other two groups. The "self-stimulated" group showed some gains over the non-stimulated group. It must be noted here that the children were apparently tested on the Gesell scales - the scales on which the stimulated group had been "stimulated to acquire the next behavioural step in each particular scale" according to a "detailed individual program".

In spite of many attempts, it has not proven possible to get further details of this study. However, the impression that the children in the stimulated group were actually taught to do the test items is borne out by the observations of a visitor to the Hospital Infantil who was shown the Gesell test equipment as the material used in the behavioural intervention programme.

In summary, however, Cravioto (1977) states that the data indicate that

> "the addition to the dietary management of a program of systematic stimulation given within the context of a good mother-child interaction brings the majority of nutritionally rehabilitated infants (7 to 9 out of every 10) back to the normal age expected levels of performance on the Gesell Scales of Development. As a contrast, only 3 of every 10 infants who received the dietary and medical treatment without systematic stimulation reached the levels of performance accepted as normal."

The mother-child interaction refered to by Cravioto is apparently the relationship with the nurses. There is evidently very little involvement of the mothers in the programme on the wards. Without giving further details, Cravioto adds that some children, whose mothers learnt to carry on the programme and whose mothers' attidudes and child rearing practices had improved, had "continued to show normal performance at each age tested" during the following year.

In Chile, Monckeberg (1979) was involved in the assessment of the relative merits of treating severely malnourished children in the traditional paediatric hospitals or in a smaller, specialist centre for the treatment of malnutrition. The traditional treatment focused exclusively on the medical and nutritional needs of the children. The Centre provided additional "psychosensory stimulation, based on the concepts developed by Piaget and by Weikert" for a half-hour twice daily in addition to a similar period of physical exercise, with "affective stimulation, provided by volunteers throughout the day". Unlike the intervention studies reported so far, the families of the children at the Chilean centre were included in the programme through, for example, the provision of counselling and the integration of the mothers into the treatment programme.

No details are given of the feeds given to the children, but surprisingly, Monckeberg says "In our experience, 30% of the children who suffer from severe malnutrition require at least 6 months of hospitalisation before they begin to show signs of a real recovery". This study, as well as McLaren's (1975) and Cravioto's (1977) report particularly long periods in hospital for the treatment of severe malnutrition. Though he does not state his criteria for "signs of real recovery", Monckeberg reports only the weight deficits and the height deficits of the children and does not report percentages of weight for height, the criterion for recovery used by nutritionists such as Ashworth (1979). As children on <u>ad libitum</u> high calorie feeds have been shown to spontaneously reduce food intake and to decelerate their weight gain when 100% weight for height is approached (Ashworth,1969), the use of weight for age as the measure of recovery from malnutrition could be responsible for the long periods of hospitalisation reported in these studies.

Unfortunately, in Monckeberg's study, the presence/ absence of psychosensory stimulation is confounded with the use of different centres and staff. For example, he attributes the lower mortality rate of the treatment centre (0 compared with 29% in hospital) and the centre's lower incidence of intercurrent infections (with a mean number of episodes of 0.3 ± 0.6 at the centre and 4.5 ± 0.2 at the hospital) to the greater contamination by pathogenic microorganisms of the hospital wards. The children in the centre generally made better clinical progress than the children treated in hospital. Without stating which standards were used, Monckeberg reports initial height deficits of 76% (hospital group) and 82% (centre group) which seem physically impossible if appropriate standards were used. At the 150th day, these deficits had been reduced to 65% and 21% repsectively.

Monckeberg only reports psychomotor quotients (test not stated). In the hospital group, there was a mean gain of 9 points from 56 ± 8 on admission to 65 ± 12 on the 150th day, while the centre group who had additional stimulation gained, on average, 30 points (from 55 ± 5 to 85 ± 7). Highly significant differences between the groups are reported at the 50th, 100th and 150th days after admission to the wards. In the centre group, which had a mean age at admission of 5 months, larger mean gains were recorded for the children admitted before the age of 6 months (24 points) than for the children admitted aged between 6 and 12 months (12 points).

The hospital group was not followed up after discharge, but 250 days after discharge, the centre group were found to have continued to catch-up in their standardised weights and heights, but their mean psychomotor DQ remained the same as at discharge.

The effects of foster placement and adoption, more radical and permanent kinds of environmental change, have also been investigated (Robertson, 1976; Winick et al, 1975; Nguyen et al, 1977; Winick, 1979).

5 severely malnourished South African children (members of the same family) were placed in foster care when they were aged between 3 years 6 months and 8 years 9 months. Apart from the comment that "all the children have been slow at school and have failed in the substandards" during their 6 year follow-up, little information is given about the intellectual abilities. Moreover, the author adds that "there are so many possible contributory factors that it is not possible to say that the intellectual retardation is the result of their early malnutrition" (Robertson, 1976).

IQ levels of Korean children of school age who were either moderately or severely malnourished in infancy, adopted into the 'enriched environments' of American families, were related to their nutritional histories by Winick and his colleagues. Age of adoption was an important influence on the magnitude of the differences between the groups. Children adopted before 2 years of age achieved at least normal IQs. The mean IQs were 102 for previously severely malnourished children, 106 for previously moderately malnourished children and 116 for those who were well-nourished. In children adopted after 2, the mean IQs were 95; 101 and 105, respectively. It is not possible from this retrospective study to determine the relative roles of nutrition, duration of malnutrition, age at adoption and genetic factors, but these data support the suggestion that a lifetime of favourable experiences may nullify the effect of severe malnutrition in infancy (Richardson, 1976).

2.4.5 Severe malnutrition in middle class populations

There have been attempts to evaluate the effects of severe malnutrition on child development in the absence of the usual concomitant social deprivation. These have typically been carried out in upper social class populations in developed countries on children with malnutrition secondary to neonatal disorders such as cystic fibrosis, pyloric stenosis or other gastrointestinal diseases. The relevance of these studies to the issue of infantile malnutrition in Third World countries has been questioned (Dobbing, 1974; Pollitt and Thomson, 1977). Pollitt and Thomson state that because of "the very fact that the malnutrition variable is divorced from the poverty variable", conclusions from these studies may not be generalisable to situations where the two factors exist, as the effects may be largely interactive rather than independent. Another important factor is that the neonatal disorders ofter require corrective surgery, an experience which may in itself have long-term sequelae.

In one study, Klein et al. (1975) report on subjects aged 5 to 14 years (mean: 9 years 2 months) who had previously experienced surgery for congenital hypertropic pyloric stenosis, which had resulted in "a brief period of starvation" ranging from "minimal dehydration" to "gross starvation" beginning between birth and 3 months. These children were compared with groups of siblings and comparison children matched for such characteristics as social class, parental education, and gestational and medical histories. No consistent differences between the groups were found in the Peabody Picture Vocabulary Test or Ravens Matrices, although within the formerly malnourished group, performance on tasks involving memory and attention, in particular, was reported to be negatively correlated with severity of early malnutrition.

Lloyd-Still <u>et al</u> (1975) had a sample of 36 patients aged 2 to 21 years from social classes III and IV. These subjects, who had experienced severe malnutrition in infancy secondary to cystic fibrosis and other gastrointestinal lesions, were tested on a range of tests (including the Merrill-Palmer, Lincoln-Oseretsky test of motor ability, WISC and WAIS) and compared with a)the test norms and b)a group of their siblings.

The wide age range with the consequent small numbers at each age level and the variety of tests necessary make interpretation of these results difficult. For the authors, the data were seen to be consistent with the hypothesis that early malnutrition can affect subsequent behavioural development, as significant differences in performance were found for the youngest children. As the IQ differences appear to diminish after the age of 5, they suggest further that the effects of malnutrition "are reversible, given adequate socio-economic support from the family", a conclusion in line with those of Richardson (1976).

Valman (1974) reports that, based on the Harris 'draw-a-man' test and school reports, a group of 8 patients aged 3 to 14 years who had early malnutrition caused by neonatal resection of the ileum (all that had been treated at one hospital over a 20 year period) did not have a frequency of mental retardation which was higher than the normal population. 13 patients with cystic fibrosis, aged 7 to 12 years, also had similar scores to a comparison group of 26 unselected schoolchildren from a local school.

The findings of these three studies, though they present some difficulties in interpretation, would appear to suggest that in a privileged setting, any effects malnutrition may have on intellectual development are temporary or at least reversible. It must be noted however, that the malnutrition experienced by the children in these studies was often in extremely brief acute episodes and quite dissimilar from the pattern of malnutrition encountered in countries where malnutrition is endemic.

In a similar vein, Stein et al (1975) examined the intellectual competence of Dutch individuals exposed prenatally to the famine of winter 1944-45 which resulted from the Nazi occupation of the Netherlands in World War II. A national population of young military recruits were tested on several measures of mental performance which included the Ravens Matrices, language comprehension test and the Bennett test of mechanical competence. This group showed no effect of prenatal exposure to famine. There did not appear to be distortion due to selective famine-induced mortality. Moreover, such social indices as social class, religion, family size and birth order did not interact with famine exposure to influence mental development. This can be seen as further eveidence in support of the hypothesised ameliorative effects of favourable environmental conditions on development after early nutritional deprivation.

2.4.6 Studies of Development of Moderately Malnourished Children.

Although moderate (subclinical) protein-energy malnutrition is more prevalent than the more severe forms (Table 1.2), this type has been the subject of fewer investigations. This is most likely because children with severe malnutrition are usually contacted when they present for treatment at a hospital or clinic, whereas children with chronic moderate malnutrition most likely will not contact medical personnel until some acute episode such as gastroenteritis or measles exacerbates their condition. Also, to some extent, interest in the effects of moderate malnutrition developed more recently, after it became apparent that severe malnutrition was associated with developmental deficits.

Some studies of moderate malnutrition have employed a cross-sectional approach, a history of moderate malnutrition being inferred from reduced anthropometric measurements, particularly reduced stature, in communities where marginal nutrition is known to be prevalent (e.g. Monckeberg et al, 1972). There have been criticisms of this assumption (Habicht et al, 1974; Birch, 1972), but significant correlations between physical growth and IQ have been interpreted, at least in part, as evidence of the effects of nutrition on development.

Monckeberg and colleagues (1972), working in Chile, assessed a random sample of 220 slum-dwellers aged 1 to 5 years (median: 3 years). 90 well-nourished middle class Chilean children of similar ages formed a comparison group. These two groups were found to have significantly different proportions of children with scores within the normal range on both the Gesell test (1 to 3 year olds) and the Terman-Merrill IQ test (3 to 5 year olds).

Within the deprived group, 2 subgroups were formed according to the children's weights. The group of 14 well-nourished children were found to have IQs that were significantly higher than the group of 76 nalnourished children in all areas of the tests. The well- nourished children, however, still fell below the level of IQs recorded by the middle class children. Furthermore, in the deprived group, the percentages of height deficit shown by the children were significantly correlated with their general DQ/IQ scores. In the group of children whose head circumference measurements were small for their age, the head circumference deficits were significantly correlated with IQ, though this relationship was not significant when cranial growth was normal. Both height and head circumference can be assumed to reflect the chronicity of the malnutrition experienced by the children.

On the basis of a nutritional survey, a significant correlation was also observed between mental performance and daily intake of animal protein, though not with total protein or total calorie consumption. Unfortunately, enough social background information was not given to make this finding meaningful, though the report does state that there was a significant negative correlation between the malnourished group's mothers' IQs and the children's growth deficits.

Monckeberg et al (1972) state that these data do not allow the formation of conclusions, but that they "strongly suggest that undernutrition is an etiological factor in the psychomotor retardation observed in groups of low socio-economic status". There is evidence that the microenvironments of children living within the same slum settlement may differ considerably (Cravioto and DeLicardie, 1972, Mora _et al_, 1974), so more of this type of information would be necessary before nutrition can be assumed to play a causal role.

One approach to the study of moderate malnutrition has been through prospective longitudinal studies of deprived populations with endemic malnutrition, in which some mothers and children have received food supplementation while others have remained on their usual diets. The rationale for these studies is that the communities were moderately malnourished and in this way, groups of chronically malnourished and non-malnourished individuals could be formed for long term study. These projects have been carried out in Latin America and the Institute of Nutrition of Central America and Panama (INCAP) study in rual Guatemala is one such project (Irwin _et al_ 1979). As Klein _et al_ (1977) expressed it in reference to this study, "the effects of deprivation are measured indirectly by observing the extent of _improvement_ with adequate nutrition".

Four Guatemalan villages, "matched in a number of demographic, social and economic characteristics" were selected for study. In 2 villages, a high calorie corn-based drink (atole) was made available, while in the others, a non protein drink (fresco) which was low in calories (less than 1/3 of the calorie content of atole) was provided. Micronutrients were adequate in the two drinks. All children under 7 years old at the beginning of the study and all born during a 4 year period were included, a total of 1639 children.

In physical development, the prevalence of retardation of height and weight was consistently greater in the fresco group than the atole group. Irwin et al (1979) report that the risk of growth retardation was almost 3 times greater at three years of age in the poorly supplemented group than in the well supplemented one.

A battery of 22 tests was given to the children to "provide the greatest chance of identifying which specific kinds of functioning are affected by malnutrition" (Klein, et al, 1977). Tests were selected and adapted to local needs and efforts were made to assess 'emic' validity (i.e. the extent to which the measured behaviours were perceived by the villagers to be of functional significance). Adult ratings of children's "smartness", parental decisions based on their assessment of children's intellectual ability, observations of children in informal settings and school performance measures were all taken into account in the validity studies (Klein et al, 1973; Irwin et al, 1977). The pattern of relationships between these measures and the tests suggested a multi-dimensional concept of intellectual competence in school children which was in many ways different from the North American concept (Klein et al, 1977), reinforcing the criticisms by such writers as Pollitt and Thomson (1977) of the choice of tests in some studies of malnourished children in developing countries.

The tests showed an increasing difference between groups of children receiving different levels of calorie supplementation. The Brazelton Neonatal Assessment Scale was administered within 10 days of birth to 157 infants (Brazelton, 1973; Brazelton et al, 1977). Although behaviour reflecting neuro-motor and social development was significantly related to children's gestational ages, birthweights, age at test and maternal reproductive histories, height and socio-economic status, their relationship to maternal supplementation was not statistically significant.

On the "Composite Infant Scale", comprising items from the Bayley, Cattell, Gesell and Merrill-Palmer tests, there was no apparent effect of supplementation at 6 months. Highly significant differences between groups with different levels of supplementation emerged at the second test session at 15 months and they were maintained at the 24 month test (Table 2.8a).

Annually from 3 to 7 years of age, the children were given the "Preschool Battery", test of memory, language and perceptual skills as well as measures of persistence on an impossible task and of inhibition and control (ability to draw a line slowly). Between the ages of 3 and 7, supplementation effects were reported in a variety of tests, but most consistently in the short term memory Digit span test (Irwin et al, 1979). Table 2.8b shows the levels of significance of group differences in the Preschool Battery at 3 and 4 years of age. At 7 years, the only significant supplementation effect was in the boys' performance on the Digit span test. In general, the boys showed more consistent effects of supplementation. Multiple regression analyses revealed significant effects of supplementary calories on composite test scores, with effects of quality of home environment removed, at 3 to 6 year tests for boys, but only at the 3

Table 2.8 Differences between groups of children classified according to amount of calories ingested: Levels of significance.

Klein, Irwin, Engle and Yarbrough, 1977.

a) Composite Infant Scale

Test	Age		
	6 mths	15 mths	24 mths
Mental scale	NS	< 0.005	< 0.005
Motor scale	NS	< 0.005	< 0.005

b) Preschool Battery

	36 mths	48 mths
Embedded figures test:		
Sum	NS	NS
Time	NS	NS
Adaptability	NS	NS
Digit Span	NS	NS
Sentence span	NS	NS
Reversal Discrimination Learning:		
Sum	NS	< 0.05
Time	< 0.01	NS
Vocabulary:		
Naming	< 0.01	< 0.005
Recognition	< 0.05	< 0.005
Verbal analogies	< 0.05	NS
Inhibition & control	< 0.01	NS
persistence	NS	NS
Composite cognitive score	NS	< 0.025

year test for girls. For girls and boys, supplementation was found to have a greater effect where the home environments were more deprived. Quality of home environment and supplementation variables together explained between 23% and 56% of test performance variance for boys and between 26% and 63% for girls.

In general, the findings on the effects of moderate malnutrition on intellectual development have been inconsistent. For instance, associations were found between mild-moderate malnutrition and mental and motor development in a study of Guatemalan infants (Klein et al, 1974), while Graves (1972) found no systematic relationships between nutritional status and intellectual development in Nepalese children of similar ages.

In another study, differences in weight were accompanied by differences in neurointegrative competence in rural Guatemalan children up to the age of 11 (Cravioto et al, 1966; Cravioto and DeLicardie, 1968). In a cross-sectional study in a rural Guatemalan village, children aged 6 to 11 years in the lowest quartile for height were compared with children of the same ages in the tallest quartile. An additional group of urban children was constituted for comparison. Visual, haptic and kinaesthetic modalities were investigated. In the rural group, marked differences in intersensory performance were found which were closely related to height. These differences were present in all three combinations of sense modalities at all ages, and were particularly clear when the number of errors of nonequivalence were compared (i.e. when child misjudged identical forms presented across two modalities). Although the authors of these reports state that the absence of this relationship in well-nourished urban school-children can be interpreted as strengthening the case for the causal role of malnutrition, this view has been challenged by Hoorweg (1976) who questions their conclusions about their urban sample. In any case, the possible effects of social differences between the children on neurointegrative performance have not been eliminated.

With moderate malnutrition, as with severe malnutrition, differences in microenvironmental characteristics may exist between the groups of undernourished children that have been studied and their peers which could account for any developmental differences between the groups. In Columbia, when children up to the age of 66 months were classified as well-nourished or moderately malnourished on the basis of anthropometry, well-nourished children obtained higher DQs than malnourished children (Mora et al, 1974). However, in the families of the malnourished children, more people were sharing less living space, fewer material goods and less food in comparison with the families of well-nourished children in the same neighbourhood. The malnourished children were also disadvantaged in other ways. They had less favourable attention from their mothers and were disadvantaged in their pre- and post-natal medical histories and current status.

In the analysis of these data, a significant proportion of DQ variance could be attributed to differences in nutritional status as measured by weight and height even when all the variance explained by the recorded health and social factors was accounted for. As a result, Mora and colleagues (1974) concluded that the effect of malnutrition on cognitive functioning was significant and can be isolated from the effects of non-nutritional factors, while conceding that if other health and social parameters had been measured the results could have been different.

In one study of subclinical malnutrition, the children were assessed on Casati and Levine's (1968) scale, a measure of Piagetian sensorimotor stages (Dasen, 1973; Dasen et al, 1977; Lavalée et al, 1979). 23 rural Baoule children from the Ivory Coast between the ages of 5 and 33 months were compared with 23 well-nourished children, matched for age. The tests included measures of object permanence, the use of intermediaries, exploration and combination of objects.

The differences between the groups on the developmental measures were found to be minimal. The malnourished children tended to perform at a lower level than the well-nourished children, the effect being more marked in the second year of life but the differences between the groups were described as "a slight delay in development rather than a qualitative change in the cognitive structure" (Lavalée et al, 1979). Delays were reportedly in the order of 1 to 2 months (Dasen et al, 1977).

The play behaviour of two groups of children between 17 and 33 months was compared. The 12 moderately malnourished children were slightly older (mean age 25.6 months) than the 11 well-nourished children (mean age 22 months), but the well-nourished children showed the greater tendency to attend to the properties of the objects and organise sequential actions. Again, the investigators report "the difference is not a matter of kind but of timing: it is the rate of development which seems to be affected to some degree by nutritional status". They make the additional comment that "the question is open whether such delays have any implications for future development or whether they are of no consequence" (Dasen et al, 1977).

In this study, the attitude of the children to the test situation was assessed. Dasen et al (1977) concluded that there was only a very slight trend for the moderately malnourished children to display a more unresponsive style than the well-nourished children and that the differences in attitude could not explain any differences in cognitive development.

These children were grouped according to anthropometry, but few differences were found on biochemical measures (only 2 out of 12 showing significant differences). The nutritional differences between the groups were therefore minimal. However, the socioeconomic survey which is reported only measured gross socioeconomic features such as income and the number of factory-made objects in the home (Dasen et al, 1977), so although the groups were described as "socioeconomically and socioculturally very homogenous", the absence of details about the microenvironments means that the possibility remains that the children's performance on the tests could be more closely related to non-nutritional than to nutritional factors.

As with severe malnutrition, studies of moderate malnutrition in children have provided data in support of the 'functional isolation' hypothesis of Levitsky and Barnes (1972). Moderately malnourished children have been shown to have reduced levels of interaction with their environments.

In cross-sectional studies in West Bengal, India and the Kathmandu Valley, Nepal, Graves (1976, 1978, 1979) reported lowered levels of exploratory and play activities in malnourished children when compared with well-nourished children of the same ages. 35 Bengali boys and 74 Nepali boys and girls were divided according to three anthropometric criteria into groups of well-nourished and malnourished individuals. The children showed marked differences in behaviour when observed in clinics and at home (Table 2.9). The well-nourished children were described typically as moving around the floor to explore toys, re-establishing contact with their mothers through distance interaction (vocalisations, looks and smiles). The malnourished children, in contrast, stayed on their mothers' laps, engaging in muted exploration of toys that they could reach. In this group, there was infrequent distance interaction, but frequent nursing (thought by Graves to be a pacifier rather than providing nourishment).

The mother' behaviour also seemed to be affected by the nutritional status of their children. This was particularly so in the Bengali group, where the mothers' behaviour towards malnourished and well-nourished children was significantly different in 4 of the 6 behaviours observed. The differences in the Nepali group were not statistically significant.

The prospective studies of nutritionally supplemented and unsupplemented children in communities where malnutrition

Table 2.9 Significance of differences in the behaviour of well-nourished and moderately malnourished children in West Bengal and Nepal.

from Graves, 1979.

Behaviour category	West Bengal	Nepal
Activity	N S	<0.01
Vigorous activity	<0.05	N S
Crying	N S	N S
Distance interaction	<0.05	<0.05
Physical interaction	N S	N S
Approach	N S	<0.05
All attachment behaviours	<0.05	<0.05

is endemic also reveal clear differences in behaviour between the children which follow the pattern of decreased interaction with the environment in the undernourished children.

These differences are clearly demonstrated in one study at Tezonteopán in rural Mexico (Chávez and Martínez, 1975, 1979; Chávez et al, 1975). Nutritional supplementation of half of a group of 34 mothers from the sixth week of pregnancy and during lactation and their offspring from 3 months of age resulted in significant differences in anthropometry as well as behaviour between the two groups of children (Chávez et al, 1974). Levels of interaction with people and objects were considerably reduced in the malnourished children(Chávez and Martínez, 1979) and this appeared to operate in two ways. First, the malnourished children showed less active exploration of their surroundings. From the age of 24 weeks, they were significantly less active and by 18 months, the supplemented children were moving six times more than the unsupplemented children. At 56 months, the supplemented children were more talkative, cried less and were more aggressive and independent than the unsupplemented children. The malnourished children were described as "apathetic", "withdrawn", "passive", "timid" and "dependent". Second, the malnourished children, apparently by being less demanding than the well-nourished children, did not elicit certain kinds of adult attention. Supplemented children were spoken to more often, were cleaned and bathed more often and received their fathers' attention in a way that was not observed in the unsupplemented children (Chávez and Martínez,1975, 1979;

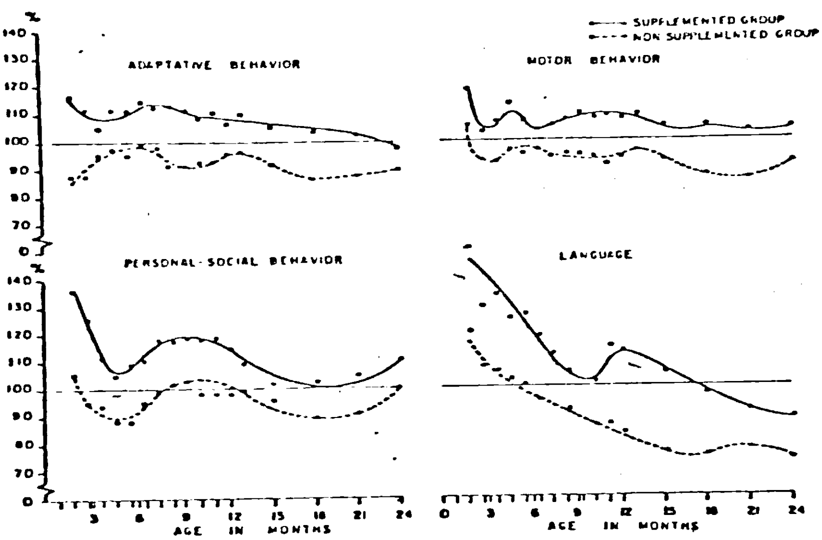
Chávez *et al*, 1975).

When assessed on the Gesell scales, there were consistent differences in favour of the supplemented children from the age of 2 months (Chavez *et al*, 1974). During the period from the third to the seventh month, these differences were slightly reduced, but later they became more pronounced. Chávez and his colleagues report that the most important differences "were due primarily to some aspects of language, which appeared much later in the non-supplemented children". The children who were relatively undernourished were described as "limited in ... cognitive and expressive capacity" (Chávez and Martínez, 1979). Unfortunately, no details are given of statistical analysis of these or the other data reported from this study. The performance of the children on the Gesell test was shown graphically (Chávez *et al*, 1974) and these results are reproduced in Fig. 2.4.

The interrelation of nutrition and the social environment of moderately malnourished children in the Latin American studies as well as in other parts of the world (e.g. Mora *et al*, 1974; Christiansen *et al*, 1977; Gupta *et al*, 1975) has also led to behavioural intervention with moderately malnourished children. These projects will be discussed in Chapter 2.4.7.

Figure 2.4 Differences in performance in the 4 areas of the Gesell test in supplemented and unsupplemented children up to 24 months

from Chávez, Martínez and Yashine, 1974



2.4.7 Behavioural Intervention with Moderately Malnourished children

In some of the studies of communities where chronic undernutrition is common, behavioural programmes have been introduced in addition to food supplementation. Two such programmes have been set up in Columbia, one in the capital, Bogotá and the other in Cali, a large city of nearly one million people.

A multi-dimensional intervention programme was instituted in Cali, Columbia under the direction of Harrison McKay (McKay et al, 1973, 1974, 1978; Sinisterra et al, 1979). Approximately 300 3-year olds were selected for treatment groups on the basis of a) low height and weight for age, b) clinical signs of malnutrition and c) membership of families with low per capita incomes. There were 4 treatment periods of 9 months (approximately 180 treatment days) each in the 3½ year experimental period and children were assigned by means of a 'lottery' process based on geographical regions of one of 4 groups T1, T2, T3, and T4, which entered the programme at the ages of 3½, 4½, 5¼ and 6¼ years and participated in 1,2,3 and 4 treatment periods, respectively (see Fig. 2.5). 38 children from high socioeconomic status backgrounds formed a comparison group (group HS) which did not participate in the intervention programme, though many of the children attended private nurseries.

McKay et al (1978) describe intervention, delivered at day centres for 5 days each week, as follows:

> "An average treatment day consisted of 6 hours of integrated health, nutritional, and educational activities, in which approximately 4 hours were devoted to education and 2 hours to health, nutrition and hygiene....The educational treatment was designed to develop cognitive

processes and language, social abilities, and psychomotor skills, by means of an integrated curriculum model."

The principal consultant in the development of the educational curriculum was David Weikart, who has himself developed intervention programmes for disadvantaged children in the United States, and his work provided the conceptual framework for this study's curriculum. (See Chapter 2.5 for a discussion of American curricula). The curriculum for Cali is reported to have included elements from a variety of sources including Lavatelli's Piagetian curriculum (Lavatelli, 1970), Bereiter and Engelmann's skills training (Bereiter and Engelmann, 1966) and the Montessori method (Orem, 1968).

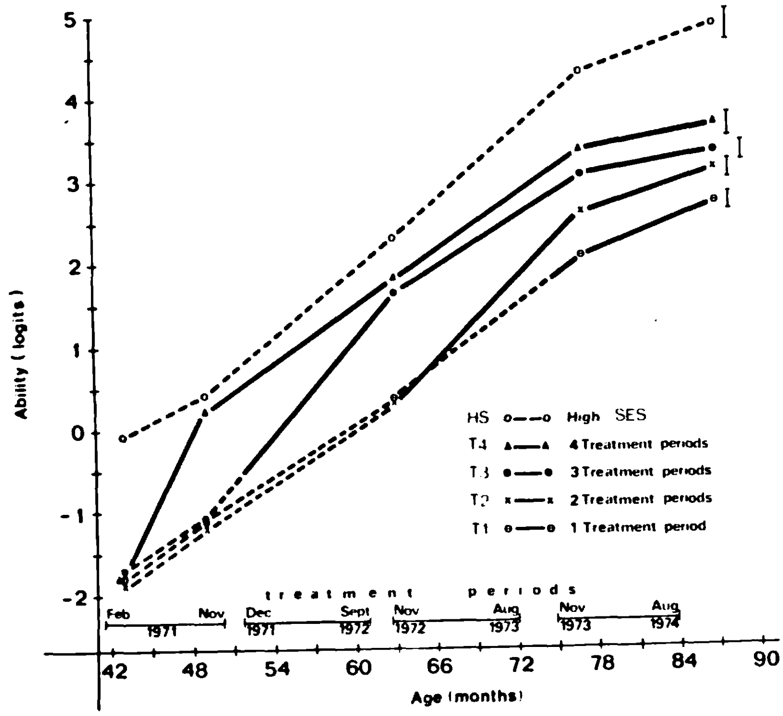
The children received medical attention at the centre and the food which was available ad libitum 3 times a day was designed to provide a minimum of 75% of the recommended daily allowances of protein and calories, supplemented with minerals and vitamins.

All children were tested at the begining of the programme and after each treatment period, whether or not they had participated in the intervention programme. A battery of age appropriate tests which included the Birch and Lefford visual-haptic intersensory integration test, Piagetian matrices and items from the WISC, was administered at each assessment point.

In contrast to Cravioto's intervention programme (Cravioto, 1977), McKay *et al* (1978) report that efforts were made to try to "prevent children from being trained specifically to perform well on test items" and they "intentionally avoided, in the education programmes, the use of material or objects

Figure 2.5 Growth of 'general cognitive ablity' in Columbian children. (means & standard errors)

from Sinisterra, McKay, McKay, Gómez and Korgi, 1979



solid lines represent periods of participation in the behavioural intervention programme from the psychological tests".

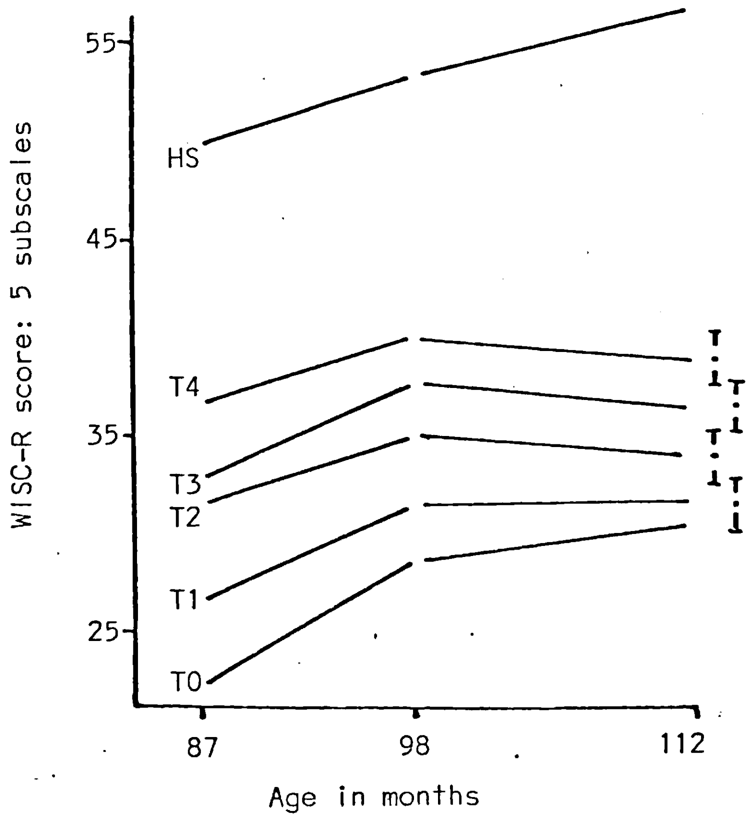
Details of the children's performance on individual tests have not been reported. McKay et al (1978) state that "under the assumption of unidimensionality, cognitive items were pooled and calibrated" to produce growth curves of "general cognitive ability". The relative performance of the groups is shown in Fig 2.5. The children's performance at the end of 1974, when they were approximately 7 years old, was in the predicted group order, but generally, the differences between the groups of children who had taken part in the intervention programme (groups T1, T2, T3 and T4) were not statistically significant unless one group had 2 treatment periods more than the other.

The programme ended as the children entered primary school. One year later, the 5 study groups were retested, as were 60 children who had been unselected from the original population of eligible children in 1971 (group T0). The relative positions of the groups were maintained, as shown in Fig 2.6.

These researchers concluded that all groups, including T1 with the briefest experience of the intervention programme, had increased in cognitive ability as a result of the programme. The groups of socioeconomically deprived children were not able to catch up with their more privileged counterparts, but McKay et al (1978) make the point that "even the smallest increment resulting from one 9-month treatment period could constitute an important improvement in the pool of human capabilities available to a given society". There are plans to report on the children's progress and achievement in primary school, but Sinisterra et al (1979) have already reported that achievement

Figure 2.6 Growth of 'general cognitive ability' in Columbian children following preschool intervention

Sinisterra, McKay, McKay, Gómez and Korgi, 1979



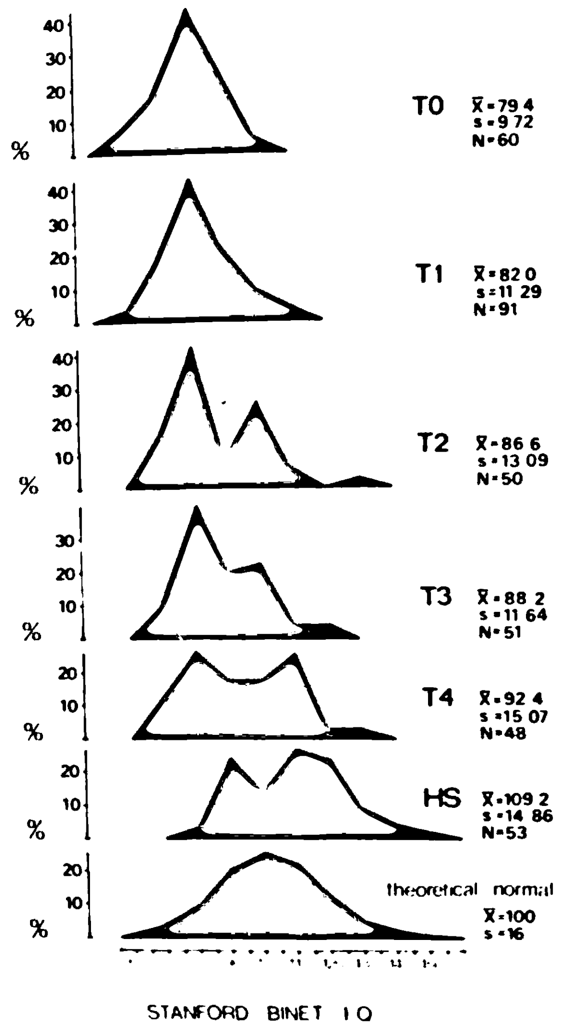
tests of reading and arithmetic show a positive relationship between the amount of preschool experience and test performance.

The lack of detail about the children's performance on specific tests as intervention progressed is unfortunate as there is the suggestion of differences in individual responsiveness to equivalent treatment periods in the increasingly bi-modal distribution of scores as the length of participation in intervention increases (Fig. 2.7). Sinisterra et al (1979) report some details about the performance of the children after the termination of the intervention programme. The subtests of the WISC which in their terms "reflect acquaintance with concepts" were the subtests in which gains were reported to be most quickly lost. These were in fact the language tests, Vocabulary and Information. The gains were apparently more persistent in tests "involving logical processes". This latter group included Arithmetic, Mazes, Similarities, Block design and Picture arrangement. As neither statistical analyses of these data nor individual test scores are reported, is is not possible to evaluate these results. Moreover, the Cali study, with its integrated health, nutritional and educational programmes, does not allow the investigation of the relative effectiveness of the separate elements in enhancing development.

Another Columbian study has addressed itself to that issue (Cremer et al, 1977; Mora et al, 1979). In Bogotá, a prospective study was instituted which involved selective provision of food supplementation and/or behavioural inter-

Figure 2.7 Distribution of scores on Stanford-Binet test at 8 years of age in Cali study

from McKay, Sinisterra, McKay, Gómez and Lloreda, 1978



Duration of intervention:
T0 none
T1 1 year
T2 2 years
T3 3 years
T4 4 years

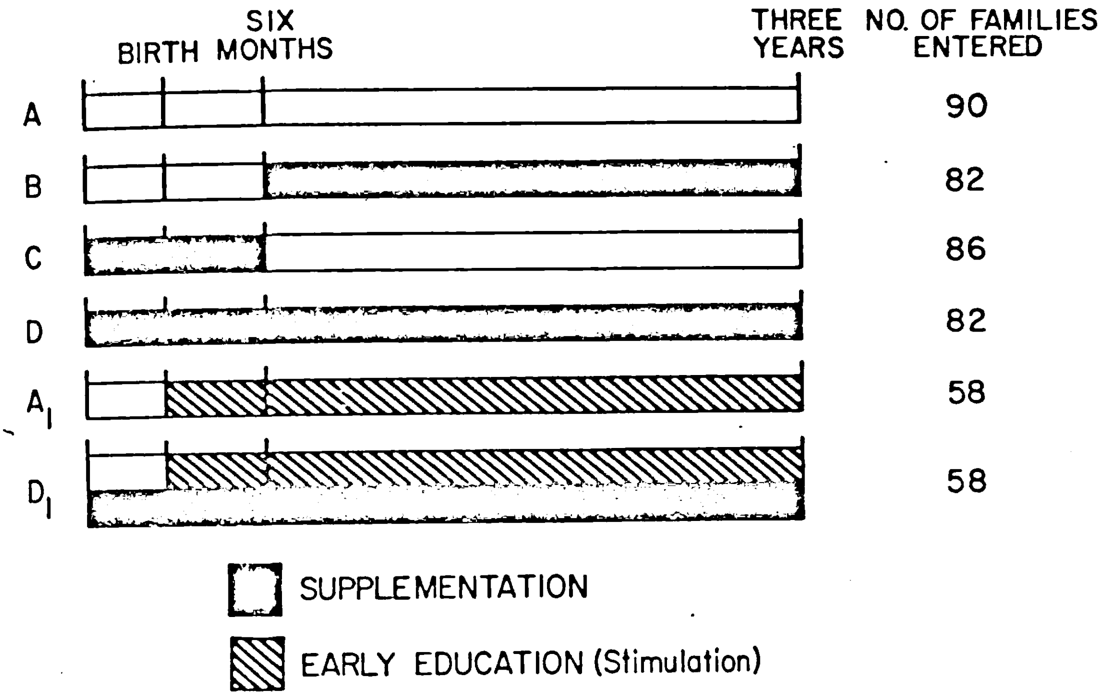
(HS = high social class comparison group) vention for low-income families. Mothers of preschool children, who were in the first or second trimester of pregnancy, were selected for inclusion in the project if 50% of the preschoolers were less than 85% of their expected weight for age (see Table 1.1). All 456 families so selected were given similar obstetric and paediatric care, but were assigned at random to treatment groups which received no intervention (group A), or for differing lengths of time received nutritional supplementation alone (groups B.C.D), behavioural intervention alone (group A_1) or both nutritional supplementation and behavioural intervention (group D_1) - shown in Fig. 2.8.

Nutritional supplementation, initiated at the end of the second trimester of pregnancy, took the form of provisions for all family members distributed weekly from "a local centre resembling a neighbourhood store". There was some evidence of a degree of substitution for their usual diet rather than the supplementation expected from the families. Nevertheless, despite the smaller differences in food consumption between the supplemented and unsupplemented families than were anticipated, pre- and neonatal supplementation was associated with lower rates of stillbirths and perinatal mortality (Cremer et al, 1977) as well as higher birthweights Mora et al, 1979).

The 'infant stimulation programme' commenced when mother and baby returned home after the birth and continued until the child was 3 years old. Trained paraprofessionals were assigned 6 to 8 families, whom they visited twice weekly for 1 hour. Mora et al (1979) describe the visits:

Figure 2.8 Intervention schedule for Experimental groups in Bogotá study

from Mora et al, 1979



"The visitor... assumed specific interactive and supportive roles within the family in order to improve mother-child and family-child interaction. Visitors made every effort to limit the content of their contacts to the domain of the cognitive funtioning of the target infant and its siblings. Their goal was to achieve increased maternal awareness of, and interaction with, the child". Play material was contructed from "scraps and objects common to the home of the low-income Bogota population".

Mora et al(1979) report on the development of the children assessed by the Griffiths Mental Development Scales at the ages of 4, 8, 12 and 18 months. DQs declined as the children got older, but the decline was less in the supplemented than the unsupplemented children. Supplementation appeared to significantly influence development of 4 of the 5 subscales of the test. It was most effective on the Locomotor scale ($p=0.003$), with slightly less effect on Performance ($p=0.011$), Personal-Social ($p=0.024$) and Eye and Hand Co-ordination ($p=0.048$). Stimulation, on the other hand, was most effective in the 5th subscale, Hearing and Speech ($p=0.001$), also affecting the Personal-Social scale ($p=0.01$). Further, the effects of stimulation and combined supplementation and stimulation on the Personal-Social scale declined with age, while the children receiving combined supplementation and stimulation showed an increasing advantage with time on the Hearing and Speech subscale.

From this study, it would appear that with moderately malnourished children, nutritional supplementation has the effect of limiting the decline in developmental quotient that is apparent in unsupplemented children. A similar effect was demonstrated in older children in the other Columbian study. In that study, in Cali (Sinisterra et al, 1979), when the children from low SES homes were tested 1 year after the termination of the intervention programme, all the children showed deficits in performance relative to the norms of the Stanford-Binet test. Children who had not participated in the intervention had average mental ages 1½ years below their chronological ages. The intervention groups showed lags in mental age of between 15 months and 5 months on average, depending on the length of their participation in the programmes. By comparison, the high SES comparison children had mean mental ages 10 months above their chronological age.

Unfortunately, actual scores are not reported, but in the Bogotá study (Mora et al, 1979), it would appear that nutritional supplementation had a greater effect on general development than the stimulation programme. In the four-way repeated measures analysis of variance for 141 children reported by Mora and his colleagues, age had the greatest effect on DQ ($F=37.884$; $p=0.001$), with stimulation least ($F=4.653$; $p=0.024$) and the effect of nutritional supplementation at an intermediate level ($F=7.478$, $p=0.008$).

The effects of social deprivation on DQ are not usually apparent before the age of 18 to 24 months (see Chapter 2.4), so this may be part of the explanation of the limited effectiveness of stimulation on DQ in the tests reported so far. However, as the authors point out, the effects of stimulation on language and social development are important as these are the areas which are reportedly most depressed in disadvantaged and/or malnourished children. On of the most comprehensive intervention programmes for socially deprived children in the U.S.A., directed by Rick Heber, started working with the children at the age of 3 months (Heber and Garber, 1975). In this project, the Gesell DQs of the Experimental group who took part in the programme and the Comparison children who did not were not significantly different at 14 months of age, though they subsequently diverged. (See Chapter 2.5). In the Bogotá study therefore it is possible that the effects of stimulation may increase as the children get older. Moreover, there is evidence from projects such as Heber's that changes in the social behaviour of the children and their assertiveness towards the adults with whom they lived were important in the cognitive changes that were demonstrated. The effect of the programme of stimulation on language development and on performance on the Personal-Social scale can be seen to be important for the subsequent development of the children. Mora et al (1979) do not offer any theories about the differential effects of nutritional supplementation and stimulation.

2.5 PSYCHOSOCIAL FUNCTIONING OF THE MOTHERS OF MALNOURISHED CHILDREN.

There has been an attempt to assess the psychosocial functioning of mothers of malnourished Jamaican children (Kerr et al, 1978). Unfortunately, due to the nature of the methodological problems apparent in this study, it is doubtful whether the validity of their findings can be totally accepted. These authors conclude that their findings "were consistent with those previously described for mothers of children with 'failure to thrive' in affluent countries". The results of interviews with two groups of mothers are summarised in Table 2.10.

The first criticism that can be made of this study concerns the nature of the sample of mothers. The total sample was small: 22 from two sources, forming subsets of 5 or 6 individuals. Group I included a subset of 6 mothers of severely malnourished children who were treated at the UHWI and another of 6 comparison mothers, whose adequately nourished children had been admitted for gastroenteritis, meningitis or heart disease. Group II comprised a set of 5 mothers from a concurrent study of feeding practices, whose children became malnourished "in spite of normal birth weights and frequent home visits emphasising proper nutrition".* In this latter group, 1 child was hospitalised, severely malnourished, at 12 months. No details are given of whether the remaining children had oedema, but on the basis of the stated standardised weights, 2 appeared to be moderately malnourished and the remaining 2 adequately nourished. There was also

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* cf. comments on sample of malnourished children in the Land of White Dust project. p 106

Table 2.10 Description of mothers of malnourished children in Jamaica

from Kerr, Bogues and Kerr, 1978.

1. Housing conditions and employment records reflect disorganisation.
2. Fewer social contacts.
3. Extended family "supervised excessively".
4. Babies' fathers not present or unsupportive.
5. Relationships were "more sterotyped and transient".
6. Relationships were more "focused on material aspects".
7. "Narcissistic concerns took precedence over the needs of the children".
8. Had suffered severe deprivation in childhood (similar to comparison group).
9. Some mothers were apathetic and dependent, others were manipulative and evasive.

a set of 5 comparison mothers with adequately nourished children.

In Group I, the malnourished and non-malnourished subsets were reported to be matched, but no statistical analyses on the socioeconomic background data are reported, and there seem to be marked differences between the sets of mothers (e.g. ages of children and mothers).

The information was obtained in open-ended interviews and few details are given of the actual comments of the mothers on which judgements such as the "inability to reflect on own behaviour" and "stereotyping relationships" were based. Moreover, there is a hint of a misunderstanding of Jamaican English usage in the report of one of the mothers' comments about a child who "Favoured his father" ('Favor' meaning 'resemble'). No objective measures of economic status (other than income, an unreliable measure of long-term conditions in this society)or home environment, or mothers' nutritional status, intelligence or educational achievement are reported, although these factors seem to be essential for the evaluation of many of the conclusions drawn. One cannot accept the authors' view that the mothers of the malnourished and the well-nourished children came from "an equally deprived environment" or many of the generalisations that are made without the accompaniment of supporting evidence (an example of the latter being: "preoccupation with their chaotic environment prevented their taking responsibility and profiting from mistakes" to describe the mothers of the malnourished children).

Richardson's earlier study in Jamaica (Richardson, 1974,

1976) raises questions about the microenvironments of malnourished children and, as Kerr and colleagues state, there is still the need to identify the features "that distinguish families of malnourished children from the majority who live under the same desperate conditions but manage to produce relatively healthy children". However, this study only suggests hypotheses for future investigation in this area and cannot be regarded as providing valid conclusions about the psychosocial functioning of the mothers of malnourished children.

2.6 SOCIAL DISADVANTAGE AND CHILD DEVELOPMENT

Severe malnutrition occurs in the most socially deprived sections of societies and often inadequate nutrition is only one aspect of a complex network of deprivations which are experienced by the child who reaches hospital with the diagnosis of severe malnutrition.

The development of socially deprived children and their more privileged counterparts has been studied in the more developed countries (Rutter and Madge, 1976; Birch and Gussow, 1970) as well as in developing countries like Jamaica (Wein, 1971a,b). There is now little dispute about whether severe environmental deprivation can affect intellectual development in children and lead to serious intellectual impairment. In his controversial Harvard Educational Review article, Jensen (1969) stated that "there can be no doubt that moving a child from an extremely deprived environment to good average environmental circumstances can boost the IQ some 20 to 30 points, and in certain extreme, rare cases, as much as 60 or 70 points". However, the consequences of the more usual, less severe forms of social deprivation and the processes involved in the relationship between environmental factors and the development of young children continue to be the subject of controversy.

The association between low socio-economic status (SES) and low IQ has been demonstrated repeatedly. Highly significant correlations have been found between parental social class and children's IQ (Deutsch et al, 1968; Douglas et al, 1968). Differences of 20 points or more have been found to separate the mean IQs of school children from the highest and the lowest SES groups (McNemar, 1940; Vernon, 1979). Mild retardation is particularly common in the children of socially disadvantaged families (Edgerton, 1979). In middle class children, such retardation is usually associated with organic brain disease, but it is more often the case in working class children that there is no apparent organic cause (Rutter and Madge, 1976). Terms such as "sociocultural retardation" are often applied to the mild retardation found in working class children. However, the role of SES in intellectual differences is a complex one and is often misunderstood (Vernon, 1979). SES is itself a composite measure which represents a wide variety of personal and material variables and often little discrimination is made within these broad categories (Caldwell and Richmond, 1967).

Although social class differences in intellectual performance are widely acknowledged, these differences are not usually apparent in children below the age of 2 years. This has been the case with the Bayley Scales (Bayley, 1965; Ireton et al, 1970) the Gesell Scale (Knoblock and Pasamanick, 1960), the Cattell Infant Scale (Golden and Birns, 1968) and the Griffiths Scales (Hindley, 1960). This may be a reflection of discontinuities in intellectual development across this period (McCall, 1979). Measures of intellectual development before the age of 2 are notoriously poor predictors of later intellectual levels (Rutter, 1970; McCall et al, 1972). For example, correlations obtained between scores in infancy and IQs after 8 years are often in the region of 0.2 (Table 2.11).

Table 2.11 Median correlations across studies between infant test scores and childhood IQ.

from McCall, 1979.

Age of childhood test (years)	Age of Infant test (months)			
	1 - 6	7 - 12	13 - 18	19 - 30
8 - 18	0.06 (4)	0.25 (3)	0.32 (3)	0.49 (6)
5 - 7	0.09 (4)	0.20 (4)	0.34 (4)	0.39 (5)
3 - 4	0.21 (11)	0.32 (12)	0.50 (7)	0.59 (6)

Numbers in parentheses give the number of studies used to calculate the median.

It also appears that the degree of continuity between test scores in infancy and in later ages may differ between social classes. Willerman et al, (1970) tested 3,000 children at 8 months and at 4 years and reported that children from high SES homes who obtained low scores in infancy usually achieved normal scores at 4, whereas low SES children with similar infant scores had lower 4 year old IQs. In addition, one cannot be sure that the failure to detect social class differences in the first 2 years is not a product of the types of test that have been used (Golden and Birns, 1976).

One of the few studies to show SES differences in intellectual development before the third year of life was by Wachs et al (1971). In a cross sectional study of 102 infants aged 7 to 22 months from two social classes, they found some differences from 15 months in performance on two of the tasks in the Infant Scales of Psychological Development, which is based on Piagetian principles of sensorimotor development. Most studies have used the traditional infant intelligence tests.

Our knowledge of how the environment influences cognitive development is still only rudimentary (Rutter and Madge, 1976). Relatively little is known about which parental practices are important for children's development. It even seems likely that different kinds of environments may suit different individuals at different ages (Cronbach, 1969).

The complexity of these relationships is demonstrated in research by Golden and colleagues at Albert Einstein College of Medicine. In a cross-sectional study of 192 black boys and girls aged 12, 18 and 24 months, no significant differences between classes were found in the Cattell Infant Test and a Piagetian object scale (Golden and Birns, 1968) but when some of the children were followed up at 36 months significant social class differences emerged (Golden et al, 1971; Golden and Birns, 1976). However, a comparative study of 60 white boys grouped according to level of education of mother and tested at 24 months and 30 months of age produced significant differences between the mean scores of the two classes at both ages (Golden and Birns, 1976). At 24 months, there was a mean difference of 21 points between the children whose mothers had no education past high school and the children whose mothers were college graduates. At 30 months, there was a mean difference of 23 points between these groups.

Van Alstyn (1929) was possibly the first to link specific home characteristics with mental age at 3 years, and studies of this type continue today. At the Syracuse Early Learning Project, Bettye Caldwell and colleagues have produced an inventory designed as a "measure of the home environment that could warn of developmental risk before the age 3" (Elardo et al, 1975). The 'Home Observation for Measuring the Environment' (HOME) Inventory provides an index of the quantity and quality of social, emotional and cognitive support available to a young child within the home. There were 6 Subscales in the form used by Elardo et al (1975). See Table 2.12. In correlation studies between children's HOME scores and scores on the Bayley Scales and Stanford Binet test, correlation coefficients range from 0.14 between HOME total scores and Bayley scores at 6 months to 0.70 between HOME at 24 months and

Table 2.12 Environmental variables measured in the Inventory of Home Stimulation used by Elardo et al, 1975.

1. Emotional and verbal responsivity of the mother.
2. Avoidance of restriction and punishment.
3. Organisation of physical and temporal environment.
4. Provision of appropriate play materials.
5. Maternal involvement with child.
6. Opportunities for variety in daily stimulation.

Binet IQs at 36 months (See Table 2.13). DeLicardie and Cravioto (1974a) also found an association between scores on a modified version of Caldwell's inventory at 6 months and IQ at 5 years of age in their Land of the White Dust study. Children in the group of survivors of malnutrition and the children matched for IQ at 5 and sex, together, were found to be significantly different from the birth matched comparison group (who had higher IQ scores) in their scores on the home stimulation inventory ($p<0.01$).

Bradley and Caldwell (1976a) investigated the relationship between HOME scores and changes in intelligence test scores from 6 to 36 months, having previously obtained a correlation coefficient of 0.50 between HOME score at 6 months and Binet at 36 months (Elardo et al, 1975). They quote Sontag et al. (1958) who found that IQ increases in elementary years were associated with certain aspects of parental behaviour, but found no such relationship in preschool children. Using 2 intelligence test scores (at 6 and 36 months), 77 children were classified as "increasers" or "decreasers" if there were changes of 21 points or more, with a third group of "nonchangers". It was possible to differentiate between groups on the basis of 6 month HOME scores. In particular, 'Maternal involvement with child', 'Provision of appropriate play material' and 'Organisation of physical and temporal environment' had a substantial effect throughout early childhood. With extreme scorers excluded (i.e. more than 120 and less than 80), there was an even stronger relationship between the HOME scores and IQ change.

Table 2.13 Correlations between total scores on the Inventory of Home Stimulation at 6, 12 and 24 months and Developmental Quotients at 6, 12 and 36 months.

from Elardo, Bradley and Caldwell, 1975.

Inventory scores	Mental Test Scores		
Age at test	Age at test		
	6 months[a]	12 months[a]	36 months[b]
6 months	0.141	0.156	0.500 **
12 months		0.252*	0.551 **
24 months			0.695 _

a Bayley Mental Development Scales

b Stanford-Binet Test

* $p < 0.05$

** $p < 0.01$

Ramey et al (1975) compared a sample of 30 infants from socially deprived homes with a mean age of 6.5 months with 30 infants from a general population group with a mean age of 6.6 months, who were matched for age, sex and parity. There was a significant overall difference between the groups on the HOME ($F=7.49$, $df=12,104$, $p<0.001$). The differences between the groups were also significant for each of the 6 subscales. These authors concluded that

> "The results suggest that homes which are thought to be potentially high contributors to the developmentally retarded population differ significantly on all of the factors measured when compared to homes drawn at random from the general population." (p.42)

Although writers in the past have referred to "deprived" or "enriched" environments and stressed the importance of "stimulation", it is the quality rather than the quantity of stimulation that is important (Wachs et al, 1971). For example, the clarity of the language environment may be an important feature as well as its complexity. Friedlander's (1971) tape recordings made in homes revealed a clamour in which several people spoke at once and Deutsch (1965) suggested that children learnt to be inattentive by living in a noisy, disorganised environment. As Rutter and Madge (1976) conclude, it is apparently the "quality, meaningfulness and range of experience available to the child" that are important. An important feature must also be the degree of match between the pattern of available environmental stimulation and the developmental level of the child at a given time (Hunt, 1961; Wachs,1977).

One aspect of intellectual development that has been found to be particularly important in social class differences in the third year of life is language development. In general, behaviours which involve language or children's responses to language are related to both social class and later IQ, whereas non-verbal behaviours are less likely to be related to social class (Golden and Birns, 1976; Heber, et al, 1969). White et al (1979) have listed language development as one of the "educational foundations" that were a risk between 8 and 24 months of age in children from socially disadvantaged homes, the others being "curiosity development", "social skills and attachment behaviour" and what they term "the development of the roots of intelligence". In Golden and Birns' (1976) sample of white boys, there was a highly significant difference ($p<0.001$)between the mean scores of the Wechsler Vocabulary test of the 'high education' and the 'low education' mothers. For the children, the 'high education' group had significantly higher verbal comprehension and production scores than the 'low education' group.

Differences in the language environment of lower class and upper class children have been highlighted in a number of studies. Wootton(1974) reported that middle class children received more explicit and informative answers from their parents with more dialogue and discussion than working class children. Along with comparable findings from Robinson and Rackstraw (1967) and Brandis and Henderson (1970), these results support Bernstein's thesis (1961) that middle class and working class individuals may operate within different linguistic codes, "elaborated" for the former and "restricted" for the latter, which are probably related to the different circumstances of the two groups. This interpretation of the social class differences in language that have been reported has itself been challenged (Rosen, 1972; Labov, 1969), but there is general acceptance that the area of language development is one in which children of low SES score at low levels on standardised tests (White, 1979).

Elardo et al (1977) found that the 6 dimensions of the home environment measured on the HOME inventory were significantly related to language development. The total score on the HOME at 6 months and at 24 months for 74 children were significantly related to the children's scores on the Illinois Test of Psycholinguistic Abilities (ITPA) at 3 years (in each case at a probability value of less than 0.01). The HOME subscales 'Emotional and verbal responsivity of mother', 'Provision of appropriate play materials' and 'Maternal involvement with child' showed the strongest overall relation to language competence.

Hess and Shipman (1967) expressed a widely held view about the role of language in the relationship between social class and cognitive development in children. They suggest that language shapes thought and cognitive styles of problem solving and is itself determined by the structures of the social system and, in particular, the family. In their observational study of mother-child interaction with 4 year olds, Hess and Shipman (1965) contrasted the middle class mother's fostering of the information processing skills that the child will need for intellectual and educational growth (for example, through the demonstration of the use of language in planning) with the working class mother's preference for imperative commands.

In general, therefore, it can be seen that low SES and social deprivation are reflected in various aspects of the child's environment in ways which can have a profound effect of the pattern of his/her development. In addition to differences in the physical environments of poor children when compared with more privileged children, there is evidence of differences in the social, emotional and intellectual stimulation in the home (Ramey et al, 1975; Bernstein and Young, 1966; Kagan and Tulkin, 1971; Tulkin, 1977) as well as in the teaching strategies adopted by the mothers in dealing with their children (Hess and Shipman, 1965). In children who have experienced clinical malnutrition, poor nutrition occurs in the context of social deprivation which characteristically has many features which contribute to poor development. In studies of the intellectual development malnourished children, therefore, it is important to take into account such factors as the social environments of the children and the emotional and cognitive support available to the child in the home.

2.7 INTERVENTION PROGRAMMES FOR SOCIALLY DISADVANTAGED CHILDREN

2.7.1 Preschool intervention programmes

With the increasing evidence of SES differences in intellectual development, in many parts of the United States over the past 15 - 20 years, attempts have been made to provide "compensatory" programmes for preschool children from socially disadvantaged homes. The aim of these programmes has been the prevention of "sociocultural" developmental retardation and later school failure in the children. They can therefore be termed "secondary prevention" programmes (Cowen, 1973). All have been designed to provide the children with experiences favourable to cognitive development, although they vary widely in scale and approach. In general, they have attempted to provide socially disadvantaged children with experiences which are thought to be within the normal experience of their more advantaged peers and which are thought to contribute to the latter group's supperior performance on intelligence tests. This attempt to give working class children the experiences thought to be present in middle class homes is often implicit in the reports of intervention programmes, but was clearly stated by Levenstein (1970), who reported that her research

> "explored the effects of helping some low-income families to assume the same function of incidental cognitive socialization which is apparently an important result of the middle-income family's 'hidden' verbal-cognitive curriculum".

American pre-school programmes can be broadly classified into the following 3 categories:

1. Group settings - day care centres or nursery schools,
   e.g. The Syracuse Early Learning Project (Caldwell, 1968).
   The Harlem Research Center Project (Palmer, 1972; Palmer and Siegel, 1977)
   The Milwaukee Project (Heber and Garber, 1975; Garber and Heber, 1977).
2. Home visiting programmes
   e.g. The infant education research programme of Schaeffer and Aronson (1972)
   The Florida Parent Education Infant and Toddler programmes (Gordon, 1970; Gordon et al, 1977, 1972)
   Mother-child Home Programme (Levenstein and Levenstein, 1971; Levenstein and Sunley, 1968).
3. Combined nursery school and home visiting.
   e.g. The DARCEE early training project (Gray and Klaus 1970)
   The Perry Preschool project (Radin and Weikart, 1967).

The most extensive intervention programme to counteract the effects of poverty on child development is the Milwaukee Project begun in the mid 1960s by Professor Rick Heber at the Rehabilitation and Training Center in Mental Retardation, University of Wisconsin (Heber and Garber, 1975; Garber and Heber, 1977). Twenty Experimental children, all Negro with no organic damage, and twenty matched Controls took part. They all lived with their mothers, who had Wechsler IQs of less than 75, in the lowest social tract in Milwaukee.

There were two major aspects to this programme: family intervention and infant intervention. The family intervention consisted of job training as well as social and remedial education for the mothers. In later stages, parent counselling and family crisis intervention were included. The intervention begun when the child was 3 months old. The children were taken every day, January to December, to a special centre. Garber and Heber (1977) say that the children "were placed in an elaborate educational programme that was both extensive and somewhat innovative" with two Curriculum Supervisors and a staff of specially trained Infant Teachers and Paraprofessionals. From 3 months, the child received the individual care of a teacher and was taught a widening range of linguistic, perceptual and cognitive activities up to the age of 2. Between the ages of 2 and 5, the education continued in small groups.

Heber and Garber report that there were no significant differences between the Experimental children and the Control children on birth and early developmental measures, but after 1 year of age, the IQ scores of the 2 groups became increasingly divergent at each test. At 6, 10 and 14 months, the Gesell scores were not significantly different. By 22 months, the Experimental children were 4 to 6 months ahead of the Control children who remained close to the norm. By 66 months of age, there was a difference of 30 points between the mean IQs of the 2 groups with the Experimental children scoring 124 and the controls 94. When some of the children were tested some time after the end of the programme when they were 8 - 9 years old, the difference had been reduced to 24 points, with the mean IQ scores falling to 104 for the

Experimental children and 80 for the Controls. In school achievement, there was little overlap between the 2 groups.

When the Hess and Shipman model was used to assess mother-child interaction during a task (Hess and Shipman, 1965), although the mothers did not differ in teaching or verbal ability, there was significantly more verbal interaction and less ignoring behaviour in the Experimental group (Heber et al, 1972). It was apparently the Experimental children who increased the level of verbal communication and information exchange with the mothers - e.g. by asking questions - and this appeared to result in faster, more successful learning.

Vernon (1979) comments that this "total immersion" programme is too costly to be practicable, a criticism also raised by other writers (Bronfenbrenner, 1974). It was an expensive programme involving extensive provision for the child and the family for a period of 6 years. Certainly, in the context of programmes for severely malnourished children, such an intensive programme would be beyond the scope of the health and welfare services in the countries where childhood malnutrition is endemic. There is the additional problem in this multifaceted approach that having obtained significant improvement it is difficult to evaluate the relative efficiency of different aspects of the programme.

In an article severely critical of the Milwaukee Project, Page (1972) concluded that this study was deficient on 3 counts, any one of which would invalidate the findings. Page criticises the lack of precise details in published reports and raises 3 questions which he says are inadequately answered. First, he suggests that "the great IQ differences in the study are associated with genetic differences in children" as there were significant differences in anthropomentry between the groups. Second, he cites the researchers' comment that "our Experimental infants have had training on items fortuitously included in the curriculum which are sampled by the tests" as providing evidence that the large gains reported may have been "based on trained items". The third issue raised by Page is the precise nature of the intervention treatment. The descriptions are termed "rhetoric with no operational meaning".

Heber's reluctance to publish details of his study has led to other criticisms. Beller (1979), for example, stated that because of Heber's failure to subject his data to public examination, "caution is indicated in the evaluation of any conclusion drawn from Heber's reported study".

2.7.2 Parental involvement in intervention

One issue that arises in the evaluation of different intervention approaches is that of the amount of maternal/ parental involvement in the teaching of the child. It has been pointed out that when parents are expected to be the main agents of intervention, the programmes are very demanding and not all disadvantaged parents are able to cooperate (Rutter and Madge, 1976). On the other hand, direct teaching of the children without the involvement of parents has been shown to produce few long term gains (Bronfenbrenner, 1974), while attempts to combine parental programmes with direct teaching of the child may sometimes have undermined the responsibility and status of the parents (Rutter and Madge, 1976).

Karnes et al, (1970) carried out a study in economically depressed neighbourhoods in central Illinois in which the mothers served as the primary agent of an early intervention programme. This differed from the majority of such programmes in that some of the work with the mothers was done in the absence of the children. 15 mothers of children with a mean age of 20 months (range 13 - 27 months) met in groups for weekly 2-hour meetings for 7 months in the first year and 8 months in the second year of the study. At these meetings the staff presented educational toys and materials and showed the mothers how to teach their children using this material. These meetings were supported by home visits "to reinforce the teaching principles introduced at the meetings and to help each mother establish a positive working relationship with her baby" Karnes et al concluded that the results they obtained "endorsed the effectiveness of the mother training program in altering in positive ways the development of disadvantaged children before the age of 3." At the end of the study period,the Experimental children scored a mean of 106 on the Binet compared with 91 scored by a matched comparison group. A group of older siblings tested prior to their mother's enrolment in the programme provided more evidence of the effectivenss of the mother training programme. 5 Experimental children's mean post-intervention score was 28 points higher than their older siblings' mean score (117 compared with 89).

The difference that was produced in this study between Experimental children and children who had not taken part in the programme is comparable with the differences obtained in other studies which used college graduates as the children's tutors (e.g. Schaefer,1969b). There is evidence from several studies that the gains made by children who had been taught at home by their mothers are, in general, equivalent to the gains made by children who had been taught by professional tutors (Spicker, 1971). Levenstein (1970), reporting on her Mother-Child Home Programme, concluded that considerable learning can take place in the home, with the major involvement of the mother, even when the mother "has limited mastery of symbolic modes of representation and is harried by the problems of large families and small income."

There is the economic advantage that home intervention by mothers can be considerably cheaper than some other models (Karnes et al, 1970), but in addition, there are other advantages - to the families and to the community. Gray (1969) stressed the value of what she termed "vertical and horizontal diffusion" of the information given to the mothers in respect of the target children. These ideas could pass to be of benefit to siblings as well as to other children in the neighbourhood. In their programme in Tennessee, Gray and Klaus found that younger siblings close in age to the Experimental children scored significantly higher on the Binet than the younger siblings of the Comparison children (Gray, 1969). The value to the families of parental involvement in intervention programmes is further demonstrated in a study which showed superior performance by the younger siblings of target Experimental children in comparison with the target children themselves (Gilmer, 1970), suggesting that the younger children obtained even greater benefits from improvements in mothers' competence.

This apparent change within the home environment can be seen also to be of long term benefit to the target child himself. A major crisicism of Head Start and other similar programmes has been the fact that the initial rapid gains made by the children very quickly disappear. A notable exception to this pattern was Klaus and Gray's Early Training Project. In this Project, intensive work was done for 3 summers with weekly home visits in the remaining months. After initial gains, over the years the Experimental children remained significantly superior to the Comparison children on measures of intelligence (Klaus and Gray, 1968; Gray and Klaus, 1970).

Radin (1972) has also investigated this question, comparing the performance of 3 matched groups of children who took part in compensatory programmes with different levels of maternal involvement. At the end of the year, no significant differences were found between the groups, but when 24 children were followed up one year later, the 2 groups with maternal involvement showed significantly greater gains in Peabody Picture Vocabulary Test score during kindergarten year than children whose mothers had not been involved in the preschool programme. Radin's conclusion was that

> "a parent programme does appear ... to enhance the mothers' perception of themselves as educators of their children and of their children as individuals capable of independent thought"(p1363).

This raises another aspect of the involvement of parents in intervention. Some programmes include activities designed to focus on the mothers' attitudes. As Karnes and her colleagues point out, (Karnes et al, 1970), such programmes hold the "potential for developing (the parents') self-help capabilities and sense of personal worth, pivotal factors in effecting broader changes within the disadvantaged family", and "through group interaction (the parent) may extend this sense of responsibility for infant, self and family to the wider community in which they live". This value to the parents has been reported in some Head Start programmes (Cicirelli et al, 1969) as well as others where parents have been included in the programmes (Badger, 1971; Gray and Klaus, 1970; Weikart and Lambie, 1969).

There is considerable evidence therefore that an essential element of any programme aimed at the children of socially disadvantaged families must be the involvement of the parents, not merely in a peripheral role which may actually undermine any gains made by the children through devaluing the parental role (Karnes et al, 1969), but as the primary agents in the physical, social, emotional and intellectual development of their children. The desirable mode of intervention appears to be to support and reinforce the development of the early relationships within the family (Schaefer and Aronson, 1972). One criticism of Heber's study, in spite of its considerable success, cites the ethical question of intervention which appears to disturb these early relationships (Bronfenbrenner, 1974).

2.7.3 Curriculum design

When Project Head Start began in 1965 there had been very few programmes for socially disadvantaged children and therefore few models existed for such remedial or compensatory programmes (Spicker, 1971). The available nursery school facilities had, in general, been developed for children from middle class families and were either relatively unstructured programmes allowing free play in an informal setting (which can be termed the 'Traditional' approach) or the highly structured Montessori method (Montessori, 1964). As the field of compensatory programmes expanded, two other types of programme were developed, one focusing on the training of specific academic skills and the other on the broader areas of cognitive development.

The four approaches may be summarised as follows :

1. "Traditional" nursery schools:

   Weikart (1969) described the Traditional approach thus: "The hallmarks ...are introduction of themes and material to acquaint the child with the wider environment, close attention to the individual social and emotional needs of each child, and a considerable degree of permissive in classroom operation".

A wide variety of materials are provided in a relatively unstructured play situation.

2. The Montessori method:

The materials provided in the Montessori nursery are selected according to a detailed programme. Banta (1972) described this approach thus:

"Each and every piece of Montessori equipment was designed to serve the child's natural tendency to work and learn...The Montessori enviornment is usually divided into 3 categories: 1. motor education; 2. sensory education; and 3. language and mathematics. "The 'planned environment' is a key Montessori idea".

In a graded programme, the children engage in exercises in sensory discriminations and manual dexterity, which form an important part of the curriculum.

3. Training in academic skills:

This approach is epitomised by the curriculum developed by Bereiter and Engelmann (1966). Advocating the deficit interpretation of SES differences in IQ, they devised a programme to teach poor children the skills on which success on norm-referenced tests of school readiness and intelligence were seen to be based. Their direct teaching techniques were aimed at producing learning at a much faster rate than normal to enable children in the programme to catch up with their more privileged counterparts.

4. Cognitive development programmes.

These programmes, like the skills training programmes, have clearly specified goals and use a systematic, sequential curriculum. For this type however the goals are defined in terms of the overall cognitive development of the children rather than in terms of specific academic skills, and the teaching techniques allow more flexibility and informality. Programmes differed in their main emphasis, some stressing language skills (e.g. Levenstein's Mother-Child Home

Programme) or concept formation (e.g. Palmer's Concept Training Curriculum) or other areas of cognitive development.

One important difference between the approaches outlined above is the degree of 'structure' - i.e. the intensity of formal teacher-child instruction (Karnes, 1969) and the degree to which activities were sequentially presented. The Traditional nursery school programme would therefore be defined as having the least structure and the Skills training the most.

Karnes et al, (1969) compared five preschool programmes with different degrees of structure. There were two Traditional programmes. One was a self-contained project-operated class of disadvantaged children (the "Traditional" group) and the other utilised a similar programme and approach, but the disadvantaged children were integrated into community-operated preschool classes of predominately middle class children (the "Community Integrated" group). The other programmes were a Montessori class, a cognitive development curriculum ("Ameliorative") and an academic skills training curriculum ("Direct, verbal").

After one year of intervention, the children were assessed for IQ and language development. The "Traditional", the "Ameliorative" and the "Direct, verbal" approaches were found to be associated with significantly higher gains in IQ and language than the Montessori and the "Community Integrated" approaches. The failure of the Community Integrated programme to produce the increases achieved by some of the others tends to support Bereiter and Engelmann's argument that it is unreasonable to expect 'catch up' in IQ and language without specific provision for the disadvantaged children. The Traditional group in this study showed significant gains. This is not always the case. Spicker (1971) argues that experimental traditional programmes may offer a more systematic approach than is usual in nursery schools. There is evidence that programmes with Traditional curricula operated outside of an experimental framework have been found to be significantly less effective with disadvantaged children than programmes designed specifically for such children (Spicker, 1971). In general, greater IQ gains have been produced with children taking part in programmes with a structured curriculum than with children in informal, traditional settings (Bronfenbrenner, 1974). The failure of the Montessori programme, however, suggests that even where there is a high degree of structure, the programme may fail to provide adequate experiences for rapid intellectual development.

Bronfenbrenner (1974) found that the greatest and most enduring gains are made in "structured programmes which include an emphasis on verbal and cognitive training". Moreover, Radin (1972) suggested that it may be that compensatory programmes for young children are more effective in teaching children how to use their intellectual abilities than in enhancing those abilities per se.

In a recent investigation of the long term effects of 11 preschool intervention projects, Lazar, Darlington et al (1978) showed that the children who attended these programmes maintained their IQ advantage 3 years after the end of the programmes. In particular, IQ gains were maintained in children who participated in the programmes of Gordon (Gordon et al, 1977), Levenstein (1977) and Palmer (Palmer and Semlear, 1976). Long term effects on achievement were also recorded, as were effects on non-cognitive measures such as how the children and the children's mothers viewed them. In general, these investigators were optimistic about the long term effectiveness of preschool intervention as a result of their study, concluding that the programmes they investigated "were apparently about equally effective in helping low income children".

2.7.4 Implications for studies of malnourished children

The American studies reported here have demonstrated some success in the amelioration of sociocultural retardation in young children. Particularly where there has been parental involvement in the programmes for the children, considerable gains have been reported and in many cases, these advantages have been maintained. In addition, it has been reported that mothers of deprived children can be very successful in the role of the principal agent of the intervention programme, and paraprofessionals have also been able to produce significant improvement in the development of the children with whom they worked.

Many of the American programmes would be too expensive to be implemented in the countries where malnutrition is endemic, but some of the elements can be adapted for use. Now that there has been such progress in the physical rehabilitation on malnourished children, behavioural intervention along the lines of some of these American programmes may be of some value in the treatment of severe malnutrition.

CHAPTER 3. INTRODUCTION TO THE JAMAICAN STUDY

3.1 THE BACKGROUND

Jamaica is a country of 2 million people which is in many ways typical of the post-colonial developing countries in the Third World in which malnutrition is endemic. Traditionally an agricultural society, Jamaica is in the paradoxical position of producing sugar and bananas for export while having difficulty in financing the importation of food for its people. It demonstrates many Third World characteristics: high immigration from rural to urban areas (more than30% of Jamaicans live in the capital, Kingston), high birth rate (35 per 1000 per year), high population density (at 400/square mile, greater than India and Japan), young population (50% under 15 years of age), low levels of education (up to 50% functionally illiterate), with a small, politically and economically powerful elite (Powell et al, 1978, Brown and Stone, 1976). The national rate of unemployment varies between 25% and 30%, but unemployment is higher for women, who are frequently the heads of households.

The patterns of mating and family life of the lowest social classes have their origins in the plantation culture of slavery. The family unit is typically a woman and her children, with a resident "common-law" husband or a visiting "baby father". 70% of children are born to unmarried parents - the legitimate/illegitimate distinction has recently been removed from Jamaican law.

In the greater Kingston area, many families in the lower socio-economic class levels inhabit overcrowded wooden houses or shanties, frequently in squatter settlements that have their parallels throughout Latin America, as in the 'barriadas' of Lima or 'Villas Miseria' of Buenos Aires. Such settlements have inadequate sanitation, resulting in a high incidence of respiratory and intestinal infections. Frequently whole families live in one room with no permanent provision for cooking. Plate 3.1 shows a typical house in a 'yard' in Kingston.

Infant mortality data in Jamaica must be regarded as incomplete because of suspected under-reporting, but the official figures give an idea of the importance of malnutrition in young children. In the period between 1968 and 1974, average annual infant mortality rates (0-1 year olds; deaths per 1000 live births) for the country as a whole and for the capital, Kingston with the surrounding parish of St. Andrew varied between 35.4 and 26.2 (Ashworth and Picou, 1976). When the mortality rates for metropolitan Kingston for the period 1968 to 1970 were compared with the rates for San Francisco, U.S.A. in a Pan American Health Organisation (PAHO) inter-American investigation of mortality in childhood (Puffer and Serrano, 1973), Kingston's rate was almost twice that of San Francisco for the neonatal period, more than 2½ times San Francisco for the 1 - 11 months age group and more than 4½ times for the 12-23 months group. In the same period, malnutrition was either the primary or secondary cause of death in

Houses in 'yards' in Kingston

Plate 3.1

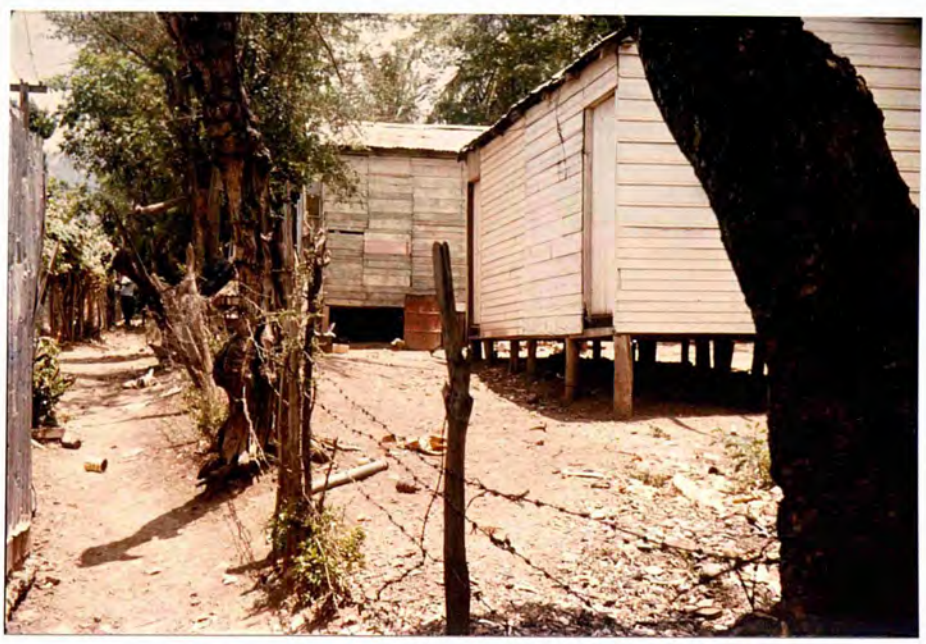


Plate 3.2

37% of the Kingston 1 to 11 month-olds and 47% of the 12 to 23 month-olds. In St. Andrew, the figures were 62% for 1 to 11 months and 86% for 12 to 23 months. In children dying of malnutrition, the peak incidence was in the 6 to 11 months age group.

Ashworth and Picou (1976) reported figures for the University of the West Indies (UWI). At the Paediatric department of the University Hospital (UHWI), for each of the years from 1972 to 1974, malnutrition was a cause of between 20% and 41% of the deaths in 1 to 24 months old children admitted to the medical wards. The picture for role of malnutrition in infant morbidity is similar. It has been estimated that approximately 25% of the children under the age of 2 admitted to UHWI each year have a diagnosis of PEM. In the year 1973-1974, of 691 children under 3 years of age admitted to the wards, 29% were moderately malnourished and 17% were severely malnourished.

Anthropometric surveys in Jamaica in the 1960s to 1970s showed that growth in the first 3 months of life was comparable to North American and European standards, but after that age, growth was depressed. Frequently, rapid deterioration was reported, persisting up to the age of 5. Ashworth and Picou (1976) also report that children aged 6 to 24 months are the most vulnerable group in Jamaica for PEM.

A longitudinal study in a rural Jamaican community found a strong relationship between growth up to 5 years of age and socio-economic variables such as standard of housing, over-crowding and ratio of wage earners to dependents in the household (Desai et al, 1970). In a group of 300 low social class children born at UHWI, moderate malnutrition at 12 months of age was associated with small birth weight, high birth order, poor housing standards, incompetent mothers, repeated gastroenteritis attacks, poor clinic attendance and poor milk intake (Grantham-McGregor et al, 1977).

This study was carried out at the Mona campus of the University of the West Indies (UWI) in Jamaica. The research reported here was part of a longitudinal investigation of mental development of malnourished children which is still in progress at the Tropical Metabolism Research Unit (TMRU) and the Paediatric Department of the University Hospital.

Some years before the present study, a group of 74 former patients of TMRU and UHWI were located and their current levels of social and psychological functioning assessed (Birch and Richardson, 1972; Richardson, et al, 1972; See Chapter 2.4.3). At least 5 years had elapsed since the period of hospitalisation of these formerly malnourished children and little was known of their development in either the acute stage of their illness or the intervening period. The new project was initiated to investigate children during their illness, with the initial plan to follow them for 6 months after discharge from hospital. For the first 4 years, from 1974 to 1978, the project was funded by the British Medical Research Council.

The research team comprised a physician who was the project's director, a psychologist and in the first instance one staff nurse (SRN). As the project progressed, a second staff nurse joined the team. The Jamaican Ministry of Health seconded Community Health Aides from their primary health care programme to take part in the intervention programme, and women from the local government agency's Special Employment Programme (known locally as "crash programme workers") made toys and ran playgroups on the wards.

3.2 THE DESIGN OF THE STUDY

This study of the effects of severe malnutrition was carried out in two phases.

In phase 1, the development of severely malnourished children who received the standard nutritional rehabilitation in hospital (the Non-Intervention group) was assessed. Children between the ages of 6 and 24 months were chosen for study as this is the age at which Jamaican children are most vulnerable to malnutrition and are most frequently admitted to hospital for treatment (Ashworth and Picou, 1976). There was a comparison group of children from similar socioeconomic backgrounds who were also admitted to hospital, but who were well-nourished and were being treated for non-nutritional complaints. Children in phase 1 were admitted to hospital between June, 1975 and September, 1976. The children were assessed on the Griffiths Mental Development Scales while in hospital and one and six months after their return home. At weekly intervals in hospital, behaviour observations were carried out in structured and unstructured situations. The children's behaviour during the test sessions was also rated. Information about the children's medical histories and social backgrounds was obtained from the mothers while the children were hospitalised and the Home Observation for Measurement of the Environment (HOME) inventory (Caldwell et al, 1966) was administered at the children's homes approximately 3 weeks after the children returned home. The mothers' verbal skills were measured on the Peabody Picture Vocabulary test (Dunn, 1965).

In phase 2, a second group of severely malnourished children was formed using the selection criteria that had been applied in phase 1. This group also received the standard clinical care on the wards, but in addition, took part in a behavioural intervention programme which started while the child was in hospital and continued after discharge. This group had the same schedule of developmental assessments as the previous groups and with the exception of the HOME, the same medical and social background information was collected for the three study groups. The intervention programme took the form of a sequence of activities in a curriculum based on Piagetian theory of cognitive development. It was designed to be carried out by the paraprofessional staff that would be available in hospitals treating malnutrition and involved the use of toys made out of scrap materials. The group with the additional behavioural programme is compared with the malnourished Non-Intervention children who received the standard treatment and with the well-nourished Comparison children to assess the effects of the intervention.

3.2.1 Methodological issues

Tizard (1974), discussing methodological problems in field studies of malnutrition, listed 3 sets of questions which have been the concern of studies in this area. The first, "what are the characteristics of societies and groups which have high rates of malnutrition in the child population?" was easily answered: "in short, malnutrition is caused by poverty, and cured by wealth which permits better feeding and a better way of life."

The second and third questions are not as easily answered. "What distinguishes malnourished children and their families from others in these societies - children not necessarily well nourished but not clinically malnourished either?", and "How can one successfully intervene to prevent malnourishment or mitigate its effects?" (p.64) This thesis reports on research which addresses itself in part to Tizard's second question, but is principally concerned with the third.

In the same paper, Tizard refers to the distinction between "practical applied research" and "research that is 'fundamental and basic' ". The research reported here would therefore fall into the first category.

However, an additional factor which any researcher venturing into this area must bear in mind is the social and political context of the subject. In the area of intervention, possibly more than in many other forms of psychological research, the long-term consequences of actions have to be given strict attention. Furthermore, it can be argued that in the broadest context, protein-energy malnutrition and its effects are the result of exploitation, and therefore researchers in this area have to tread particularly carefully. An important element of this design was the attention to the resources of the host community. Tizard's third question was therefore modified and reformulated as "how can this community, with its limited resources, intervene to mitigate the effects of malnourishment?" This had the effect of moving the research further into the 'practical applied' category, because the investigation of the possible effects of intervention was combined with the development of a feasible model for a long-term programme of intervention.

The design of this research raises several methodological issues. In common with the majority of studies in this area, it has an ex post facto design. In each case, the malnourished child was selected for study after the diagnosis of severe malnutrition had been made. No first hand information is available about the premorbid development of the children. Moreover, although the aim was to assess the effects of a particular treatment, random allocation of subjects to treated and untreated groups was not possible. The presence or absence of malnutrition was determined before the research began and the assignment of malnourished children to Non-

Intervention and Intervention groups was dependent on the date of the child's admission to hospital.

The diagnosis of malnutrition and the decision to admit a child to the wards were made by the medical staff, as was the decision about when a child was fit for discharge. It is clear that these decisions were made in the context of factors prevailing at the time. The fact that the study groups were constituted over a period of 30 months means that changing circumstances at the hospital or in the community during that time may have influenced the study in ways that cannot be measured. The temporal separation of the two malnourished groups was unavoidable in this study for two main reasons. It was necessary first to obtain data on the development of the children who were receiving the standard treatment for severe malnutrition. This information was not previously available for this population and was necessary for the design and evaluation of the behavioural programme. Second, it would not have been possible to keep Non-Intervention and Intervention conditions separate in the same hospital. Medical and nursing staff work throughout the paediatric wards and therefore any new practices that were introduced for the Intervention children would also have affected the Non-Intervention group if they were in the hospital at the same time.

The inclusion of a Comparison group of children who have also experienced hospitalisation is an important aspect of this study. Although several writers have commented on the possible effects of long periods of hospitalisation on malnourished children (e.g. Lloyd-Still, 1976b; Latham, 1974), no previous study has reported attempts to control for these effects. Lloyd-Still (1976b) wrote :

> "..duration of hospitalisation may be one of the more important factors accounting for the wide variation in results from different studies. The effects of the prolonged duration of hospitalisation of malnourished children is an important variable that has been neglected." (p. 128)

Similarly, Latham (1974) wrote:

> "Any differences found in psychological functioning in malnourished children could have resulted in part from a long period of hospitalisation, or to relative immobilization and loss of learning time, or to a period of maternal (or family) deprivation while in the hospital." (p. 557)

Acknowledging that hospitalisation was not likely to explain all the differences, citing the work of Bowlby (1952), Latham suggested that hospitalisation was a factor deserving some consideration. He proposed that the "period of emotional anxiety and fear resulting from separation from home and family while hospitalised" was an important difference between survivors of severe malnutrition and well-nourished comparison children in many studies.

For some time it has been known that hospitalisation in early childhood can produce behavioural disturbance at least in the short term (e.g. Blom, 1958; Schaffer and Callender, 1959; Langford, 1961; Robertson, 1970; Bowlby, 1975;). It is only recently however that the possibility of long-term consequences of early hospital admissions has been acknowledged. In fact, it was widely believed that the behavioural disturbances following early hospitalisation were seldom persistent (Douglas, 1975). In a sample of 958 British children born in 1958, Douglas (1975) found an association between one admission of more than 1 week duration or repeated admissions, particularly in the period between 6 months and 4 years, and an increased risk of adolescent behaviour disturbance. Five adverse ratings of behaviour were considered. Nervousness was not associated with early hospitalisations, whereas troublesome behaviour, poor reading, delinquency and unstable job-history increased with both the number and length of admissions before 5 years. The adverse ratings for adolescents with a history of early hospitalisation did not appear to be an artifact of initial selection or similar biases in the sample. Family instability and hospitalisation interact to exacerbate the behavioural problems. Another English study (Quinton and Rutter, 1976) generally confirmed Douglas' (1975) findings.

A Canadian research team (Sigal, 1974; Sigal and Gagnon, 1975) have investigated the behaviour of school children who had been hospitalised before 5 years of age for croup, nephrosis or gastroenteritis. Their data suggested that severity of illness and measures of parents' worries about the child's illness were associated with conduct disorders in 8 to 12-year-olds.

The hospitalisation of the severely malnourished children, reported as up to a year in duration in some studies, must therefore be regarded as an important factor in any hypothesised relationship between early nutritional status and subsequent behaviour and development.

In this study, therefore, a comparison group of children of the same ages as the malnourished children was formed to provide an intra-community comparison group. Such a group is useful in the attempt to unravel the many elements of the experiences of the severely malnourished child that could contribute to or in some way influence the pattern of his development. However, it must be noted that there may be inherent problems in trying to compare children who have experienced different diseases.

A further difficulty arises from the impossibility of 'blind trials' in a study of this type. First, the observations and testing were carried out by two people who were involved with the study throughout and therefore not only knew the hypotheses that were being tested, but also knew the circumstances of all the children who were taking part. Moreover, in hospital there was no way of disguising the fact that one was testing either a malnourished or a well-nourished child.

With a longitudinal study such as this, with frequent contact with the subjects and repeated testing, there is the risk that the situation is being transformed by the very act of measurement. In a sense, the Non-Intervention group were not receiving the standard treatment for malnutrition because the fact that the development of the children was being assessed, at the very least, would have focused attention on this aspect of the child, which may not otherwise have been significant to either the clinical staff or the children's parents. However, this kind of effect is unavoidable.

The assessment of development in malnourished children is not without its problems. The prime concern is whether severe malnutrition in infancy results in mental retardation. But, as Vernon (1969) pointed out, mental capacities cannot, like height and weight, be measured on absolute or ratio scales. Results have to be assessed in reference to the distribution of results in a population of comparable individuals.

No norms exist for the development of Jamaican children. An early study (Curti et al, 1935) found Jamaican children relatively retarded in comparison to the Gesell norms in all but gross motor development. More recently, Grantham-McGregor and colleagues undertook a survey of 300 infants born at UHWI. 65 of the sample had Gesell developmental assessments at 1 year (Grantham-McGregor and Hawke, 1971). On all of the 5 scales of the test, the children's mean scores, expressed in weeks of development, exceeded 52 weeks as shown in the following table.

Table 3.1 Mean scores on the Gesell test for 65 children at 1 year.

from Grantham-McGregor and Hawke, 1971

	GROSS MOTOR	FINE MOTOR	ADAPTIVE	LANGUAGE	PERSONAL-SOCIAL
MEAN SCORE (weeks of development)	58.3	55.6	53.6	55.4	53.9

The highest scores were attained in gross motor development. 11 children (16.9%) achieved levels between 66 and 71 weeks. The gross motor development of 252 children from the sample was assessed on the Gesell schedules on at least 6 occasions in the first year of life and Grantham-McGregor and Back (1971) report that "the Kingston infants consistently attained each gross motor item earlier than the normal Gesell Infants". The Kingston children started to walk at earlier ages than European children in samples from Stockholm, Brussels, London, Paris and Zurich (Hindley et al, 1966). 70% of the Jamaican children were walking by 12 months, while the median ages for the European groups ranged from 12.4 months for Swedish children to 13.6 months for Swiss children.

As Grantham-McGregor and Hawke (1971) point out, this was not a randomly selected group as it comprised women specifically selected for hospital delivery in an area with an insufficient number of obstetrical beds. 80% of the mothers were working class and in this sample, infants from the upper SES groups performed significantly better than infants from the lower SES groups in language ($p<0.01$) and fine motor behaviour ($p<0.05$). The 10 children with the heaviest weights were significantly better in language than the 10 lightest children ($p<0.01$), though none of the children were malnourished and the reason for the associations cannot be stated.

Any precocity shown by these children at the age of 1 year was lost over the next 2 years in children studied longitudinally from this group (Back et al, 1972). This would appear to be an artifact of the biased social class composition of the sample. There is evidence of relatively retarded development of working class Jamaican children from a study of 4 year old children in Kingston (Wein, 1971a, 1971b). Children entering the State primary schools were found to be developmentally 18 months behind their more privileged counterparts entering private preparatory schools.

There have recently been programmes to provide better day care and nursery school facilities for socially deprived children in Jamaica, but apart from the work of the van Leer Foundation's Project for Early Childhood Education with children between 4 and 7 (e.g. Wein, 1971a, 1971b), there has only been one published report of research on preschool intervention in Jamaica. Grantham-

McGregor and Desai (1975) used Palmer's Concept-training curriculum (Palmer, 1971) for a home visiting programme with preschool children in the suburbs of Kingston. They were able to demonstrate mean gains of 10 points on the Griffiths Mental Development Scales for the 20 children who entered the programme at 34 to 40 months of age and who received a maximum of 29 weekly one-hour visits. 21 comparison children who did not participate in the programme showed a mean decline between the pre- and post-tests of 3 points, with 15 of these children showing losses of up to 15 points. All but 1 of the index children showed a gain in DQ over the intervention period with 10 children gaining between 10 and 24 points.

These results, together with Wein's findings (1971a, 1971b), demonstrate the effects of social deprivation on Jamaican children and the scope for improvement through intervention.

The application of tests of mental development in countries in which their validity and reliability have not been established has been questioned by several writers (e.g. Berry and Dasen, 1974; Pollitt and Thompson, 1977). In many studies, including the work of Grantham-McGregor et al (Grantham-McGregor and Back, 1971; Grantham-McGregor and Hawke, 1971) and Geber and Dean's classical paper on African children (1957), it has been recognised that the development of children in Africa, Latin America and the Caribbean follows patterns which make North American and United Kingdom norms inapplicable, particularly in the first twelve to eighteen months of life. In this study, therefore, it was recognised that the absolute level of the Developmental Quotient would have only limited value. However, it is argued that the main interest is in the relative positions of the groups of children and the influence of specific social, nutritional and behavioural factors on these relative positions, and in such a case, the Griffiths Scales could be used satisfactorily. However, it must be acknowledged that some caution is necessary in the interpretation of the scores of the children on a test that was neither designed for them, nor standardised on an equivalent population.

CHAPTER 4. SUBJECTS

In the first phase of the study, the development of young children diagnosed as suffering from severe malnutrition and receiving the standard hospital treatment was investigated. A group of severely malnourished children, the "Malnourished (Non-Intervention) Group", was constituted from admissions to the medical paediatrics wards of the University Hospital of the West Indies (UHWI) and the metabolic ward of the Tropical Metabolism Research Unit (TMRU) at the University of the West Indies. For comparison, a group of well-nourished children was also selected from the admissions to the medical paediatrics wards during the same period - the "Comparison Group".

4.1 SELECTION CRITERIA

On the basis of the medical histories collected by the doctors at the time of a child's admission to the wards and from data collected at the initial interview with the parent or guardian by the research staff, children were selected for the study groups according to pre-defined criteria.

All children between the ages of 6 and 24 months, admitted to TMRU or the UHWI wards between June 1975 and

October, 1976 were eligible for the study, but the following categories of children were excluded from the sample:

1. Children with unknown date of birth.
2. Children from institutions.
3. Multiple births.
4. Children with meningitis, encephalitis, cerebral tumour, gross physical abnormality or any other chronic disease other than malnutrition requiring repeated hospitalisation or likely to affect the development of the child.
5. Children living outside of the Greater Kingston area.
6. Children whose mothers or guardians had completed secondary school.
7. Children who lived in houses above certain standards of sanitation, facilities and room occupancy.

   The last two conditions were in effect measures of socio-economic status - education and standard of housing being 2 of the most useful measures in this society.

The children were assigned to the Non-Intervention or Comparison group according to the Wellcome classification of nutritional status (Table 1.1), based on the child's weight and age, and the presence/absence of nutritional oedema.

In the majority of cases, the family member with whom we dealt was the mother of the child, but in addition we met a few fathers, grandmothers, stepmothers or aunts. Throughout this report, for convenience, the term "mother" will be used as the general term for the adult family member or guardian unless otherwise stated.

All children who fulfilled the selection criteria were taken into the study with the exception of one child who was admitted to the ward at a time when it was not possible to include another subject.

The informed consent of the children's parents or guardians was obtained and it was made clear that refusal to take part in the study would not in any way affect the availability of medical care. Although involvement in the study required the inconvenience of regular additional visits to hospital, the possibility of direct access to the medical facilities of the UHWI probably acted as an important incentive in a community where medical services are in short supply.

In the period of the study reported here - June, 1975 to September, 1978 - only one child was lost from the sample. This was a boy from the Comparison group who was not available for the 6 months post-discharge test and is therefore excluded from the longitudinal analysis. The maintenance of the study groups was due to the considerable cooperation of the families of the children who informed the research staff of changes of address, and also to the considerable persistence of the research nurses, who found the children at each of their new homes.

4.2 DESCRIPTION OF THE SAMPLES

4.2.1 Methods

Background information about the children was obtained during interviews with the mother when a child was in hospital and from a visit to the home approximately 3 weeks after the child's return home.

The following aspects of the children's home environments and hospital stay are included in the analyses reported here:

Background information

1. Child's age on admission.

   When a birth certificate was available, mother was asked to bring it in for the date of birth to be checked.

2. Child's birthweight.

   Birthweights were recorded from mothers' histories. Records were not available for inspection to confirm this information. Some of the children were not born in hospital and were not weighed at birth. In these cases, from a series of questions to the mother (e.g. comparing the size of the child at birth to other children who had been weighed), estimates of the child's birthweight were made on which decisions about the inclusion of the child were made.

3. Mother's verbal ability.

While the child was in hospital, mother was given the Peabody Picture Vocabulary Test (Dunn, 1965). In this measure of verbal comprehension, the subject is required to indicate which of four line-drawings is referred to by a single word spoken by the tester. This test had previously been used in Jamaica (Wein, 1971; Grantham-McGregor and Desai, 1975).

4. Socioeconomic status.

This was assessed from the standard of the housing in which the family lived. In this population, this is the most reliable measure of the long-term economic condition of the family.
The rating scale is shown in Appendix I. There was a maximum score of 12, based on the state of repair, sanitation and the number of people living in the home.

5. Quality of developmental stimulation in the home.

Three weeks after the child returned home, mother and child were visited at home by a nurse who gave the Bettye Caldwell HOME Inventory (Caldwell et al, 1966). This inventory was modified for use with young Jamaican children (See Appendix I.). The inventory consists of 69 items (questions to mother and observations by interviewer), classified into 9 groups (Table 4.1). For each child, there was therefore a total score and 9 scores from the subgroups.

Table 4.1 Caldwell 'Home Observation for Measurement of the Environment' (HOME) Inventory modified for Jamaica.

Classification of items.

	Subgroup	No. of items
I	Organisation of a stable environment	7
II	Developmental stimulation available	7
III	Quality of language environment	10
IV	Avoidance of restriction	10
V	Communication with society	6
VI	Emotional climate	6
VII	Breadth of experience	7
VIII	Physical environment	7
IX	Availability of play materials	9
	Total:	69

Hospitalisation measures

6. Diagnosis by Paediatrician in charge of ward.

7. Length of hospitalisation.

   The total number of days spent in hospital was recorded.

8. Severity of initial illness.

   The number of days that elapsed after the child was admitted to hospital before he was considered fit enough to be tested was used as a measure of the severity of the child's initial illness.
   The criteria used to define fitness for first test are listed in Chapter 5.1.3. (page 248). There are undoubtedly problems in comparing the hospital experiences of children suffering from diseases as disparate as malnutrition and diptheria and this simple measure applied the same criteria to assess the state of the children in the initial stages of hospitalisation.

Nutritional Status

Nutritional status throughout the study was assessed on the basis of anthropometry. Weight, height and head circumference were measured for each child and they were expressed as percentages of the standards for the appropriate age and sex using the Boston standards for weight, height and head circumference (Stuart and Stevenson, 1969). The fiftieth percentile at each age level is taken as the standard for that age.

The following standardised measures were used:

1. Per cent weight for age (i.e. child's weight as a percentage of the standard weight for that age and sex).
2. Per cent height for age (a measure of the degree of stunting of growth and therefore chronicity of malnutrition; Waterlow and Rutishauser, 1974).
3. Per cent head circumference for age.
4. Per cent weight for height (a measure of the degree of wasting; Waterlow and Rutishauser, 1974).

4.2.3 Results

Non-Intervention group

The Non-Intervention group comprised 18 children (11 female and 7 male) diagnosed as having marasmus, kwashiorkor or marasmic-kwashiorkor (Table 4.2.)

Table 4.2 Malnourished (Non-Intervention) group
Classification of types of malnutrition

Sex	Female	Male	All
N	11	7	18
Diagnosis			
Kwashiorkor	-	1	1
Marasmic-Kwashiorkor	3	-	3
Marasmus	8	6	14

The mean scores of the Non-Intervention children for the nutritional status variables are shown in Table 4.3.

At their lowest weight in hospital, the Non-Intervention children had a mean score for %weight for age of 52.1, ranging from 37 to 62. Only one child was

Table 4.3 Means and standard deviations of Anthropometric measures at first test.

Non-Intervention and Comparison Groups

	Non-Intervention Mean	(SD)	Comparison Mean	(SD)	F	P
% WT/age at first test	55.1	(8.16)	88.7	(8.24)	132.4147	0.0000
% HT/age at first test	88.0	(5.08)	101.6	(3.48)	73.8770	0.0000
% HC/age at first test	91.3	(3.51)	99.5	(3.67)	41.4729	0.0000
% WT/HT at first test	73.2	(9.90)	86.6	(8.94)	15.8571	0.0000
lowest % WT/age in hospital	52.1	(6.70)	87.6	(8.96)	165.0626	0.0000

The following abbreviations will be used in this report:

% WT/AGE = per cent weight for age

% HT/AGE = per cent height for age

% HC/AGE = per cent head circumference for age

% WT/HT = per cent weight for height.

Table 4.4 Standardised anthropometry of Malnourished (Non-Intervention) children in hospital and after discharge.

Means and Standard deviations

Standardised Anthropometry	In Hospital: Admission		In Hospital: Discharge		1 month after discharge		6 months after discharge	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
% WT/AGE	55.1	(8.16)	66.8	(6.37)	73.0	(8.02)	78.8	(7.54)
% HT/AGE	88.0	(5.08)	87.9	(4.74)	88.9	(4.45)	90.7	(4.44)
% HC/AGE	91.3	(3.51)	91.7	(3.51)	93.9	(3.10)	95.0	(2.97)
% WT/HT	73.2	(9.90)	90.6	(12.81)	92.5	(8.43)	92.2	(7.28)

diagnosed as having kwashiorkor (at 62% weight for age, with nutritional oedema), while the others were diagnosed as having marasmus or marasmic-kwashiorkor. At the time of the first developmental assessment, these children showed height deficits of between 5 and 23 per cent of their expected height for age, with a mean score of 88%. This degree of stunting is interpreted as an indication of the chronicity of the malnutrition. At their lowest weight in hospital, with the exception of the child with kwashiorkor, the children showed extensive wasting, being on average 69% of the expected weight for their height (ranging from 63% to 78%).

The boys and girls of the Non-Intervention group are compared in Table 4.5. There were no statistically significant differences between the two sexes on the social background and nutritional variables measured, although the girls tended to stay in hospital longer than the boys (F=2.2302, N.S.) and appeared to be more severely ill on admission to hospital (F=1.1337, N.S.). The girls also had mothers who achieved slightly higher scores on the PPVT (F=0.5630, N.S.).

The Non-Intervention children's scores on the HOME inventory are shown in Table 4.6. In all of the sub-groups, the malnourished children obtained low scores, notably a mean of 14.2% of the possible score for 'Availability of play materials'.

Table 4.5. Description of Non-Intervention group divided by sex.

Mean scores and standard deviations.

	Non-Intervention group				F	p
	Boys (n=7)		Girls (n=11)			
	Mean	(SD)	Mean	(SD)		
Birthweight (kg)	3.00	(0.59)	2.93	(0.49)	0.0608	0.8084
PPVT	56.7	(16.01)	62.1	(14.06)	0.5630	0.4639
Standard of housing	6.4	(1.51)	6.5	(1.91)	0.0009	0.9762
Age on admission (months)	13.2	(4.75)	12.4	(4.37)	0.1400	0.7132
Total days in hospital	37.0	(19.22)	54.3	(26.34)	2.2302	0.1548
Admission to first test (days)	5.0	(2.08)	9.3	(10.37)	1.1337	0.3028
Lowest % WT/AGE in hospital	52.6	(9.38)	51.8	(4.83)	0.0510	0.8242
Lowest % WT/HT in hospital	86.4	(6.63)	89.2	(4.00)	1.2255	0.2846

Table 4.6 Home Observation for Measurement of the Environment (HOME)

Means and Standard deviations of scores obtained by the Non-Intervention and Comparison groups.

HOME subgroups (a)	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Organisation of environment (7)	4.7	(0.77)	4.3	(0.83)	1.8182	0.1876
Developmental stimulation (7)	3.1	(1.66)	3.3	(0.83)	0.2243	0.6392
Language environment (10)	4.9	(2.21)	5.7	(1.49)	1.2524	0.2720
Avoidance of restriction (10)	7.0	(1.26)	6.7	(1.77)	0.1846	0.6705
Communication with society (6)	2.17	(1.04)	2.14	(1.03)	0.0042	0.9490
Emotional climate (6)	3.89	(1.13)	3.57	(1.02)	0.6763	0.4174
Breadth of experience (7)	3.11	(1.64)	3.36	(1.55)	0.1857	0.6696
Physical environment (7)	3.61	(2.15)	4.79	(2.08)	2.4210	0.1302
Availability of play materials (9)	1.28	(0.83)	1.86	(1.29)	2.3796	0.1334
Total (69)	33.72	(6.12)	35.71	(6.17)	0.8293	0.3697

(a) Maximum score in parentheses.

<u>Comparison Group</u>

All adequately nourished children admitted to hospital for non-nutritional reasons who fulfilled the criteria listed in chapter 4.1 were potential Comparison children. An additional criterion was that the child should be expected to remain in hospital for at least 9 days (i.e. to have at least 2 DQ assessments in hospital). 21 children were therefore included in the Comparison group (13 males and 8 females).

Of this original group, 6 children left hospital before the second test and are therefore excluded from the longitudinal analysis. 1 child was lost from the study before the second post-discharge test and is also excluded from these analyses, reducing the Comparison group to 14 children (9 males and 5 females).

The Comparison children are compared with the Non-Intervention children in Table 4.7. The children were not significantly different in severity of initial illness, but the malnourished children had a longer average delay before the first test,with more variability between the children than the well-nourished children (F=0.6706, p=0.4193). The children of the two groups were of similar ages on admission (F= 0.0147, p= 0.9044), but there was a highly significant difference between the groups on length of hospital stay (F= 16.4597, p=0.0003). The Comparison children had a history of significantly higher birthweights (F=4.0372, p=0.0536) and they came from homes of a slightly higher standard than the malnourished children, albeit of minimal standards of habitation (F=14.4682, p=0.007). The mothers of the well-

Table 4.7 Description of Non-Intervention and Comparison groups

Means and standard deviations of background and hospitalisation measures.

	Non-Intervention n = 18		Comparison n = 14		F	P
	Mean	SD	Mean	SD		
Birthweight (kg)	2.96	0.52	3.33	0.52	4.0372	0.0536
PPVT	60.0	14.63	68.1	10.63	3.0138	0.0928
Standard of housing	6.4	1.72	8.6	1.34	14.4682	0.0007
Age of admission (months)	12.7	4.40	12.5	4.82	0.0147	0.9044
Total days in hospital	47.6	24.77	18.6	11.18	16.4597	0.0003
Admission to first test (days)	7.6	8.33	5.6	4.69	0.6706	0.4193

nourished children had a slight advantage over the mothers of the malnourished children in verbal ability (PPVT raw scores: F=3.0138, p=0.0928), but mothers of both groups only achieved scores equivalent to the norms for school-children.

The anthropometry of the Comparison group on admission to hospital is shown in Table 4.3. They were equal to the standards in height and head circumference. Though by definition well-nourished, they were, on average, below the standards for weight for their age and weight for height. This may be a reflection of genetic differences between the Jamaican sample and the American population on which the standards were developed, but is more likely to be a reflection of the fact that the Comparison group was chosen from a very deprived section of the Jamaican population (Desai et al, 1969, 1970).

The boys and girls in the Comparison group are compared in Table 4.8. Within the group, the males and females were very similar. The boys tended to be smaller than the girls (lowest weight for age in hospital: F=2.9680, N.S.) and were apparently slightly more severely ill than the girls (severity of initial illness: F=0.4661, N.S.; total days in hospital: F=1.2077, N.S.), but none of these differences even approached statistically significant levels.

The Comparison children's scores on the HOME inventory are shown in Table 4.6. The children's scores were very low. The mean score of 35.71 was only 51.75% of the possible maximum of 69, even after the modifcations which involved reducing the requirements for a positive score from the levels used in the United States (See Appendix I).

Table 4.8 Description of Comparison group divided by sex.

	Comparison				F	P
	Boys (n = 9)		Girls (n = 5)			
	Mean	SD	Mean	SD		
Birthweight (kg)	3.30	0.59	3.38	0.41	0.0684	0.7981
PPVT	68.0	11.74	68.2	9.58	0.0011	0.9747
Standard of housing	8.7	1.50	8.4	1.14	0.1182	0.7369
Age on admission (months)	11.4	4.74	14.3	4.88	1.1859	0.2975
Total days in hospital	21.0	13.18	14.2	4.66	1.2077	0.2933
Admission to first test (days)	6.2	5.63	4.4	2.30	0.4661	0.5077
Lowest % WT/AGE in hospital	84.8	7.51	92.8	9.80	2.9680	0.1106

Table 4.9 Standardised anthropometry of Comparison children in hospital and after discharge.

Means and Standard deviations.

	Time of Measurement							
	In Hospital				1 month after discharge		6 months after discharge	
	Admission		Discharge					
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
% WT/AGE	88.7	(8.24)	92.9	(9.05)	94.6	(9.38)	96.7	(9.69)
% HT/AGE	101.6	(3.48)	101.1	(3.67)	101.1	(3.08)	101.7	(3.42)
% HC/AGE	99.5	(3.67)	99.4	(3.48)	99.4	(4.01)	100.1	(3.03)
% WT/HT	86.6	(8.94)	92.0	(8.95)	92.5	(8.43)	94.2	(8.74)

4.2.3 Discussion

It was originally planned to have 20 children in each group, but it was only possible to include 21 Comparison children and 18 Non-Intervention children in the time available. The Comparison group was further reduced for the purposes of the longitudinal analyses because of the short hospital stays of some of the children. Because of the nature of the selection procedure, it was not possible to control certain characteristics of the sample to the extent that one would have wished.

Children of low birthweight or those suspected of having pre-term births were excluded from the groups. Nevertheless, the Comparison children had birthweights that were significantly higher than the malnourished children. On the socioeconomic measure, standard of housing, the comparison children had significantly higher ratings than the malnourished children. On this measure, however, it must be noted that even the maximum possible score of 12 would represent a very low standard of housing. So that although there was a difference between the groups, it would be fair to say that all the children came from homes with the very minimum of physical amenities.

As shown in Table 4.6, the microenvironments of the children in the two groups were very similar. The Malnourished (Non-Intervention) children and the well-nourished Comparison children obtained similar scores in the subgroups of questions and the total score for the Caldwell HOME inventory (9 subgroups and total: all NS). This is a surprising finding in the light of reports from the Land of the White Dust study in Mexico (DeLicardie and Cravioto, 1974). In that community, the quality of the stimulation in the homes, as measured on the HOME from the age of 6 months, was predictive of the children that would become malnourished in the second year of life. Malnourished children obtained lower scores on the HOME than matched well-nourished comparison children (see Chapter 2.4.3). There are several possible explanations of the differences between the two studies. In the first place, this may merely be a reflection of differences between the two cultures - a rural Mexican village contrasted with an urban environment in Jamaica. Furthermore, it may be that these differences are due to differences in sample selection. As suggested in chapter 2, the children who became malnourished in the Land of the White Dust may be atypical of groups of malnourished children in the Third World. A family that has a malnourished child in spite of regular advice may be particularly deviant in the social, emotional and intellectual environment that prevails in the home.

The scores in both groups were very low. With a possible maximum total score of 69 points, no child in either group achieved more than 46 points. This confirms that malnutrition occurs in families at risk for sociocultural mental retardation, but cannot contribute to explaining why some of the children became malnourished.

The fifth subgroup, 'Communication with society', was added to the HOME to test the suggestion that restricted communication with the world outside the home was a characteristic of the mothers of malnourished children (Cravioto and DeLicardie, 1976a; Richardson, 1974; Kerr et al, 1978). However, the two groups of children were very similar in this subgroup (F=0.0042, p=0.9490), failing to support the hypothesis. It is notable that both groups had mean scores of less than 2 points of a possible maximum of 9 for 'Availability of play materials', which included items about manufactured toys and scrap materials (See Appendix I).

There was a highly significant difference between the groups in the length of hospital stay (F=16.4597, p=0.0003). Although the Comparison children share the experience of hospitalisation with the malnourished children, the length of hospital stay of the former group was considerably shorter than that of the latter group. One Non-Intervention child stayed in hospital for 111 days, while the maximum for the Comparison group was 46 (the average stay for the malnourished Non-Intervention group was 47.6 days). However, as the Comparison children spent at least one week in hospital, they would fall into the category of children at risk for subsequent adverse behavioural sequelae according to Douglas' (1975) findings.

The groups did not differ significantly on age of admission or the length of the time from admission to the first test. In addition, their mothers' verbal abilities did not differ significantly across the groups.

In general, the Comparison children obtained slightly more favourable ratings than the Non-Intervention children. Both groups came from very deprived homes, but it may be that the differences between the groups in SES, birthweight and mothers' verbal ability, though slight, were sufficient to make the difference between adequate and poor nutrition in the first 2 years of life.

CHAPTER 5. DEVELOPMENT OF THE MALNOURISHED (NON-INTERVENTION) AND COMPARISON CHILDREN

5.1 METHODS

5.1.1 The Griffiths Mental Development Scales

The development of the children was assessed at regular intervals using the Griffiths Mental Development Scales (Griffiths, 1954, 1970). The Griffiths scales were designed for the testing of babies and young children from birth to eight years of age. For children up to 24 months, the test comprises 5 subscales; A.Locomotor, B. Personal-social, C. Hearing and Speech, D. Eye and Hand Coordination and E. Performance. From the beginning of year 3, there is an additional subscale: F. Practical Reasoning.

The Griffiths Test for children up to the age of 24 months was originally published in 1954. The test was standardised on English children in London, who were seen in Infant Welfare Centres, nurseries, hospital waiting rooms and private homes. When the test was extended for use with 2 to 8 year old children (Griffiths, 1970), a new standardisation resulted in 2 test items per month throughout the first 2 years. Above 24 months, there is one item for 2 months of development. The 1970 standardisation of the Scales was used in this study.

A Locomotor Scale

In the first two years, this scale measures "that series of developing skills that result in the achieving of the upright posture by the child and lead on to learning to walk, run, climb and so on " (Griffiths, 1954). In the third year, the items test rapid and controlled movement and balance.

B Personal-Social Scale

For this Scale, described by Griffiths as a measure of "social adaptation" (1954, p153), the presence and help of the child's mother or guardian is essential for complete assessment. As the tests in hospital had to be carried out in the absence of the children's mother, this scale was omitted from the test in this study.

C Hearing and Speech Scale

This measure of language development includes items assessing reaction to sounds ('2 months: listens to bell - softly rung'), comprehension of speech ('16 months: one object in box identified') and speech production ('3 months: makes 2+ different speech sounds', '30 months: defines by use (2+ items) cup, knife, chair, etc'). The standard visual material was used for this scale, but a few limited alternative answers were allowed (as permitted by Ruth Griffiths for a previous study by Grantham-McGregor).

D Eye and Hand Coordination

Griffiths (1954) described this scale as measuring, initially,

> "the various stages of hand development and their association with vision in the general grasping and manipulation of objects and environment. Later on, the use of a pencil on paper, the building of toys or bricks one upon another, the rolling of a ball, and other natural activities common to every child, find a place in this scale and are tested for in a play way."

She stresses that the educational implications of this scale are considerable as

> "here we have the beginnings of both writing and drawing in the manipulation of pencil on paper, and thus the using of the first educational implements and materials"

and beyond the second year it is

> "closely associated with the curricula of nursery and infant schools" (1954, pp 183-4).

E Performance

In Griffiths' terms

> "we now face the child with a number of practical test situations that call upon his ingenuity and readiness to respond" (1954, p 199).

After the first 3 months, and up to the 3 years 8 months level, this scale consists almost exclusively of items in 2 major sequences. One series involves 3 small wooden "brick boxes" (an adaptation of Froebel's Gift III) and the second series involves a set of form boards.

F Practical reasoning

This scale was added for the third year because "certain skills and items of learning could not be fitted logically into these five scales when extended" (Griffiths, 1970, p13). It includes items measuring digit memory span and understanding of size and length. As few children reached this level of the test in the period reported here, this scale will not be included in the analyses.

Four subscales will therefore be reported. These are Locomotor, Hearing and Speech, Eye and Hand Coordination and Performance.

5.1.2. Observations of the children's behaviour during tests

The DQ is derived from the number of items in the Griffiths Scales that the child passes, but takes no account of the child's other responses during the test session. During each test session therefore, the tester rated 3 aspects of the behaviour of the child in order to assess whether differences in the responses of the child to the test procedure could explain any individual changes in the DQs and differences between the scores of the two groups.

The children were rated for (a) cooperation with the tester, (b) the amount of interest shown in the test material and (c) the amount of vocalisation during the session. The scales were adapted from the Infant Behaviour Record of the Bayley Scales of Infant Development (Bayley, 1969).

(a) Cooperation with the tester

This scale had 7 levels (See Appendix I). The readiness with which a child attempted the test items was assessed by the tester after the test. Whether the child succeeded in the task was not relevant to this measure, which ranged from 'resists all suggestions or requests' with a score of 1 for a child who completely refused to cooperate to 'very readily and enthusiastically enters into nearly all suggested games' with a score of 7. This scale was modified from Bayley's 'Cooperativeness' scale.

(b) Interest in test materials

This scale also had 7 levels. The child's interest in the test materials and his/her manipulation of the objects were rated. Modified from Bayley's 'Object Orientation', it involved the assessment of the duration of the child's interest, again disregarding whether the child was able to pass the test item, or whether the child was engaged in the task required by the tester. (See Appendix I).

(c) Vocalisation

This was a measure of the amount of vocalisation by the child during the test sessions. There were 4 levels in this rating scale (See Appendix I), ranging from 1 for a child who was completely silent, to 4 for 'frequent vocalisations throughout the test'.

5.1.3 Schedule of test sessions

All groups of children were tested according to the following schedule:

Test 1

The child's developmental level on admission was assessed between 48 and 96 hours after admission to hospital unless he was considered unfit to be tested. The predefined criteria of fitness to be tested required the absence of intravenous infusions, nasogastric tubes, physical restraint or oxygen tents. In addition, children were also defined as unfit for testing if they were clinically dehydrated, markedly dyspnoeac, febrile (temperatures of more than $100^{o}F$) or hypothermic (less than $97^{o}F$), in pain or were subject to such conditions as uncontrolled fitting.

All tests in hospital (ie. tests 1 - 3) were carried out in the absence of the children's parents or guardians.

Test 2

This assessment was carried out in hospital one week after Test 1.

Test 3

A third test was carried out when the child was discharged by the paediatrician, (as far as possible, within 2 days of the child actually leaving the hospital ward,) providing that this was at least one week after Test 2.

Test 4

This was the first developmental assessment after the child's return home. Each child was brought back to the hospital for testing, accompanied by a parent or guardian, approximately one month after s/he left hospital.

Test 5

Six months after returning home from hospital, the children were brought back to hospital for the fifth test, again accompanied by a parent or guardian.

Further tests were scheduled for 12,18 , 24,36 and 48 months after discharge from hospital.

5.2 RESULTS

In the first phase of the study, the development of the malnourished (Non-Intervention) children was compared with that of the well-nourished (Comparison) children during hospitalisation and in the months following discharge from hospital.

All of the 18 Non-Intervention children had all of the scheduled tests. However, as the Comparison children had a shorter mean stay in hospital (Table 4.6), some of the children did not stay long enough to have all three tests in hospital. All 21 Comparison children had the first test in hospital and test 4 after discharge. One Comparison child was lost to the study before test 5 and is excluded from this analysis. Of the remaining 20 Comparison children, only 14 children had Test 2 and of these, only 6 stayed long enough to have Test 3 as well. For 8 of the comparison children Test 2 was, in effect, their discharge test as they left hospital less than a week later. For the comparison group therefore developmental level at Discharge was taken to be the child's score at his last test in hospital, whether this was Test 2 (8 children) or Test 3 (6 children). For the Non-Intervention group, all the children had Test 3 as a measure of their developmental level at Discharge.

For analyses comparing the development of the children up to 6 months after discharge from hospital therefore, the Non-Intervention group comprised all 18 malnourished children and the Comparsion group comprised 14 well-nourished children.

The two groups were compared at 4 points, 2 tests while the children were in hospital and 2 tests after discharge from hospital:

1) on admission to hospital
2) before discharge from hospital
3) one month after discharge from hospital
4) six months after discharge from hospital.

The analysis of this longitudinal development data was carried out using repeated measures analysis of variance. Computer analysis employed the GENSTAT computer package, developed at Rothamsted Experimental Station (Alvey et al, 1977). This allowed the comparison of groups of unequal numbers by the method of least squares. Summary tables from these analyses are reproduced in Appendix III.

Cross-sectional comparisons of the developmental data were carried out by the SPSS BREADKOWN and ANOVA programs (Nie et al, 1975).

Table 5.1 General DQs of Non-Intervention and Comparison children.

Means and Standard deviations.

Time of test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	61	(19.7)	86	(15.4)	15.318	0.0005
Discharge	77	(12.0)	98	(14.9)	19.047	0.0001
1 month after discharge	83	(11.7)	107	(11.4)	33.4530	0.0000
6 months after discharge	82	(12.1)	105	(11.2)	30.1685	0.0000

5.2.1 General Developmental Quotient of the Griffiths Test

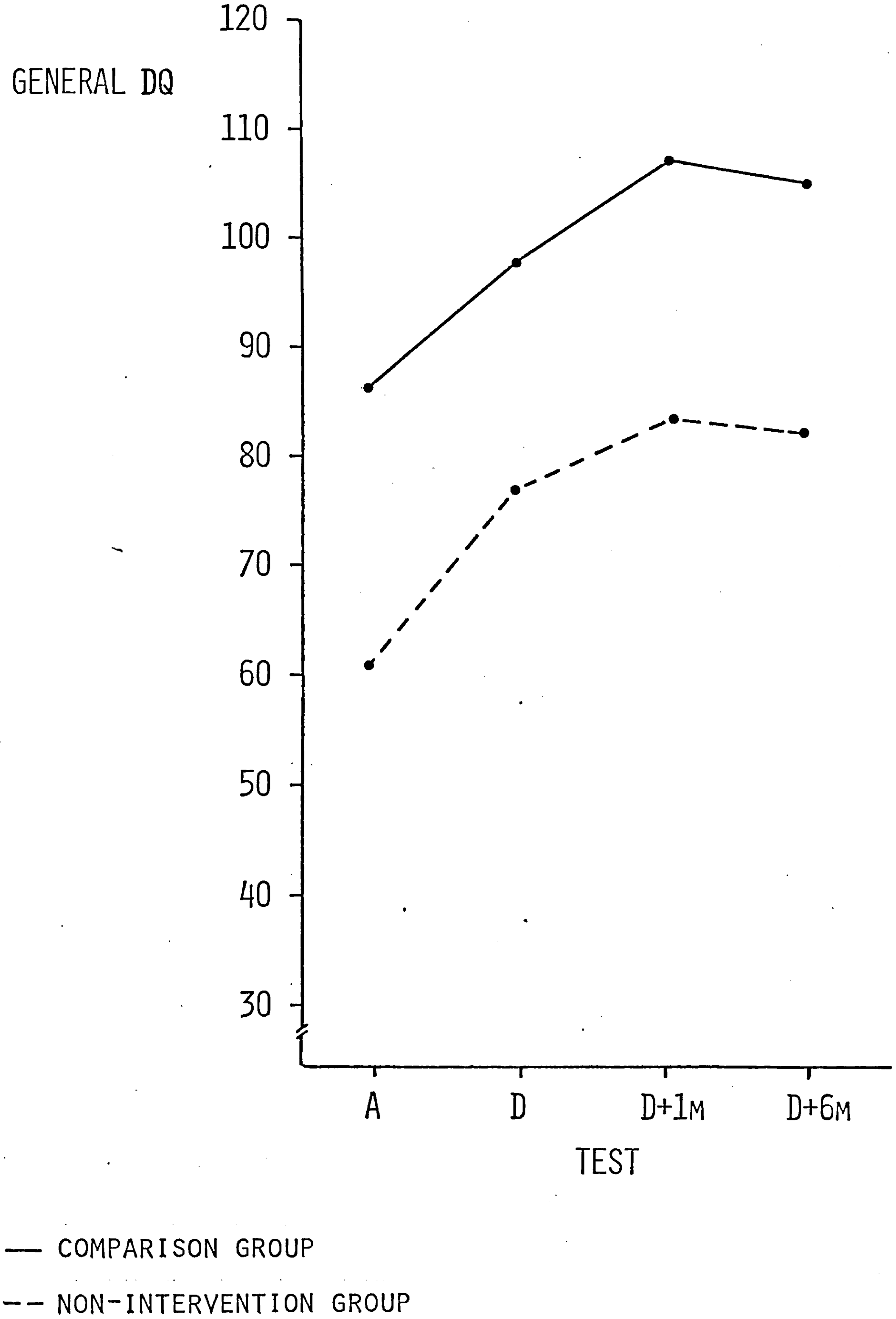
Table 5.1 shows the mean scores and the standard deviations of the DQs for the Malnourished (Non-Intervention) and Comparison groups. The Non-Intervention children, who received the standard treatment of physical and nutritional rehabilitation, showed an increase in DQ from admission to discharge of 16 points. The increase in mean score from admission to the 6 month post-discharge test was 21 points.

A comparison of the scores of the two groups at the 4 stages of hospitalisation and recovery reveals that although there is a highly significant difference between the groups ($F=26.825$, $p=0.000$), the pattern of change over the 4 tests is very similar in the two groups as shown in Figure 5.1 (test: $F=49.434$, $p=0.000$; test x group: $F=0.418$, NS).

Sex did not make a significant difference in either group (sex: $F=0.021$; sex x group: $F=0.075$; sex x test: $F=0.356$; sex x test x group: $F=0.887$; all NS).

The general DQ scores were made up of scores on 4 subscales of the Griffiths Test. These were Locomotor, Hearing and Speech, Eye and Hand Coordination and Performance.

Figure 5.1 Mean General DQs of Non-Intervention and Comparison children on admission, at discharge, 1 month and 6 months after discharge.



5.2.2 Locomotor Scale

The means and standard deviations of the quotients obtained by the two groups on the Locomotor Scale are shown in Table 5.2.

In this scale, at each test, the Non-Intervention children had a mean score that was 28 - 30 points lower than the mean for the Comparison children. The Comparison children obtained high quotients in Locomotor development, characteristic of Jamaican children of this age (Grantham-McGregor and Back, 1971). There was, however, considerable variation in the scores of the children. There was a difference of 85 points between the highest and the lowest scores on admission (Standard deviation for Comparison group at Test 1: 23.34) and at the 6 months test there was still a range of 79 points (SD.= 20.47).

In the Non-Intervention group, there was a range of approximately 50 points at each test (SD on admission = 14.56; SD at 6 months = 15.60.).

As with the General DQ, the scores on the Locomotor scale improved significantly from the Admission to the 6 month post-hospital test (test: F=29.764, p=0.000; test x group; F=0.109, NS).

Males and females followed a similar pattern in both groups (sex: F=0.002; sex x group: F=0.007; sex x test: F=0.286, sex x group x test: F=1.586; all NS .).

Table 5.2 Locomotor DQs of Non-Intervention and Comparison groups.

Means and Standard deviations at 4 tests.

Time of test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	72	(14.56)	102	(23.34)	19.6018	0.0001
Discharge	83	(15.36)	111	(20.22)	19.9665	0.0001
Discharge + 1 month	91	(15.21)	119	(13.75)	28.6564	0.0000
Discharge + 6 months	90	(13.46)	120	(20.47)	21.7751	0.0001

There was therefore no sign up to six months after the children left hospital of the malnourished children catching up with the well-nourished children in gross motor development. At the 6 month test, the malnourished children's mean score was 1½ standard deviations below that of the well nourished children. This was the case in spite of considerable catch up in their nutritional status (Table 4.4 and 4.9).

There is some evidence from electronmicroscopic data from contemporary research at T.M.R.U. by Hansen-Smith (1977) that when muscle tissue was examined prior to the discharge of children who had recovered from PEM, there was still considerable deterioration in cell structure which is characteristic of muscle tissue when children are first admitted to hospital. The wasting of muscle tissue is a characteristic of marasmic children (see Table 1.1). The evidently slow recovery of muscle could therefore contribute to the relative retardation in the gross motor development of the survivors of PEM.

Table 5.3 Hearing and Speech DQs of Non-Intervention and Comparison children.

Means and Standard deviations at 4 tests.

Time of test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	39	(23.95)	47	(17.82)	1.1377	0.2947
Discharge	58	(16.70)	68	(22.55)	1.9891	0.1687
Discharge + 1 month	70	(13.62)	94	(10.88)	29.6228	0.0000
Discharge + 6 months	74	(13.46)	93	(8.15)	21.9910	0.0001

5.2.3 Hearing and Speech

Table 5.3 shows the means and the standard deviations on the Hearing and Speech subscale of the Griffiths Test for the Non-Intervention and Comparison groups.

In the repeated measures analysis of variance the difference between the groups in the Hearing and Speech scale was significant at the 1% level ($F=13.044$, $p<0.01$). The scores on this scale were extremely low when the children were first tested in hospital. In the Non-Intervention group, 4 children scored 12 points or less at the first test. Many children were completely silent for the duration of the test session.

There were large increases in the scores across the tests (test: $F=57.960$, $p=0.000$). The Comparison children showed a mean increase of 45 points between admission and 6 months post-hospital and the Non-Intervention children showed a smaller increase, gaining 35 points. As a result, the mean difference between the groups increased from 8 points at the first test in hospital to 19 points at the 6 months post-hospital test, although this was not statistically significant (test x group: $F=2.43$, NS).

The sexes were not significantly different (sex: $F=0.328$; sex x group: $F=0.885$; sex x test: $F=0.846$; sex x test x group: $F=1.317$; all NS).

Table 5.4 Eye and Hand Co-ordination DQs of Non-Intervention and Comparison children.

Means and Standard deviations at 4 tests.

Time of test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	65	(25.48)	94	(17.11)	13.6647	0.0009
Discharge	80	(14.39)	103	(14.14)	19.9620	0.0001
Discharge + 1 month	84	(11.56)	106	(16.19)	21.3517	0.0001
Discharge + 6 months	85	(14.60)	105	(12.97)	15.4686	0.0005

5.2.4 Eye and Hand Coordination

The means and standard deviations obtained by the Non-Intervention and the Comparison children are shown in Table 5.4.

As in the repeated measures analysis of variance on the other subscales, the group difference was highly significant for Eye and Hand Coordination (group: F=24.537, p=0.000). There was also a significant test effect (F=13.040, p=0.000). Although the gain in scores was greater in the Non-Intervention group than in the Comparison group (a mean gain of 20 points compared with 11 points by the Comparison children), which reduced the difference between the groups, this was not statistically significant (group x test: F=0.924, NS).

The sexes were not significantly different on this scale (sex: F=0,146; sex x group: F=0.131; sex x test: F=0.108; sex x test x group: F=0.279; all NS).

Table 5.5 Performance DQs of Non-Intervention and Comparison children.

Means and standard deviations at 4 tests.

Time of test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	67	(26.54)	100	(19.25)	15.1911	0.0005
Discharge	88	(12.05)	110	(12.60)	26.4766	0.0000
Discharge + 1 month	86	(16.62)	107	(9.72)	16.9726	0.0003
Discharge + 6 months	78	(14.17)	102	(11.04)	26.0529	0.0000

5.2.5 Performance

Table 5.5 shows the means and standard deviations for the Non-Intervention and the Comparison groups on the Performance subscale of the Griffiths test.

In the repeated measures analysis of variance the Performance scale also produced significant differences between the groups (group: F=26.824, p=0.000) and a significant test effect (test: F=12.774, p=0.00). However the pattern of change, which was similar in the two groups (group x test: F=1.752.NS), was different in the Performance scale from the other subscales. The only increase in mean scores occured while the children were in hospital. The Non-Intervention children gained an average of 21 points between admission and discharge and the Comparison children gained 10 points. However in both groups, there was a decrease in scores after the children returned home. The Comparison children's quotients returned to the levels attained on admission to hospital, while the Non-Intervention children lost half of their initial gain.

As in the other subscales, sex did not contribute significantly to the analysis (sex: F=0.127; sex x group: F=0.108; sex x test: F=0.927; sex x test x group: F=0.334, all NS).

5.2.6 Behaviour during test sessions

Repeated measures analysis of variance was carried out on the children's ratings for their cooperativeness with the tester, their degree of interest in the test material and the amount of vocalisation.

Cooperativeness with tester

Mean scores are shown in Table 5.6.

The groups were not significantly different in their general level of cooperativeness with the tester during the Griffiths assessment (repeated measures analysis of variance: F=0.638, NS). There was, however, a highly significant test session effect (F=31.244, p=0.000). In addition, the groups differed in the pattern of change over the 4 test sessions (test x group: F=2.693, p=0.05) as the initial scores of the Non-Intervention children were lower than those of the Comparison children.

The most marked change in the cooperativeness of the children in both groups occured during their period in hospital. The mean cooperativeness score for the Non-Intervention group increased by more than 100%, from 2.3 to 4.7, while the Comparison group had a smaller increase in mean score, from 3.1 at the admission test to 4.4 at discharge, so that at this point the groups were not significantly different (F=0.2604; p=0.6136).

Table 5.6 Cooperativeness with Tester.

Non-Intervention and Comparison groups.

Test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	2.28	(1.13)	3.14	(1.09)	4.7367	0.0375
Discharge	4.67	(1.19)	4.43	(1.45)	0.2604	0.6136
Discharge + 1 month	4.33	(1.33)	4.93	(1.14)	1.7837	0.1917
Discharge + 6 months	4.56	(1.20)	4.36	(1.01)	0.2470	0.6228

After discharge, when the children were tested for the first time with mother present, 1 month after they had returned home, whereas the Comparison children became slightly more cooperative, the Non-Intervention children became slightly less so. By the second post-discharge test, both groups had returned to levels slightly below those attained at discharge. In both groups, however, the changes in mean scores after the initial change in hospital were all less than 0.6 points.

Interest in test material

Mean scores are shown in Table 5.7.

The Comparison children were rated as more interested in the test material than the Non-Intervention children at the first test session (F=11.9452, p=0.002), and in the repeated measures analysis of variance, the effect of group was significant at the 5% level (F= 4.307).

There was a highly significant test session effect (F=36.156, p=0.000) as well as a significant interaction between test and group (F=3.410, p=0.025). There was a marked increase in the children's interest in the test materials between the first and last tests in hospital, as there had been in the level of cooperativeness with the tester. Both groups were less interested in the materials at the post-discharge tests than they had been at the end of their stay in hospital, but these differences were less than 0.5 points in each group.

In a similar pattern to that for Cooperativeness with the Tester, although the Malnourished (Non-Intervention) children start off with lower scores, they had caught up with the Well-nourished children by discharge and both groups change little over the last three tests.

Table 5.7 Interest in Test Material.

Non-Intervention and Comparison groups.

Test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	2.50	(1.20)	4.00	(1.24)	11.9452	0.0017
Discharge	5.50	(0.99)	5.64	(1.34)	0.1214	0.7300
Discharge + 1 month	5.44	(0.98)	5.36	(0.84)	0.0702	0.7929
Discharge + 6 months	5.11	(1.23)	5.50	(1.02)	0.9097	0.3478

Vocalisations

Table 5.8 shows that the Non-Intervention and Comparison children were very similar in the amount of vocalisation during the tests.

In the repeated measures analysis of variance, the only statistically significant effect was the test session effect (F=6.737, p.0.001).

Table 5.8 Vocalisations.

Non-Intervention and Comparison groups.

Time of test	Non-Intervention		Comparison		F	P
	Mean	(SD)	Mean	(SD)		
Admission	1.8	(0.86)	2.0	(0.88)	0.2917	0.5931
Discharge	2.8	(0.88)	2.8	(1.05)	0.0005	0.9816
Discharge + 1 month	2.7	(1.02)	2.5	(0.94)	0.4008	0.5315
Discharge + 6 months	2.7	(1.07)	2.7	(0.83)	0.0005	0.9819

5.3 Discussion

The increase in the developmental quotients of children during recovery from severe PEM has been previously reported. Cravioto and Robles (1965) and Yaktin and McLaren (1970) reported such increases in the developmental levels of children in Mexico and Lebanon. Their findings contributed to the belief, apparently quite widespread among physicians, that nutritional rehabilitation produced a spontaneous improvement in mental development which was related to the improvement in nutritional status.

The present study is unique in the inclusion of a contemporary, hospitalised Comparison group of well-nourished children.

The Comparison well-nourished children show an improvement in developmental status that closely mirrors the improvement in the malnourished children (Figure 5.1). The well-nourished children show a similar improvement in DQ to the malnourished children without, of course, a change in nutritional status comparable to that of the children recovering from PEM. This leads to the conclusion that the changes in DQ are due to factors other than nutrition.

The children's behaviour during the tests sessions was rated for cooperativeness with the tester, interest in the test material and amount of vocalisation. It was thought that differences in these aspects of the children's response to the test situation could have an influence on the level of the children's DQ scores. In repeated measures analysis of variance on the cooperativeness measure and the rating of interest in the test materials, there were highly significant test session effects ($p=0.0000$ for both measures). Furthermore, in both measures, there were significant interactions between group and test session (group x test session: cooperativeness : $p<0.05$; interest: $p<0.025$). On both measures of behaviour, the malnourished children obtained particularly low scores at the first test session, though they were not significantly different from the Comparison children at subsequent tests.

The measure of vocalisation produced a different pattern from the other two behaviour measures. There was a significant test session effect ($p<0.001$), but the two groups were very similar throughout. Vocalisation was measured on a 4 point scale, in contrast to the 7 levels of the other scales. It is possible that a more sensitive scale may have discriminated between the groups.

These changes in behaviour during the tests may have contributed to the improvements observed in test performance in both groups. To test if this was the case, further analyses were carried out on the longitudinal DQ data. The children's ratings on the Cooperativeness with Tester, Interest in Test Material and Vocalisation scales were introduced as covariates at each test point. The results of this analysis on the general DQs are shown in Table 5.9 . The effect of the covariates was significant at

Table 5.9 General DQ at 4 Tests

Non-Intervention and Comparison Groups

Analysis of Covariance: values of F

SOURCE	Raw Scores		Adjusted Scores	
	F	P	F	P
Group	26.825	0.001	29.262	0.001
Sex	0.021	NS	0.001	NS
Group x sex	0.075	NS	0.011	NS
Test session	49.434	0.000	12.947	0.001
Test x group	0.418	NS	0.397	NS
Test x sex	0.356	NS	0.893	NS
Test x group x sex	0.887	NS	1.535	NS

Covariates at each Test:
Cooperativeness with tester
Interest in test material
Vocalisation.

better than the 1% level of confidence ($F=11.460$, $df=3,25$; $p<0.001$). However, although there was a marked reduction in the value of F for the test session effect in the analysis of variance on general DQs adjusted for covariates, a highly significant test session effect remained (adjusted DQs: test session: $F=12.947$, $df=3,81$, $p<0.001$). Figure 5.2 shows the adjusted means for the general DQ.

For the subscales of the test, the covariates had a significant effect on the scores on the Eye and Hand Co-ordination scale (Table 5.10), but not on the other sub-scales.

The 3 measures of the children's behaviour during the test sessions, taken together, contribute to our understanding of the changes observed in performance on the developmental assessment scales, but do not completely explain them. These were very gross measures of behaviour and it may be that they were not sensitive or comprehensive enough to measure the changes in the children's behaviour that were relevant to their test performance.

A certain amount of the improvement in scores is probably due to the children's increasing familiarity with the testing procedure. Furthermore, the first test, though delayed until a child was judged to be 'fit to be tested', was nevertheless administered to children who were still very unwell. The improvement in scores in hospital, with the marked similarity across the groups, is likely therefore to be a reflection of the children's recovery from illness. After discharge,the mothers'

Figure 5.2 General DQ adjusted for covariates (behaviour during test sessions).
Non-Intervention and Comparison groups.

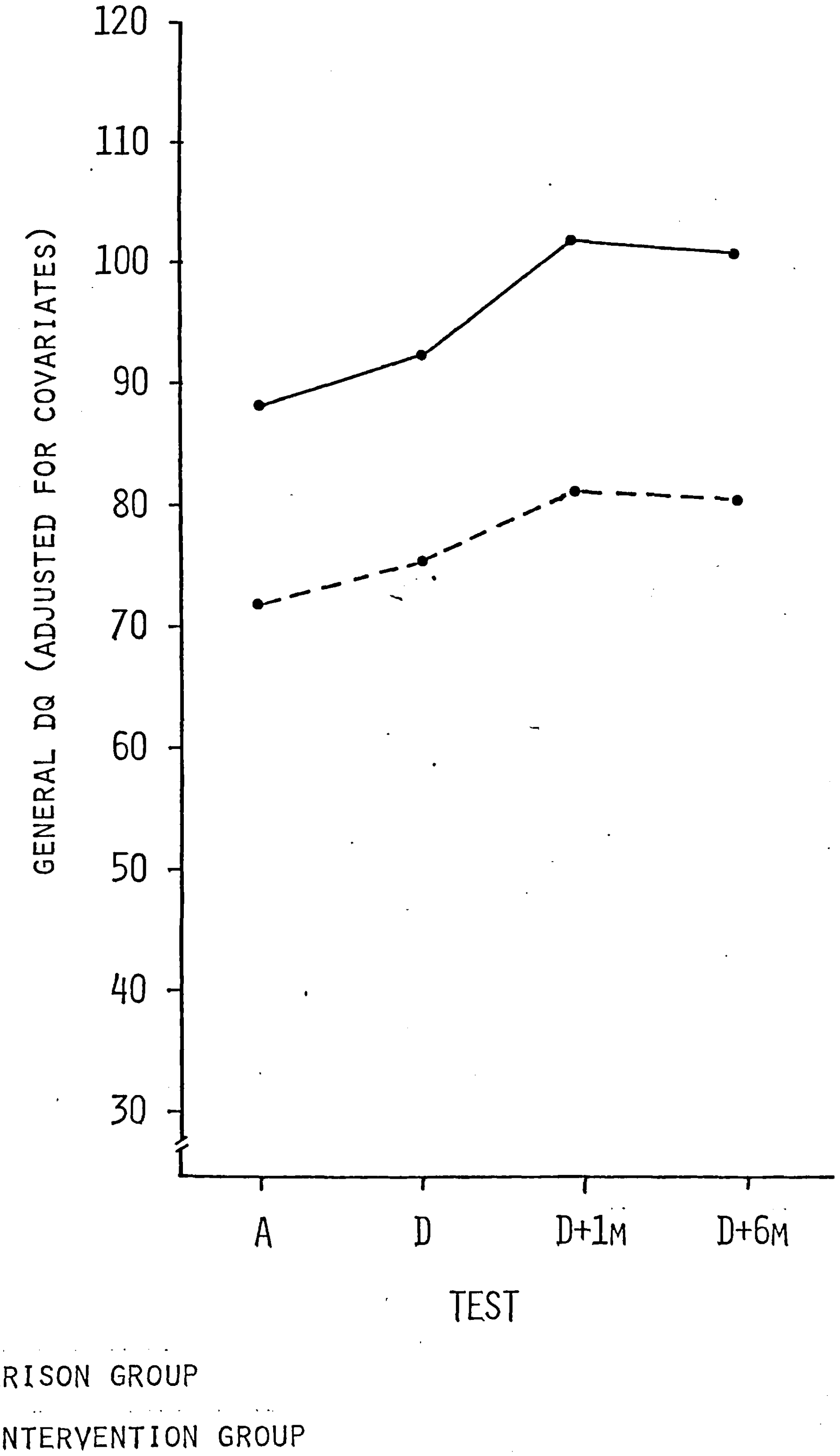


Table 5.10 Eye and hand Co-ordination DQ at 4 tests.

Non-Intervention and Comparison groups

Analysis of Covariance: Values of F.

SOURCE	Raw Scores		Adjusted Scores	
	F	P	F	P
Group	24.537	0.001	27.507	0.001
Sex	0.146	NS	0.065	NS
Group x sex	0.131	NS	0.032	NS
Test session	13.040	0.001	1.193	NS
Test x group	0.924	NS	0.210	NS
Test x sex	0.108	NS	0.161	NS
Test x group x sex	0.279	NS	1.087	NS

Covariates = behaviour during test.

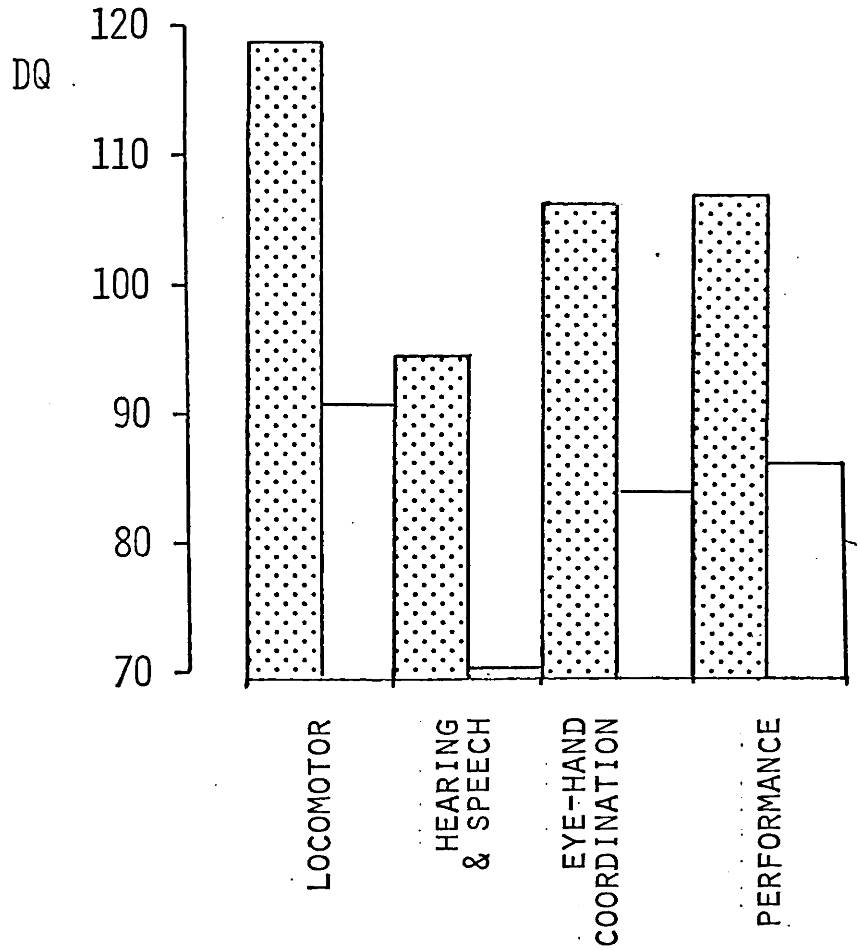
presence and the information that they would have been able to contribute during the test may have contributed to the children's improvement between the discharge test and the 1 month post-discharge test, which was particularly marked in Hearing and Speech, a scale which incorporates information from mothers.

The scores on the subscales of the Griffiths test, when taken together for a particular session, give a 'developmental profile' of the individual child. Griffiths placed great emphasis on the diagnostic value of such a comparison (Griffiths, 1954, pp 81-114). The test was standardised to make the subscales equal in difficulty and a child developing at an even rate would be expected to attain equivalent scores across the scales.

There has been some speculation about whether severe malnutrition produces a generalised or a specific retardation of development (chapter 2.4.2). Comparison of the developmental profiles of the Non-Intervention and the Comparison groups at the two post-hospital tests (Figs. 5.3 and 5.4) shows that the malnourished children have a similar profile of development to the well-nourished children, suggesting a generalised retardation. Both groups show highest scores in the Locomotor scale and lowest scores in Hearing and Speech, with Eye and Hand Coordination more advanced than Performance.

Once again the issue of the cultural specificity of tests is raised. It would seem to be the case here, as in the other studies previously cited (e.g. Grantham-McGregor and Hawke, 1971; Geber and Dean, 1957), that

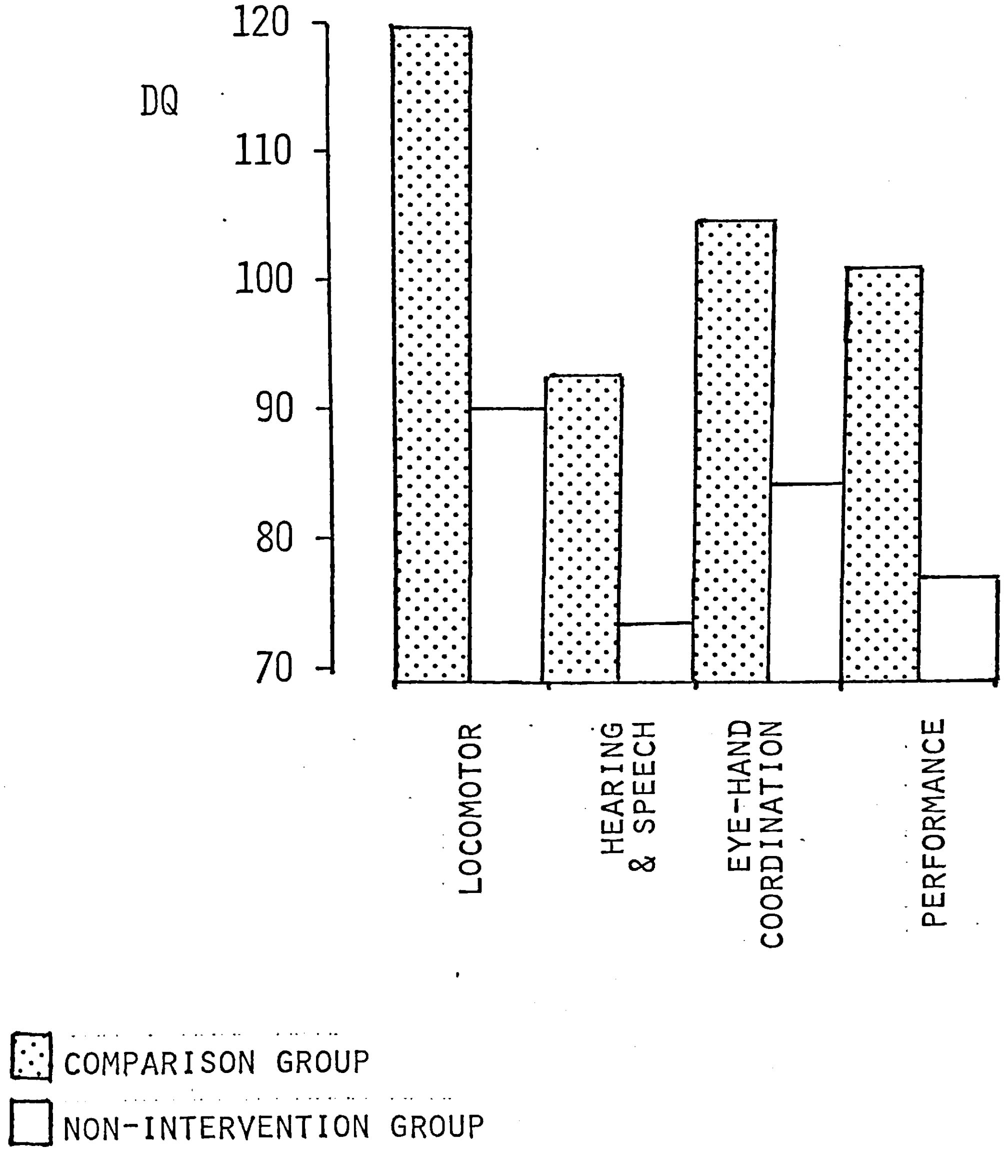
Figure 5.3 Developmental profiles of Non-Intervention and Comparison children 1 month after discharge.



COMPARISON GROUP

NON-INTERVENTION GROUP

Figure 5.4 Developmental profiles of Non-Intervention and Comparison children 6 months after discharge.



there are cultural differences in the rate of development of children in the different areas measured by such tests.

Although the malnourished children do show a deficit in language development in their profiles, such a deficit appears to be characteristic of well-nourished children from comparable social backgrounds. Language development has been noted to be particularly 'at risk' in deprived children (Chapter 2.6). The characteristic relative precocity in gross motor development is also evident in the developmental profiles of the malnourished children.

The malnourished children therefore show a similar profile to the well-nourished children, but at a level approximately 20 points below them. Both groups show improvement in scores in hospital. Up to 6 months after discharge from hospital, in general DQ and in the 4 constituent subscales, the malnourished children appear to be developing at a parallel rate to the well-nourished children and therefore there is little sign of the malnourished children catching up.

This parallel rate of development of rehabilitated malnourished children and well-nourished children is an important finding. The changes in DQ in hospital, which were previously thought to reflect a 'catch-up' in developmental status due to nutritional rehabilitation in malnourished children, must now be viewed in a different light. The observations of the children's behaviour during the test, which did not take into account how well the children performed on the test items, but measured their response to the test situation, suggest that improvement in hospital is due partly, but not wholly, to the children's increasing responsiveness to the demands of the test situation.

The similarities in the development of the two groups of children in the six months after discharge suggests that the ability of the formerly malnourished children to acquire new skills has not necessarily been adversely affected by the experience of malnutrition. Further, this leads to the hypothesis that a programme of activities geared to providing a sequence of experiences which would facilitate the acquisition of new skills and the elaboration of concepts could help the survivors of severe malnutrition to 'catch up' in development with their well-nourished peers.

CHAPTER 6. THE BEHAVIOUR OF THE MALNOURISHED (NON-INTERVENTION) AND COMPARISON CHILDREN IN HOSPITAL

The suggestion has come from research with malnourished animals and with humans that malnutrition may affect the development of individuals by reducing the amount of contact it makes with its environment. This has been formulated as a hypothesis about the 'functional isolation' of the individual as a result of malnourishment (Levitsky and Barnes, 1972). Severely malnourished children have been described as "apathetic" and "unresponsive", but few systematic observations have been reported. Studies of moderately malnourished children in their homes have also provided evidence of altered patterns of responsiveness related to nutritional status, whether from reports of lower levels of exploratory behaviour in malnourished children (e.g. Graves, 1979) or increased social interaction by nutritionally supplemented children (Chavez and Martinez, 1979).

Such community studies are not possible with severely malnourished children. Once severe malnutrition has been diagnosed, a rehabilitation programme should be introduced without delay, and this usually requires hospitalisation. As a result, systematic observation of severely malnourished children while they are on their usual diet at home cannot be carried out. The behaviour of the severely malnourished child on admission to hospital is the best available indicator of his behaviour in the period preceding the diagnosis of malnutrition.

The behaviour of the severely malnourished children in hospital may however be somewhat different from their usual behaviour at home. The composition of the diet in hospital may be different from the child's usual diet and the energy intake in hospital is likely to be greater than in the period at home, even before high calorie feeding is introduced. These differences in diet may affect behaviour. However, the effects of such improvement in diet would be to minimise the differences between the malnourished children and their well-nourished peers. The behaviour in hospital can also be expected to be affected by the experience of hospitalisation. In this study, all the children were observed in hospital. The stages that a young child goes through in response to hospitalisation have been documented by Robertson (1970), Bowlby (1975) and others. It would be expected that the experience of separation from mother and family that is the result of hospital admission would produce alterations in the behaviour of both the malnourished and the well-nourished children.

However, in the absence of other opportunities to observe the behaviour of severely malnourished children, these observations were carried out while the children were in hospital and their behaviour was compared with a well-nourished comparison group who share the experience of admission to hospital.

6.1 METHODS

A record was made of each child's behaviour in 2 situations:

a. An 'unstructured' situation - in the child's cot on the ward.

b. A 'structured' situation - when a standard set of toys was put into the cot.

6.1.1 'Unstructured' behaviour observations on the Ward

In the 'unstructured' situation on the ward, the spontaneous behaviour of the children was observed while they were unattended in their cots during the day. Observations were carried out within thirty hours of the first developmental assessment, usually on the same day, and were repeated at weekly intervals during the child's stay in hospital. Observation sessions were omitted when children did not pass the criteria for fitness to be tested - eg. if the child was febrile or had a nasogastric tube (Chapter 5.1.3) or when they were restrained in any way. Observations were done when the child appeared to be neither sleepy nor hungry and they were not observed immediately after injections or other medical procedures. The observer sat at least 8 feet from the child and there was no interaction between observer and child.

The following time-sampling schedule was used for the unstructured observations. The child was observed for the first 5 secs. of each 30 second period for 5 minutes, with 25 secs. for recording. This was repeated after a 2 minute interval, making a total of 20 observation periods spread over 12 minutes. There were 3 of these 12 minute cycles of observation periods, commencing at the beginning of successive half-hour periods. A complete observation session, therefore, comprised 60 five-second periods spread over a minimum of 72 minutes. This schedule was followed as far as the children's and the wards' routines allowed, but it was frequently necessary to have longer intervals between the 12 minute cycles. If the observations were interrupted during the 12 minute periods, those observations were repeated.

The following categories of behaviour were recorded for each 5-second unstructured observation period:

Activity	A composite score for Activity level, with a possible range of 0 to 240, was derived from a record of movements of the head, limbs, trunk or change between 8 defined positions.
Exploration	The amount of exploratory behaviour or play was scored according to whether the child used one or two hands to investigate anything in his/her cot and whether s/he was looking at what s/he was doing. The composite score had a possible range of 0 to 120.

Affective state The affective state of the child was assessed as either 'Unhappy' - actively showing displeasure (e.g. by crying or whimpering), 'Apathetic' - passive, expressionless, 'Alert' - interested and actively looking at his/her surroundings, or 'Happy' - positively expressing pleasure or excitement (e.g. by smiling and laughing).

Vocalisations A record was made of whether the child vocalised (other than crying) during the observation period.

Autoerotic and Stereotyped behaviour

A record was made of whether the child engaged in either 'Autoerotic' behaviour such as thumb-sucking, or 'Stereotyped' behaviour such as repetitive rocking or head-banging.

Details of the behaviour categories and the scoring are given in Appendix I.

6.1.2 'Structured' behaviour observations on the wards

The structured observations were designed to compare the responses of the malnourished and the well-nourished children to play material. These observations were carried out on the same day as the unstructured observations, with similar criteria for assessing fitness to be tested.

Each child was presented with a standard set of toys (See Table 6.1).

Table 6.1 Toys for structured behaviour observations

6 small painted wooden blocks
1 small box (cut from milk carton)
2 metal model cars
1 doll
Triangular piece of cloth
1 small plastic rattle
1 toy that makes noise when squeezed

The child's play with the toys was recorded on a time-sampling schedule over a period of 20 minutes, beginning 1 minute after the presentation of the set of toys. The child was observed for the first 3 secs. in each ½ minute for 5 minutes. The 5-minute cycle was repeated twice, separated by 2-minute intervals. For the structured observations, therefore, a complete session comprised thirty 5-second observation periods over a period of 20 minutes, after which the toys were removed from the cot. When toys were thrown or fell out of the cot during the session, they were returned by the observer without interacting with the child and this was done during the interval or if at least 4 toys were out.

The Affective state of the child as well as the amount of Exploratory behaviour, Vocalisations, Autoerotic and Stereotyped activity were recorded in the same way as for the unstructured observations. In addition, a record was made of the toys with which a child played and the actions performed on each toy were coded as one of the 13 categories in Table 6.2. The categories were adapted from Tilton & Ottinger (1964) and Ortiz (1972) who had observed the play of older mentally retarded and normal children.

Table 6.2 Categories for play with toys

Hold
Touch
Manipulate
Drop, throw
Pound
Oral contact
Shake
Push, pull
Objects in or out of box
Pick up, put down, hand to hand
Regard to properties, no combination
Regard to properties, combination
(Other)

The number of observation periods before a child was observed playing with the toys was noted, as was the number after the last recorded play in each session. There was also a 'total play with toys' score which was the total number of separate actions on toys that were recorded for the complete session.

Further details are given in Appendix I.

6.2 RESULTS

Data are presented for 18 malnourished Non-Intervention children and 14 well-nourished Comparison children. Records were incomplete for the first Structured observations session for one of the Non-Intervention children so he is excluded from the analyses of those data. The Comparison group comprises those children from the original group of 21 who had at least 2 observations sessions: 14 children.

The groups are compared at 3 points during their hospitalisation: at the first observation session, at the second session one week later, and at the children's last session before discharge from hospital. Because their hospitalisation was of relatively short duration, for all but 4 of the Comparison children, the second session was their last in hospital. When behaviour at discharge is reported, for these Comparison children this will refer to the second session. The remaining 4 Comparison children were discharged after between 3 and 5 sessions. The majority of the Non-Intervention children were discharged after 3 to 9 sessions, but 1 child stayed in hospital long enough to have 12 sessions.

6.2.1 Unstructured behaviour observations

In these observations, the scores for Activity at the 3 sessions for the Non-Intervention and Comparison groups are compared.

Table 6.3 Median scores for 'Activity' at first, second and last sessions

Non-Intervention and Comparison groups

	Median Score		U	P (2-tailed)
	Malnourished	Comparison		
First session	43.5	76.5	218.5	0.0002
Second session	74.5	83.5	169.0	0.1071
Last session	73.5	88.5	168.0	0.1159

Maximum possible score: 300

At the first session, the Comparison children were significantly more active than the malnourished Non-Intervention children (Mann-Whitney U=218.5, p=0.0002). The malnourished children's activity levels showed a rapid increase between the first and the second sessions, with little change thereafter. At the second session, there was a difference of 9 points between the median scores of the 2 groups (U= 169.0 p=0.1071). When the final sessions of the children are compared, the similarity between the groups persists (U= 168.0, p=0.1159).

The median scores for Exploration are shown in Table 6.4.

Table 6.4 Median scores for 'Exploration' at first, second and last sessions.

Non-Intervention and Comparison groups

	Median Score		U	P (2-tailed)
	Malnourished	Comparison		
First session	11.0	5.0	100.0	0.3378
Second session	16.5	14.5	145.5	0.4643
Last session	15.5	20.5	156.0	0.2666

Maximum possible score: 180

The scores for Exploration are not significantly different across the groups in any of the three comparisons.

Tables 6.5, 6.6 and 6.7 show the Affective state of the children at each observation session. Initially, the Comparison children were rated as significantly more 'Unhappy' than the malnourished children (U=218.5, p=0.0002) while the malnourished children were significantly more 'Apathetic' (U=69.0. p=0.030.4). By the second session, these differences had largely disappeared, with both Unhappiness in the Comparison group and Apathy in the Malnourished group considerably reduced. When final

Table 6.5 Median scores for Non-Intervention and Comparison groups.

Affective State at first 'Unstructured' observation session.

Affective state	Group		U	P (2-tailed)
	Malnourished	Comparison		
Unhappy	0.2	17.5	218.5	0.0002
Apathetic	18.5	4.0	69.0	0.0304
Alert	39.5	27.5	103.0	0.3980
Happy	0.1	0.0	-	-

Table 6.6 Median scores for Non-Intervention and Comparison groups.

Affective state at second 'Unstructured' observation session.

Affective State	Group		U	P (2-tailed)
	Malnourished	Comparison		
Unhappy	0.6	0.4	139.0	0.6395
Apathetic	1.5	0.4	90.5	0.1801
Alert	47.5	49.5	146.5	0.4415
Happy	0.2	0.4	148.5	0.3980

Table 6.7 Median scores for Non-Intervention and Comparison groups.

Affective state at last 'Unstructured' observation session.

Affective State	Group		U	P (2-tailed)
	Malnourished	Comparison		
Unhappy	0.2	0.4	146.0	0.4643
Apathetic	1.0	0.4	111.0	0.5867
Alert	52.5	49.5	114.5	0.6666
Happy	2.5	0.5	108.5	0.5115

sessions are compared, the malnourished children and the well-nourished children showed similar patterns for Affective state.

Positive vocalisations were rare. In the first week, only 6 malnourished children (33% of the group) and 6 Comparison children (43% of that group) made sounds other than those associated with crying during the first session of unstructured observations. For children who did vocalise, the mean score for the malnourished children was 3.5, and for the Comparison children it was 8.3. At the last session, 13 of the 18 Non-Intervention children scored, on average, 10 points for vocalisation and 13 of the 14 Comparison children had an average score of 9 points.

Only 2 Non-Intervention children and no Comparison children showed stereotyped behaviour during the first session of observations. One child was observed in this behaviour on one occasion. The other child, who was observed in stereotyped behaviour in 16 observation periods in the first session, maintained this level in all but the last of her 8 sessions in hospital.

There was a tendency for more autoerotic behaviour in the malnourished children at the first session ($U= 87.5$, $p=0.1453$), but there were no significant differences between the groups on this measure (second session: $p=0.8077$, last session: $p=0.7220$).

Table 6.8 Quality of play at first structured observations session.

Malnourished (Non-Intervention) and Comparison groups.

	Median Scores			
	Malnourished (17)	Comparison (14)	U	P (1-tailed)
Exploration	22.0	36.0	173.0	0.0161
Total number of play actions	14.25	30.75	191.0	0.0017
Periods before play recorded	0.667	0.125	106.5	0.0261
Periods after play recorded	1.667	0.182	130.0	0.1158
Number of different actions	4.125	7.33	204.0	0.0002
Number of toys used	3.25	6.66	223.0	0.0000

6.2.2. Structured behaviour observations

Table 6.8 compares the two groups on the measures of quality of play. On 4 out of 6 of these measures there were significant differences between the groups. The Comparison children had higher scores than the Malnourished children on the composite 'Exploration' rating (U=173.0, p=0.0161) and recorded a higher mean number of separate actions on toys (U=191.0, p=0.0017). The Malnourished children had a significantly longer latency period before play with the toys was recorded (U=106.5, p=0.0261). The number of periods after the last recorded play was not significantly different across the groups (U=130.0, p=0.1158), although the median score was higher for the Malnourished children than for the Comparison children. The Comparison children used significantly more different actions in their play (U=204.0, p=0.0002) as well as playing with more of the toys (U=223.0, p=0.000). Stereotyped behaviour and voçalisation occured very rarely while the children had the toys, and the children were generally assessed as alert (Table 6.9.).

Table 6.9 Affective state at first Structured Observations Session.

Malnourished (Non-Intervention) and Comparison groups.

Affective State	Median score		U	P (2-tailed)
	Malnourished	Comparison		
Unhappy	0.21	0.38	194.0	0.4785
Apathetic	0.44	0.68	123.0	0.1582
Alert	26.0	29.5	208.5	0.2439
Happy	0	0	-	-

The median scores of the groups at the second observation session are shown in Table 6.10. At this session, the groups were not significantly different in any of the categories of Affective state. The children in both groups engaged in more play activity in the second session than in the first, but the significant differences between them remained ('Exploration' rating: U=199.5, p=0.0004, Total

Table 6.10 Quality of play and affective state at second structured observations session.

Malnourished (Non-Intervention) and Comparison group.

	Median Scores		U	P
	Malnourished (17)	Comparison (14)		
Quality of play				
Exploration	35.50	42.50	199.5	0.0004
Total number of play actions	25.00	33.50	190.5	0.0017
Periods before play recorded	0.350	0.038	76.0	0.0459
Periods after play recorded	0.154	0	91.0	0.1397
Number of different actions	6.17	7.33	182.5	0.0051
Number of toys used	4.00	6.25	211.0	0.0000
Affective state				
Unhappy	0.31	0.35	99.5	0.4444*
Apathetic	0.07	0.54	114.5	0.8603*
Alert	29.56	29.63	128.5	0.7101*
Happy	0.11	0.20	131.5	0.6246*

* 2 - tailed.

number of play actions: U=190.5, p=0.0017). The groups also remained significantly different in the number of different actions that they used and the number of toys with which they played (No. of different actions: U=182.5, p=0.0051; No. of toys: U=211.0, p=0.0000). There were no differences in the time before the children started playing and the number of periods after the last recorded play.

When the children's last sessions in hospital were compared (Table 6.11), the malnourished children were only significantly different from the comparison children on one measure - the number of toys used (U=187.5, p=.0029).

In hospital, therefore, the malnourished and the well-nourished children were significantly different in their pattern of play with toys when first admitted. By discharge, however, with the exception of the number of toys used, these differences were no longer present.

To further investigate the differences between the groups in the quality of their play at the first session, additional analyses were carried out on data from this session. For these analyses, in contrast with the earlier comparisons, data from all the children who had the first session of structured behaviour observations were included. The groups therefore comprise 17 Malnourished (Non-Intervention) children and 20 well-nourished Comparison children.

3 measures were selected as possible influences on the children's play at the first session. These were the

Table 6.11 Quality of play and affective state at last structured observations session.

Malnourished (Non-Intervention) and Comparison groups.

	Median scores			
	Malnourished (17)	Comparison (14)	U	P
Quality of play				
Exploration	44.25	44.50	128.5	0.3550
Total number of play actions	32.13	31.50	114.0	0.4301
Periods before play recorded	0.107	0.038	106.0	0.3123
Periods after play recorded	0.031	0.115	121.0	0.4766
Number of different actions	7.57	7.33	126.0	0.3991
Number of toys used	5.56	6.50	187.5	0.0029
Affective state				
Unhappy	0	0	-	-
Apathetic	0	0	-	-
Alert	29.73	29.72	119.0	1.0000*
Happy	0.27	0.28	118.0	0.9844*

*2 - tailed.

lowest weight for age recorded in hospital (i.e. nutritional status), DQ one month after discharge from hospital (thought to be the first true assessment of the developmental levels of the children) and the number of days between admission and the first session (severity of initial illness). Table 6.12 shows the intercorrelations between these variables and 3 of the measures of quality of play with the toys - number of different actions, number of different toys used and total number of play actions - for the two groups combined. For the 37 children, these variables were highly interrelated, the only non-significant relationship being that between severity of initial illness and nutritional status.

When each group's scores were anlaysed separately, the relationships between the variables differed considerably between the groups (Table 6.13). In the Malnourished group, the correlation coefficient obtained between DQ and the number of different actions was +0.49 ($p<0.025$) and -0.45 between severity of initial illness and number of different actions ($p<0.05$). In the Comparison group, these coefficients were +0.19 and -0.10 respectively (both NS). There was a similar pattern for the variable 'number of toys used': with severity of illness, there were correlation coefficients of -0.66 in the Malnourished group ($p<0.005$) and only +0.17 in the Comparison group (NS); with DQ, the coefficients were +0.41 in the Malnourished group ($p<0.05$) and +0.06 in the Comparison group (NS).

Table 6.12 Relationships* between measures of nutritional status, severity of initial illness, quality of play at first structured observations session and developmental level at first post-discharge test.

Non-Intervention and Comparison groups combined (N=37)

	DQ (1mth after discharge	Days before 1st test	Lowest weight for age	Number of different actions	Number of different toys
Days to First Test	- .34[a]				
Lowest Weight for age	+ .75[d]	- .25			
Number of different actions	+ .62[d]	- .39[c]	+ .53[d]		
Number of different toys	+ .64[d]	- .44[d]	+ .61[d]	+ .88[d]	
Total number of play actions	+ .51[d]	- .33[b]	+ .45[d]	+ .89[d]	+ .76[d]

* Pearson product-moment correlation coefficients

a. p 0.05

b. p 0.025

c. p 0.01

d. p 0.005

Table 6.13 Relationships[a] between measure of nutritional status, severity of initial illness, quality of play at first structured observations session and developmental level at first post-discharge test.

17 Malnourished Non-Intervention (M) and 20 Comparison children (C)

		DQ (1 mth after discharge)	Severity of initial illness	Lowest weight for age in hospital
Severity of initial illness	M	- .36		
	C	- .27		
Lowest weight for age in hospital	M	+ .35	- .17	
	C	+ .08	- .35	
Number of different actions	M	+ .49**	- .45*	+ .15
	C	+ .19	- .10	- .06
Number of different toys	M	+ .41	- .66***	+ .06
	C	+ .06	+ .17	- .05
Total number of play actions	M	+ .25	- .29	- .18
	C	+ .24	- .27	+ .12

a Pearson product-moment correlation coefficients

* p 0.05

** p 0.025

*** p 0.005

Table 6.14 Values of R for multiple regression analyses on measures of quality of play in structured behaviour observations.

Non-Intervention and Comparison groups combined. (N=37)

Independent variables : DQ (1 month after discharge.
Lowest weight for age in hospital.
Severity of initial illness.

Dependent Variable	R	R^2	P
Number of different actions	0.653	0.427	0.000
Number of different toys	0.708	0.501	0.000
Total number of play actions	0.544	0.296	0.000

With the two groups combined, multiple regression analyses were carried out on each of the play measures - number of different actions, number of different toys used and total number of play actions. The independent variables were DQ, severity of initial illness and nutritional status. These 3 variables together explained significant proportions of the variance in the play measures (Table 6.14). The 3 independent variables explain 43% of the variance in the number of different actions, 50% of the variance in the number of different toys used and 30% of the variance in the total number of play actions. However, the independent contributions of DQ, severity of illness and weight are very low (Table 6.15).

Table 6.15 Independent contributions of DQ, Lowest weight for age in hospital and severity of initial illness to variance in measures of quality of play: Values of partial R^2.

Non-Intervention and Comparison groups combined (N=37)

Dependent variable	Independent variable		
	DQ (1 mth post-discharge)	Severity of illness	Lowest wt/age in hospital
Number of different actions	0.080	0.035	0.009
Number of different toys	0.040	0.054	0.044
Total number of play actions	0.048	0.027	0.010

Multiple regression analyses on the play measures were also carried out on the groups separately. For the Malnourished group, the 3 independent variables only explained a significant proportion of the variance in one of the 3 analyses - number of different toys used (R=0.69, R^2 =0.480, p=0.032). The explained variance for the number of different actions was 33% (R=0.570, p=0.152) and for the total number of play actions was 20% (R=0.443, p=0.401) (Table 6.16).

Table 6.16 Values of R for multiple regression analyses on measures of quality of play in structured behaviour observations.

Non-Intervention group (N=17)

Independent variables: DQ (1 month after discharge.)
Lowest Weight for age in hospital.
Severity of illness.

Dependent Variable	R	R^2	P
Number of different actions	0.570	0.325	0.152
Number of different toys	0.693	0.480	0.032
Total number of play actions	0.443	0.196	0.401

Table 6.17 Independent contributions of DQ, lowest weight for age in hospital and severity of initial illness to variance in measures of the quality of play: values of partial R^2.

Non-Intervention group (N =17)

Dependent variable	Independent Variable		
	DQ (1 mth post-discharge	Severity of initial illness	Lowest wt/age in hospital
Number of different actions	0.117	0.087	0.002
Number of different toys	0.047	0.301	0.014
Total number of play actions	0.060	0.052	0.087

Table 6.17 shows the independent contributions of severity of initial illness, DQ and weight to the variance in the 3 play measures. For the number of toys used, in the Malnourished group, the severity of illness measure made the largest independent contribution to the explained variance (partial R^2 = 0.30). The independent contributions of DQ and nutritional status were considerably less (DQ: partial R^2 =0.05; nutritional status: partial R^2 =0.01).

However, DQ made the highest independent contribution to the variance in the number of different actions the Malnourished children performed (partial R^2 =0.12) with severity of illness contributing slightly less (partial R^2 =0.09) and nutritional status least (partial R^2=0.002).

For total number of play actions, the independent contributions were also very low, but the order of importance was different from the other two, with nutritional status as the largest independent contributor to the variance (partial R^2 =0.09), followed by DQ (partial R^2 = 0.06) and severity of illness (partial R^2 =0.05).

In the Comparison group, the associations between the variables were very low and in the multiple regression analyses, severity of illness, DQ and nutritional status did not contribute significantly to the explained variance in the play measures in this group (Tables 6.18 and 6.19).

The pattern of children's play is known to be related to their age and developmental level (Uzgiris, 1967; Rosenblatt, 1977). It was thought that the differences between the groups on the measures of quality of play may have been a reflection of the significant differences between the groups in development, but that these effects may have been masked by the use of DQ which has the effect of removing the age factor from the measure of development. To investigate this possibility, one way analyses of covariance were carried out on the play behaviour measures with the mental ages of the children as covariates. In each of these analyses, the significant differences

Table 6.18 Values of R for multiple regression analyses on 3 measures of quality of play in structured behaviour observations.

Comparison group (N=20)

Independent variables: DQ (1 month after discharge).
Lowest weight for age in hospital.
Severity of initial illness.

Dependent variable	R	R^2	p
Number of different actions	0.222	0.049	0.842
Number of different toys	0.202	0.041	0.165
Total number of play actions	0.321	0.103	0.616

Table 6.19 Independent contributions of DQ , lowest weight for age in hospital and severity of initial illness to variance in measures of the quality of play: values of partial R^2 .

Comparison group (n =20)

Dependent variable	Independent variable		
	DQ (1 mth post-discharge)	Severity of initial illness	Lowest wt/age in hospital
Number of different actions	0.030	0.006	0.009
Number of different toys	0.013	0.033	0.0001
Total number of play actions	0.032	0.034	0.0009

between the groups remained after the effects of mental age were taken into account (Table 6.20).

Table 6.20 Quality of play at first structured observation session: Values of F for raw scores and scores adjusted for mental age (one way analysis of variance).

Non-Intervention and Comparison groups.

Play variable	Values of F for group effect	
	Raw scores	Adjusted for mental age
Number of different actions	15.933**	17.118**
Number of different toys	27.694**	29.017**
Total number of play actions	10.768*	11.404*

** p = 0.001

* p = 0.002

6.3 DISCUSSION

The inequalities in the lengths of hospitalisation in the two groups were the unavoidable consequence of the nature of the samples. Because of the short stay of the Comparison children, the main comparisons that are possible are between the children on admission to hospital and before discharge. By the second observation session, most of the malnourished children would have been established on high calorie feeding and their behaviour at this stage is compared with that of the well-nourished children at the same session. For 10 of the Comparison children, therefore, the same data are used for two sets of analyses as their second session was also their discharge sesssion.

According to the stages in the response to separation and hospitalisation by children of this age proposed by Robertson (1970) and Bowlby (1975) the child goes through stages of 'protest', 'despair' and 'detachment'. After an initial period of fretting and crying, children in the second half of the first year and the second year in particular, appear to 'settle down' to life in the hospital. Robertson proposed that in the third stage of this process, the child appeared no longer to be concerned about the absent parent, and would readily interact with anyone present in the ward.

In this study, the observation sessions were not frequent enough to record these changes in behaviour. However, the first observation session shows that in some respects the two groups of children behaved very differently in reaction to the experience of hospitalisation. Acknowledging the possibility that hospitalisation would to some extent produce distortions of normal behaviour, this study set out to examine differences in the behaviour of the two groups.

In the unstructured observations, the Comparison children showed behaviour typical of the 'protest' stage in the first session. The malnourished children, on the other hand, were more apathetic and uninterested in their environment than the Comparison children, with low levels of activity. The difficulties involved in the interpretation of observations of behaviour in hospital are demonstrated by the Comparison children who, although much more active than the malnourished children, directed this activity towards the expression of acute distress and did not play very much with any material that may have been in their cots. This produced the unexpected result that the malnourished children had higher scores than the well-nourished children for Exploration in the first unstructured observations. At the second session one week later, when the amount of 'protest' had reduced considerably, the Exploration scores of the Comparison group increased markedly. The differences between the groups in Exploration did not approach levels of statistical significance.

Malnourished children have previously been described as apathetic. Despite the confounding factor of hospitalisation, these results are in line with the findings of researchers with moderately malnourished children (e.g. Chávez and Martínez, 1979). On admission to hospital, when as far as nutritional intake is concerned, they were in the nearest state to their previous condition at home, the malnourished children were likely to be quiet and undemanding. Activity levels in the malnourished group showed a rapid increase after the first week, but the increase in Exploration scores was more gradual and their scores remained behind (though not significantly behind) the Comparison children at discharge.

In the structured observations, the general picture presented at the first session is that when given toys, the Comparison children played significantly more than the malnourished children and explored more of the toys with a greater variety of actions than the malnourished children. There was an increase in the amount of play by both groups at the second session, one week later, but the differences in quality remained. By discharge however. the malnourished children had caught up with the Comparison children in all the quality measures but the number of toys used. The recovered malnourished child therefore is still apparently exploring fewer of the objects in his environment than the well-nourished child even when toys are specifically provided.

In the malnourished group, both the number of different actions and the number of toys used at the first session were significantly associated with developmental level and severity of initial illness, whereas these associations were negligible in the comparison group. The number of different actions and the number of toys used by the malnourished children were positively correlated with DQ, but negatively correlated with the number of days in hospital before the first test. This measure of severity of illness showed a moderate negative correlation with DQ level in both groups, but had a considerably greater correlation with these play scores in the malnourished group than in the well-nourished group at the first session.

Within each group, nutritional status showed little association with the quality of play measures, but when the groups were combined, the correlations reached statistical significance reflecting the significant difference between the groups.

The scores of the two groups on these aspects of the quality of their play with toys at the first session are significantly different from each other and are also different in their relationships with developmental, health and nutritional measures.

In the multiple regression analyses further attempts were made to explain the differences in play between the children. These analyses did not prove to be very helpful in the case of the comparison group as the 3 independent variables (DQ 1 month after discharge, severity of initial illness and nutritional status) did not explain a significant proportion of the variance in the play measures. In the malnourished group, the 3 independent variables only explained a significant proportion of the variance in the number of toys used, with severity of initial illness making the largest independent contribution.

There were significant differences in the way in which the Non-Intervention children and the Comparison children played with the toys when they were first admitted to hospital. With the two groups taken together, severity of initial illness, nutritional status and developmental level together explained a significant proportion of the variance in the number of actions that the children used, the number of toys that they played with and the total number of play actions that they performed during the observations. Notably, 50% of the variance in the number of toys with which the child played was accounted for by this group of physical and developmental measures and this was the only one of the categories measured that had not completely normalised in the malnourished group by discharge.

When the two sets of observations are taken together, it would seem that the malnourished children's exploration of their environment was less thorough than the well-nourished children. The lack of play material on the ward may be analagous to the situation in the children's own homes. In the HOME inventory, both groups of children obtained very low scores on the subgroup IX 'Availability of play materials' (Table 4.6). The unstructured ward environment may also be analagous to the children's homes in another respect. In general, both appeared to be busy, noisy environments containing many people whose attention was often directed away from the children. The pattern of behaviour of these severely malnourished children suggested that they were less likely to demand the attention of the adults around them than the well-nourished children.

The initial differences that were observed between the groups would therefore tend to support the hypothesis that malnutrition has the effect of isolating the child from his environment, reducing the quantity and the quality of the individual's interaction with the objects in his world. These findings taken with the fact that in the period after treatment, the malnourished children followed a pattern of development which was similar to that of the well-nourished children, lead to the hypothesis that behavioural intervention with severely malnourished children during nutritional rehabilitation and continuing after discharge could enable them to catch up in development with the children who have not experienced severe nutritional deprivation.

CHAPTER 7. DESCRIPTION OF THE MALNOURISHED (INTERVENTION) GROUP

This group comprised all the children suffering from severe malnutrition admitted to the metabolic ward of TMRU or the medical paediatric wards of UHWI during the period from October, 1976 to November, 1977 that fulfilled the selection criteria that had previously been applied to the Malnourished (Non-Intervention) group (See Chapter 4.1). A total of 21 children were included in this group.

Background information was obtained from the mothers of the children in interviews while the children were in hospital as it had been collected in the first phase of the study. The following information was collected on each child:

1. Child's age on admission
2. Child's birthweight.

   Unfortunately, birthweights were not available for 8 of the children in this group. These children had not been weighed at birth, but from mothers' descriptions, it was concluded that the children had not been abnormally small and they were included in the sample. The difficulties involved in the retrospective collection of birth data have already been described with respect to the earlier groups.

3. Mother's verbal ability. (PPVT)
4. Socioeconomic status.

   Homes were assessed when the homes were visited for the intervention programme.

The HOME inventory was not carried out with the Intervention group. It was decided that as the research staff were engaged in advising the mother on the types of issues that are assessed by the Inventory, it would not be feasible to carry out this interview.

The hospitalisation measures were the same as in Phase 1:

1. Diagnosis
2. Length of hospitalisation
3. Severity of initial illness.

The intention was to get a second group of malnourished children, in all respects comparable to the Non-Intervention group, so that the effects of the additional intervention could be assessed. Table 7.1 compares the anthropometry of the two groups of malnourished children. The groups were not significantly different from each other and in all of the measures, with the exception of lowest weight for age in hospital, the mean scores of the groups are less than 1 percentage point apart. There is a difference of 2.3% between the means for lowest %weight for age, which is not statistically significant ($F=0.9879$, $p=0.3267$).

Table 7.1 Anthropometry of the 2 groups of Malnourished children on admission to hospital.

Means and Standard deviations.

	Malnourished groups					
	Non-Intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
Lowest % WT/AGE	52.1	(6.70)	54.5	(8.21)	0.9879	0.3267
Lowest % WT/HT	69.2	(9.40)	70.7	(7.00)	0.3012	0.5864
% WT/AGE at 1st test	55.1	(8.16)	57.9	(10.12)	0.8508	0.3623
% HT/AGE at 1st test	88.0	(5.08)	88.7	(4.62)	0.2117	0.6481
% HC/AGE at 1st test	91.3	(3.51)	91.8	(3.77)	0.1703	0.6822
% WT/HT at 1st test	73.2	(9.90)	74.8	(8.53)	0.3101	0.5810

The backgrounds of the two Malnutrition groups are compared in Table 7.2. There were no significant differences between the groups on any of the variables measured. There was the tendency for the Intervention children to be less severely ill on admission (F=2.1881, p=0.1475) and to remain in hospital longer than the Non-Intervention children (F=1.6055, p=0.2130), but the differences were negligible.

The birthweights of the 13 children in the Intervention group for whom these data were available were not significantly different from those of the Non-Intervention group (F=0.2730, p=0.6053).

In the Intervention group, there were 10 children with nutritional oedema (4 with kwashiorkor and 6 with marasmic-kwashiorkor). In all cases of kwashiorkor, at their lowest weight in hospital, the children were between 62% and 64% of their expected weight for age and were therefore only marginally above the limit for marasmic-kwashiorkor. In addition, the height deficits shown by these children lead to the conclusion that they had all experienced chronic malnutrition.

Table 7.2 Description of the Non-Intervention and Intervention groups.

Mean scores and standard deviations.

	Non-Intervention n = 18		Intervention n = 21		F	P
	Mean	(SD)	Mean	(SD)		
Birthweight (kg)	3.0	(0.52)	3.1 *	(0.80)	0.2730	0.6053
Age on admission (months)	12.7	(4.40)	12.5	(3.03)	0.0119	0.9138
PPVT	60.0	(14.63)	60.9	(14.40)	0.0377	0.8471
Standard of housing	6.4	(1.72)	6.5	(1.57)	0.0227	0.8812
Total days in hospital	47.6	(24.8)	56.8	(20.9)	1.6055	0.2130
Admission to 1st test (days)	7.6	(8.33)	4.6	(3.79)	2.1881	0.1475
Lowest % WT/AGE in hospital	52.1	(6.70)	54.5	(8.21)	0.9879	0.3267
Lowest % WT/HT in hospital.	69.2	(9.40)	70.7	(7.00)	0.3012	0.5864

* n = 13

8 missing cases (38%)

Within the Intervention group, the backgrounds of the boys and girls are compared in Table 7.3. The 13 boys and 8 girls were not significantly different in the scores that their mothers obtained on the PPVT (F=2.1569, p=0.1583) or in their standard of housing (F=1.9913, p=0.1744). The birthweights that were available for 8 boys and 5 girls were also very similar (F=0.3182, p=0.5840). Their nutritional status was similar (lowest %weight for age: F=0.0019, p=0.9660; lowest % weight for height: F=1.5842, p=0.2234), and their hospital stay equivalent (length of stay: F=0.0397, p=0.8442; severity of initial illness: F=1.1614, p=0.2947).

The backgrounds of the Intervention group and the Comparison group are shown in Table 7.4. Like the Non-Intervention group, the Intervention group differed from the Comparison children on standard of housing (F=15.9940, p=0.0003) and length of hospital stay (F=39.2715, p=0.0000). Unlike the other Malnutrition group, however, the Intervention group did not differ significantly from the Comparisons in birthweight (F=0.9382, p=0.3420) or mothers' PPVT scores (F=2.5348, p=0.1209). cf. Table 4.7.

The anthropometry of the 2 groups of malnourished children was compared in repeated measures analysis of variance. Standardised measurements of weight for age, height for age, head circumference for age and weight for height were compared at the time of the first developmental assessment in hospital, at discharge, 1 month and 6 months after discharge. Means and standard deviations are shown in Table 7.5.

Table 7.3 Description of Intervention group divided by sex.

Mean scores and standard deviations.

	Intervention				F	P
	Boys (n = 13)		Girls (n = 8)			
	Mean	(SD)	Mean	(SD)		
Birthweight	3.00[a]	(0.57)	3.34[b]	(1.13)	0.3182	0.5840
Age on admission	12.2	(3.5)	13.2	(2.01)	0.5204	0.4795
PPVT	57.4	(12.32)	66.6	(16.48)	2.1569	0.1583
Standard of housing	6.2	(1.73)	7.1	(1.13)	1.9913	0.1744
Total days in hospital	57.5	(22.89)	55.6	(18.47)	0.0397	0.8442
Admission to 1st test (days)	3.9	(2.10)	5.8	(5.57)	1.1614	0.2947
Lowest % WT/AGE in hospital	54.5	(7.61)	54.6	(9.67)	0.0019	0.9660
Lowest % WT/HT in hospital	72.2	(6.89)	68.3	(6.92)	1.5842	0.2234

a) n = 8

b) n = 5

Table 7.4 Description of Intervention and Comparison groups.

Mean scores and Standard deviations.

	Intervention		Comparison		F	P
	n = 21		n = 14			
	Mean	(SD)	Mean	(SD)		
Birthweight	3.1*	(0.80)	3.3	(0.52)	0.9382	0.3420
Age on admission	12.5	(3.03)	12.5	(4.82)	0.0026	0.9595
PPVT	60.9	(14.40)	68.1	(10.63)	2.5348	0.1209
Standard of housing	6.5	(1.57)	-8.6	(1.34)	15.9940	0.0003
Total days in hospital	56.8	(20.85)	18.6	(11.18)	39.2715	0.0000
Admission to 1st test (days)	4.6	(3.79)	5.6	(4.69)	0.4393	0.5121

* n = 13

Table 7.5 Anthropometry of Non-Intervention and Intervention Malnourished groups at 4 tests.

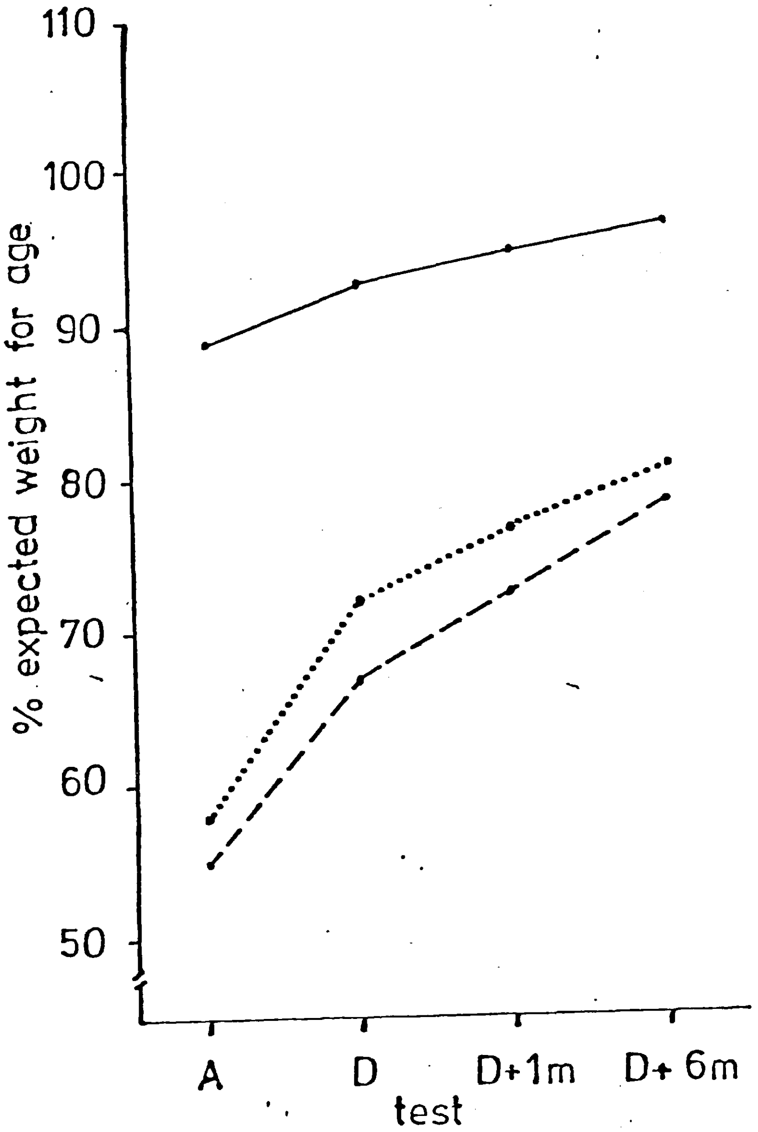
Means and Standard deviations.

	Group	Time of Measurement							
		Admission		Discharge		Discharge + 1 month		Discharge + 6 mths.	
		Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
% WT/AGE	Non-Int.	55.1	(8.16)	66.8	(6.37)	73.0	(8.02)	78.8	(7.54)
	Int.	57.9	(10.12)	72.0	(11.20)	77.0	(10.33)	80.6	(10.53)
% HT/AGE	Non-Int.	88.0	(5.08)	87.9	(4.74)	88.9	(4.45)	90.7	(4.44)
	Int.	88.7	(4.62)	88.6	(4.25	90.0	(3.54)	90.7	(3.73)
% HC/AGE	Non-Int.	91.3	(3.51)	91.7	(3.51)	93.9	(3.10)	95.0	(2.97)
	Int.	91.8	(3.77)	93.1	(3.98)	94.2	(3.08	96.4	(3.86)
% WT/HT	Non-Int.	73.2	(9.90)	90.6	(12.81)	92.5	(8.43)	92.2	(7.28)
	Int.	74.8	(8.53)	91.5	(9.02)	93.4	(10.18)	93.6	(8.87)

In the analyses on all of the anthropometric measures, the only significant effect was the main effect of time. The main effects of group and sex as well as the interactions between group, time and sex were all non-significant in the analyses of data from the 2 malnourished groups. The Intervention and the Non-Intervention groups can therefore be regarded as equivalent in the pattern of their physical growth during recovery and during rehabilitation from malnutrition.

Mean scores of the Non-Intervention, Intervention and Comparison groups for the four standardised anthropometric measures are shown in Figures 7.1, 7.2, 7.3 and 7.4.

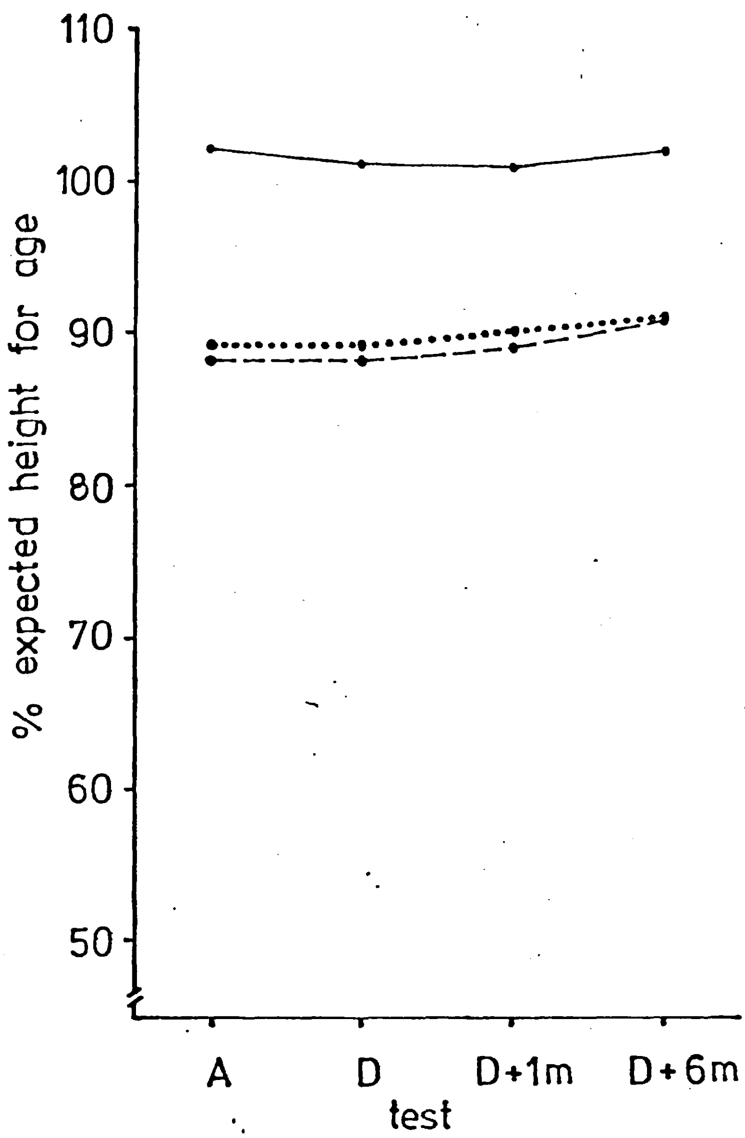
Figure 7.1 Anthropometric measurements of Non-Intervention, Intervention and Comparison children at 4 tests.



—— Comparison group

– – – Non-Intervention)
)Malnourished groups
······· Intervention)

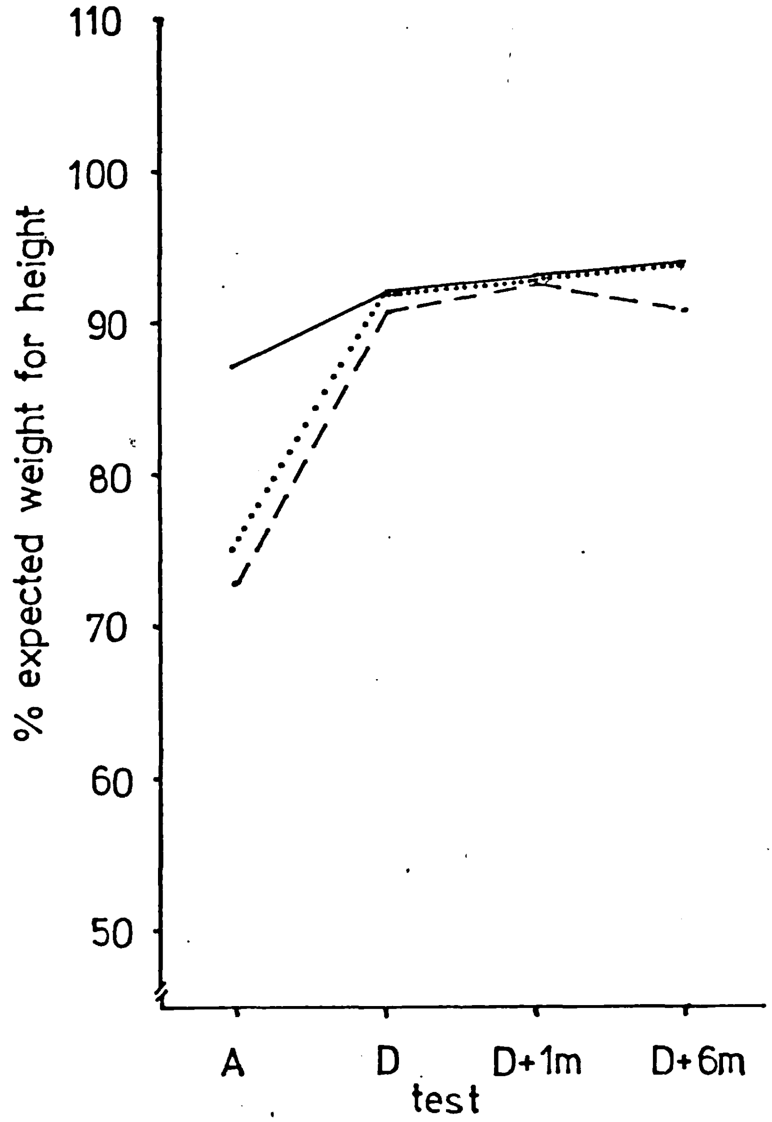
Figure 7.2 Anthropometric measurements of Non-Intervention, Intervention and Comparison children at 4 tests.



— Comparison group

-- Non-Intervention)
)Malnourished groups
..... Intervention)

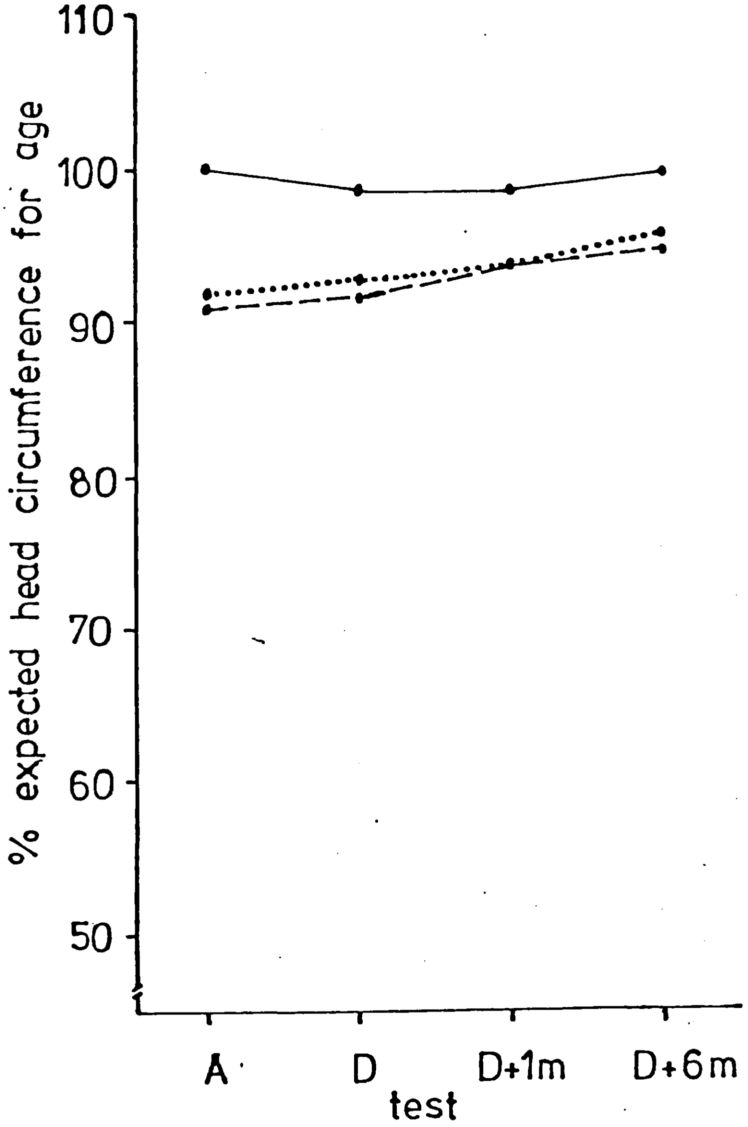
Figure 7.3 Anthropometric measurements of Non-Intervention, Intervention and Comparison children at 4 tests.



— Comparison group

-- Non-Intervention)
)Malnourished groups
····· Intervention)

Figure 7.4 Anthropometric measurements of Non-Intervention, Intervention and Comparison children at 4 tests.



—— Comparison group

– – Non-Intervention)
)Malnourished groups
····· Intervention)

CHAPTER 8. DESIGN OF THE INTERVENTION PROGRAMME

The main aim of the second phase of the Jamaican Malnutrition Study was to investigate whether the development of children recovering from severe PEM could be enhanced by a programme of behavioural intervention designed within the limited personnel and material resources available. The scale of many of the compensatory programmes designed for socially disadvantaged children in the U.S.A. was completely beyond the scope of the Health or Education services of the countries where malnutrition is endemic. The Jamaican situation imposed 2 major limits. First, only a limited number of staff could be available to carry out such a project on any permanent basis and these would be people with low levels of education, who would not be able to manage a complex programme or utilize a complicated, written curriculum. The daily involvement of professional staff would not be feasible in any long term implementation of such a programme. The second limitation was imposed by the fact that neither the hospitals, faced with budget deficits in the financing of urgent medicines and surgical equipment, nor the parents of the children would be able to provide money for play material for the programme.

From a review of the issues in the design of compensatory programmes for pre-school children (Ch. 2.7), the following conclusions were drawn for the present study:

a. The involvement of the child's family was essential for the maintenance of any gains that might be achieved in hospital.

b. Acknowledging that in working with families of children who had suffered severe PEM one is dealing with a particularly deprived group in particularly difficult circumstances, there is evidence from the U.S.A. as well as in Jamaica (Grantham-McGregor and Desai, 1975) which suggests that such mothers can be the principal agents of enhanced development in deprived children.

c. Paraprofessionals with limited formal education can be as successful in working with mothers and pre-school children in compensatory programmes as more highly qualified staff. A nurse took part in the earlier, successful Jamaican pre-school intervention project, but as the success of the programme depended largely on the mothers' co-operation and her playing with her child, the evidence suggested that a para-professional could be as effective in working with the mothers.

d. The most appropriate approach to the behavioural intervention would be a sequential, cognitively-oriented curriculum of activities which could be systematically followed according to the develop-mental level of the individual children.

A programme was therefore developed for the Mal-nourished (Intervention) group that followed a specially designed curriculum for children aged 6 to 36 months, which utilised, for the most part, toys made from scrap material.

The plan of the programme for the Intervention group was as follows:

After each child had been given Test 1 and had had the first set of behaviour observations (See Chapter 5.1.3 - Timing of tests), and for the duration of his/her stay in hospital, s/he had sessions of play following the curriculum for one hour a day, 6 days of each week. Mothers were encouraged to participate in these sessions wherever possible. When leaving hospital, each child was given the set of toys currently in use and parents were shown the appropriate activities. After the child returned home, s/he was visited for one hour per week, during which the child's progress was discussed with his/her parent or guardian. The play activities for the next week were discussed with the adult and toys were added or exchanged. Parents/guardians were encouraged to have daily toy-play sessions with the child. (See Appendix II)

The play in hospital and the home visits were carried out by one of three people. There was one nurse (SRN) experienced in paediatric nursing, who was selected by the researchers and seconded to the project by the UHWI. The nurse was assisted by two Community Health Aides (CHAs), seconded to the research project by the Public Health Dept. of the Jamaican Ministry of Health. The CHAs were women with limited secondary education who had undergone a short course in home visiting and had previously been based at Health centres as assistants to the Public Health Nurses (Health Visitors). The nurse stayed for the duration of the project. There was one change of staff in the CHAs.

It was decided that neither the doctor nor the psychologist should work directly with the parents and children in the Intervention group. There were two reasons for this decision. One was that the research was designed to test the success of the programme as run by the paraprofessionals with a view to long-term implementation; the second being that the researchers were involved in the assessment of all the children and could not therefore work closely with one group. The doctor did not do any of the home visits and the psychologist only visited the homes as an observer as part of the training of the nurse and the CHAs, and on a few occasions to meet family members or to assist the regular home visitor when particular problems arose.

Play groups were organised for all of the patients in the medical paediatrics wards and the TMRU metabolic ward during phase two of the study.

8.1 THE CURRICULUM

The Curriculum for this stage of the project was designed for use with children aged 6 to 36 months, although the achievement of specific skills was stressed rather than the chronological age of the children. On completion of these items a modified version of Palmer's Concept Training Curriculum (Palmer, 1971), previously used with 3 year old Jamaican children (Grantham-McGregor & Desai, 1975) would form the basis of the programme.

At the end of their period in hospital, the malnourished children in Phase 1 (the Non-Intervention group) were significantly behind the Comparison children (See Table 5.1). This retardation appeared in all the subscales of the Griffiths Test rather than being a specific deficit in one area (Fig. 5.3). The relative positions of the scores in the four subscales were very similar in the two groups.

The programme designed for the Intervention group was therefore aimed at accelerating the development of children across a wide range of areas. The emphasis was on cognitive development, but gross motor development and aspects of social-emotional development were also included.

The theoretical base of the Intervention programme was essentially Piagetian. Development was defined in terms similar to Uzgiris and Hunt's (1975) description of "transformation of interrelated competencies to progressively higher levels" which was achieved through the interaction of the child possessing a given level and range of competencies with appropriate environmental conditions to allow repetition of existing schemes, but also to encourage exploration and thus transformation of these behaviours. Favouring the hypothesis that malnutrition in some way 'functionally isolates' the individual from the environmental experiences favourable to development, it was therefore hypothesised that by the provision of a planned programme of environmental stimulation the retardation of the survivors of severe PEM could be ameliorated to some degree. The aim was therefore to find a limited number of tasks that were attractive to parent and child and which would provide the infant and toddler with the necessary range of experiences.

The three aspects of the home environment which were found to be important in early childhood by Bradley and Caldwell (1976b)were included as elements of the programme. Through play sessions based on the teaching of sequences of activities (which involved both the provision of appropriate play materials and the organisation of the environment), the development of the mother-infant relationship was facilitated (and thereby, maternal involvement with the child was enhanced).

Implicit in the design was the attempt to provide the mothers of the Intervention children with information and to foster attitudes which, in the long term , would make the mothers more aware of the developmental needs of their children and enable them to provide the "incidental cognitive socialisation" (Levenstein, 1970) thought to be important for young children.

With the families of malnourished children, one was dealing with a population raising particular difficulties. The Non-Intervention group demonstrated the multiplicity of handicaps characteristic of socially disadvantaged groups in general and those peculiar to such groups in Third World urban areas. As an observer, one could appreciate the frustrations and the physical constraints on the families which would prevent many of the actions and attitudes which are seen to be important for the overall development of young children. The standard of housing of the families was appalling -recorded in the children's scores on the Housing Index (representing the minimum of facilities and sanitation) and their scores on the HOME inventory. The mothers' own verbal abilities were also very limited. The raw scores achieved by the mothers of the comparison group were equivalent to the norms for school-children.

A programme had to be designed which gave due regard to not only the limits of the available staff and hospital resources, but also to the realities of the families with whom we were working.

The Intervention curriculum was designed in two levels. Level One (broadly 6 to 18/24 months) corresponded to Piaget's stage of Sensorimotor intelligence and Level Two (18 to 36 months) focused on the transition to pre-operational thinking, emphasising the development of the symbolic functions of language and imagery.

Each task was tested for inclusion against the following criteria:

1. Achievement of the required task could be conceived of as development as described above.
2. The purpose of the task had to be clear and the child's progress should be clearly measurable by the mother and to some extent by the child himself.
3. The play material had to be readily available or easily made in large quantities. It also had to be attractive to hospital staff and to the children's families to encourage their support and assistance and they often had concepts of 'toys' greatly influenced by commercial advertising.

As originally conceived, the Intervention curriculum was considerably more complex than it is in its present form. In consultation with the Home Visitors, it was simplified and implemented in its final form.

Few specific items for social and emotional development are included in the curriculum. These areas of development were catered for by more indirect means which may be summarised as follows:

a. Home Visitors demonstrated a positive attitude to the mother. Mother was seen as the agent of the child's improved development and her ability to do so was stressed. Her efforts were praised (in care of her children and her home) and her problems in this role were discussed. However,the Home Visitors were advised to take care not to get involved in family or neighbourhood quarrels and to maintain a neutral position, encouraging mother to analyse her own situation and make her own decisions.

b. Home Visitors demonstrated a positive attitude to the child. Children were never labelled 'retarded' or 'mentally retarded'. The explanation was rather in terms of the child's development being "slowed down by severe illness". It was also stressed that the child was chosen for the study (i.e. a privilege rather than a stigma). The child's strengths were repeatedly pointed out to the mother and she was encouraged to praise them - whether this was weight gain, the achievement of a new skill or even a pleasant smile. It was important to encourage family pride in each child.

c. The importance of the relationships between the members of the household was stressed.

d. The play sessions should help the development of a warm relationship between the mother and the child. Positive styles of child rearing were demonstrated and encouraged. Jamaican parents are inclined to use rather punitive methods of child rearing, having little faith or indeed knowledge of other approaches to controlling the behaviour of their children. Wherever possible, the Home Visitors explained and demonstrated the advantages of praise and reward for good behaviour and achievement over punishment, particularly corporal punishment, for wrong doing or failure.

e. The individuality of the child was stressed. The mother was encouraged to observe each child and the need for individual attention and for an individual approach was discussed and demonstrated.

f. Advice on the training of social skills was included when appropriate. Mothers' suggestions for tasks to be taught were included as much as possible.

The physical development of the children was catered for specifically by the gross- and fine-motor tasks included in sections I and VII. It was unavoidable that with the regular contact between the mothers and the hospital staff some of the Intervention children's mothers may have received extra nutrition advice, but care was taken to keep the amount of such advice equal across the groups. All of the mothers were encouraged to take advantage of the free food supplements available from the hospital and the Government run clinics. The mothers were told when these foods were available at TMRU and all mothers could request it when they came up for tests or doctors'clinics.

The Home Visitors' Manual (Appendix II) included an introduction to the Intervention programme curriculum, a summary of instructions for carrying out the programme in hospital and for the conduct of home visits. Sections 2 and 3 gave a summary of the curriculum for each of the two levels and instructions on how to teach each activity and the actions which the child would be expected to perform.

8.1.1 Level one (6 - 18/24 months)

The Home Visitors' Manual for Level One is reproduced in Appendix II.

Level One comprised a selection of the activities and games frequently played with children up to the age of two. In the manual, the activities were listed in 8 scales. These were arranged in order of difficulty, with Block A being the easiest and D the most difficult in this level. The activities were selected according to the criteria listed above to facilitate development in 6 areas. The developmental areas and the corresponding scales in the manual are as follows :

1. Gross motor (locomotion) skills - Scale I
2. Prehension - Scales II and VII
3. Differentiation of means and ends - Scale II
4. Development of the object concept - Scale III
5. Language development - Scales IV and VIII
6. Elementary classification - Scales V and VI

Scale I Gross Motor Development

Items in this scale were selected to facilitate the achievement of physical development milestones. They consisted of physical exercises (eg. kicking in a bath of water) or activities which encourage the development of erect posture and bipedal locomotion (e.g. mother calling child and offering a toy 3 feet from child).

There is considerable evidence that in the first 2 years of life, negro children achieve gross motor mile-ones at an earlier age than the norms for North American or European populations (Geber and Dean, 1956, 1957; Ainsworth, 1967; Grantham-McGregor and Back, 1971). In this study, the Comparison children were producing mean scores of 111 and 119 after discharge from hospital and a comparison of the age of walking in studies in the United Kingdom and Jamaica (Chapter 3.2.1) demonstrates the advantage shown by the Jamaican children.

Scale II Grasping Objects

The first block of activities in this scale was aimed at the development of prehensile skills. Further activities for the development of prehension were included in Scale VII. Blocks B and C of this scale comprised 4 activities involving the use of the relationships between objects in grasping.

The sequence of activities was selected as representative of Piagetian sensorimotor stages, (Piaget, 1953; Uzgiris and Hunt, 1975) involving a developing differentiation of the means-end relationship and the use of objects as tools. Included in this group were tasks requiring the child to pull a support to obtain a toy placed beyond his reach (found by Uzgiris and Hunt, 1975 in the majority of their sample of children by 8 months), or use of string to retrieve a toy when in view (12 months, Uzgiris and Hunt, 1975) or when toy was out of vision (13 months, Uzgiris and Hunt, 1975).

Scale III Searching for Objects

The sequence of activities in this scale, which were also adapted from Uzgiris and Hunt's (1976) Scales of Infant Development, cover Piaget's sensorimotor stages 3 to 5 in the development of the object concept. This area of development is a topic of much debate (Oates, 1979, p149), but as Bower and Paterson (1972) commented, "the development of the mature object concept is generally reckoned to be one of the most significant steps in intellectual development in infancy". The activities in this scale include the visible and invisible displacement of objects in a sequence of hiding games requiring the child to deduce the location of objects while presented with increasingly complex patterns of cues.

The interpretation put on the stages in the infant's ability to solve such problems has been modified over the years since it was first formulated by Piaget (Piaget, 1953), largely due to the work of Bower and his colleagues (Bower and Paterson, 1972; Bower, 1979), who challenged the idea that the child failed to appreciate that objects existed when out of sight. A more likely explanation seems to be one involving the child's ability to reconcile a moving object with a stationary object and to appreciate the spatial relationships between objects, and between objects and himself (Bower, 1979). These hiding games were included as 'facilitatory intervention' (Bower and

Paterson, 1972) to produce the kind of conflict which in Bower's terms would "impel the child to change his definitions of spatial labels from egocentric to relativistic ones" (Bower, 1979) and thus accelerate development.

Scale IV Sounds and Words

This scale, along with VIII BOOKS, was designed to facilitate language development. Throughout the programme, mothers were encouraged to talk to their children with the advice that their child's understanding of speech was probably greater than most adults would expect and that language ability would only develop adequately if stimulated to do so. The activities ranged from the stimulation of vocalisation (cooing and babbling) to the encouragement of imitation of sounds and later direct teaching of words. Mothers were advised to teach children the names of people and familiar objects in the home and, in addition, simple coloured pictures were provided.

The importance of live language directed to children of this age (even more than language overheard) has frequently been stressed. White (1972) concluded that the most effective language environment for enhancing development is where language occurs in a clear, meaningful context, related to what the child is doing at the time. This was the kind of language environment that mothers were encouraged to provide for their children.

Scale V Shape

The scale was introduced at Block C of the curriculum with activities centred on a set of pairs of brightly coloured nesting cups of different shapes. Further activities with shapes were included in the Second Level of the curriculum.

VI Sorting and Matching

In Level One of the curriculum, the activities ranged from learning to put objects into an open cup to elementary classification (eg. sorting a collection of blocks and spoons). At this stage, objects were used which provided several cues by which classification could be carried out (eg. colour, shape, texture and size) as this degree of redundancy has been shown to be necessary with children of this age.

Severely malnourished children are reportedly deficient in this area. Brockman and Ricciutti (1971) reported deficits in the performance of Peruvian rehabilitated marasmic children on classification tasks (Chapter 2.2.3). Data from animals (Zimmermann, 1976; Levitsky, 1979a) and humans (Lester, 1975, 1976) suggest attentional deficits in individuals previously subjected to nutritional deprivation.

Scale VII Fine Motor

The activities at this level of the Fine Motor Scale were of 2 types. After the child has demonstrated his/her ability to pick up an object that s/he can see (Scale II), the activities in this scale were designed to refine further his/her prehensile skills. First, s/he is required to pick up and place small wooden blocks one on top of the other: a task which requires considerable coordination of sensory and motor functions, not only in the refinement of grasping, but also in the control of placement and release of the objects. In addition, the 'posting bottle' requires greater precision in placing small objects into the bottle. Both tasks provide the opportunity for the refinement of thumb opposition and thumb-index finger manipulation of objects.

8.1.2 Level Two (24 to 36 months)

The Home Visitors' Manual for Level Two is reproduced in Appendix II.

At this level, each child had at least 2 activities each week: one selected from either Scale I (Gross Motor) or Scale VII (Fine Motor), and another from Scales IV (Language), V (Shape) or VI (Sorting and Matching). Additional activities could be selected from Scales II (Use of tools), III (Problem solving) and VIII (Additional Toys).

Scale I Gross Motor Activities

In the period from 24 to 36 months, children become more competent in walking and running. With improvements in balance and coordination, they begin to master the skills of jumping, hopping, throwing, kicking and catching (Espenschade and Eckert, 1967*). Level two of the Gross Motor scale includes 8 activities of this type.

Scale II Use of Tools

This section, following from activities involving the use of intermediary objects to obtain toys, comprised 5 different activities, including drawing with crayons and using a spoon and scissors.

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*A.S.Espenschade & H.Eckert (1967), Motor Development, Merrill: Columbus, Ohio.

Scale III Problem Solving

The 4 games included at this level in Problem Solving, which succeeded the hiding games of Level one, emphasised perception and memory tasks. Children were required to identify pictures of objects which were partially concealed or, at a later stage, to learn to identify familiar objects by touch. In other games, children had to remember and identify objects.

There is evidence that formerly malnourished children have difficulty in tasks involving integration of information from several sensory modalities (Champakam et al, 1968; Cravioto and DeLicardie, 1970; Witkop et al, 1970). In addition, there is the suggestion of attentional deficiencies in recent reports (Lester, 1975, 1976) and poor performance on short term visual memory tasks (Nwuga, 1977). Games in this scale were particularly relevant to this area. This scale includes items adapted from an American intervention programme (Jason, 1974).

Scale IV Language

In Level two, the language tasks ranged from those requiring the labelling of objects and pictures to tasks involving the description of the child's or the adult's actions and the use of books and pictures.

Scale V Shape

At the second level, this scale included the matching of wooden and cardboard shapes as well as simple jigsaw puzzles with up to 3 pieces.

Scale VI Sorting and Matching

Following on from Level one, at this older level, further classification tasks make use of pictures and include sorting by colour.

Scale VII Fine Motor Activities

These included unscrewing plastic bottle tops and threading painted bobbins onto narrow plastic tubing.

Scale VIII Additional Activities

In addition to the six categories above, there were a selection of toys which could be used as alternative material for areas I to VI or as the basis of other play activities.

These included fabric dolls, doll's houses and furniture made out of cardboard or wood and models of cars and animals (commercial toys and wooden models).

8.2 ASSESSMENT OF HOME INTERVENTION

The Intervention children's participation in the programme was assessed in 4 measures:

Number of visits

The number of visits made by the nurse or CHA to each child between tests varied. This was influenced by the scheduling of the tests, but in addition, on occasions, no one was at home when the visitor called. Bad weather, public holidays or illness also resulted in missed visits.

Percentage of visits with mother

This records the number of visits in which the home visitors worked with the mother or guardian of each child as a percentage of the total number of visits in the interval between tests. For some visits, the home visitors worked with other adults or children in the home.

Percentage of visits carried out by the nurse

This records the percentage of visits in which the nurse participated. On some of the visits both the nurse and a CHA were present. Although numbers of subjects were small, this variable was included to allow the assessment of whether the performance of the children was related to the proportion of visits carried out by the nurse.

'Participation rating'

At each visit to a home, the visitor recorded on a 3-point scale her assessment from reports from the family of the frequency of play sessions with the child since the last visit (see Home Visits' Manual - Appendix II). This scale ranged from 1 - "Adult did not play with child during the previous week" to 3 -"Adult played with child regularly - throughout week". Mean scores were calculated for each child for the period between discharge and the first post-discharge test and between the first and second post-discharge tests as well as for the total period from discharge to the 6 month test.

Details of the Intervention children's scores on these measures are shown in Tables 8.1 and 8.2.

Table 8.1 Assessment of Intervention group

	Mean	Standard deviation	Minimum score	Maximum score
Total number of visits	19.19	4.48	13.0	31.0
Mean Participation rating	1.98	0.41	1.00	2.60
% of visits with mother	76.7	33.3	0	100.0
% of visits carried out by nurse	54.1	26.5	0	93.8

Table 8.2 Assessment of Intervention group: Comparison of boys and girls.

	Mean Score			
	Males	Females	F	P
Total number of visits	19.6	18.5	0.2963	0.5925
Participation rating	2.08	1.83	1.9926	0.1742
% of visits with mother	77.1	76.2	0.0033	0.9551
% of visits carried out by nurse	52.2	57.1	0.1647	0.0086

CHAPTER 9. THE DEVELOPMENT OF SEVERELY MALNOURISHED CHILDREN RECEIVING BEHAVIOURAL INTERVENTION IN ADDITION TO NUTRITIONAL REHABILITATION.

In the second phase of the study, the development of the Malnourished (Intervention) children was compared with that of the two groups from Phase 1, the Malnourished (Non-Intervention) and the well-nourished Comparison groups. The Intervention group was compared to the Non-Intervention group to determine the effects of the behavioural programme on the pattern of recovery of severely malnourished children during and after nutritional rehabilitation. Further comparisons were carried out with the well-nourished children to assess whether the addition of the behavioural programme enabled the malnourished children to catch up with the developmental levels of the well-nourished Comparison group.

9.1. COMPARISON OF THE DEVELOPMENTAL LEVELS OF THE MALNOURISHED NON-INTERVENTION AND INTERVENTION GROUPS

9.1.1 General Developmental Quotients

All the malnourished children (N=39) had the 3 scheduled hospital tests and the 2 post-discharge tests. The mean DQs of the Non-Intervention and Intervention groups at the 5 developmental assessments are shown in Fig.9.1. The means and standard deviations, and the results of one way analyses of variance at each test session are shown in Table 9.1.

Figure 9.1 Mean General DQs of the Non-Intervention and Intervention groups at 5 tests.

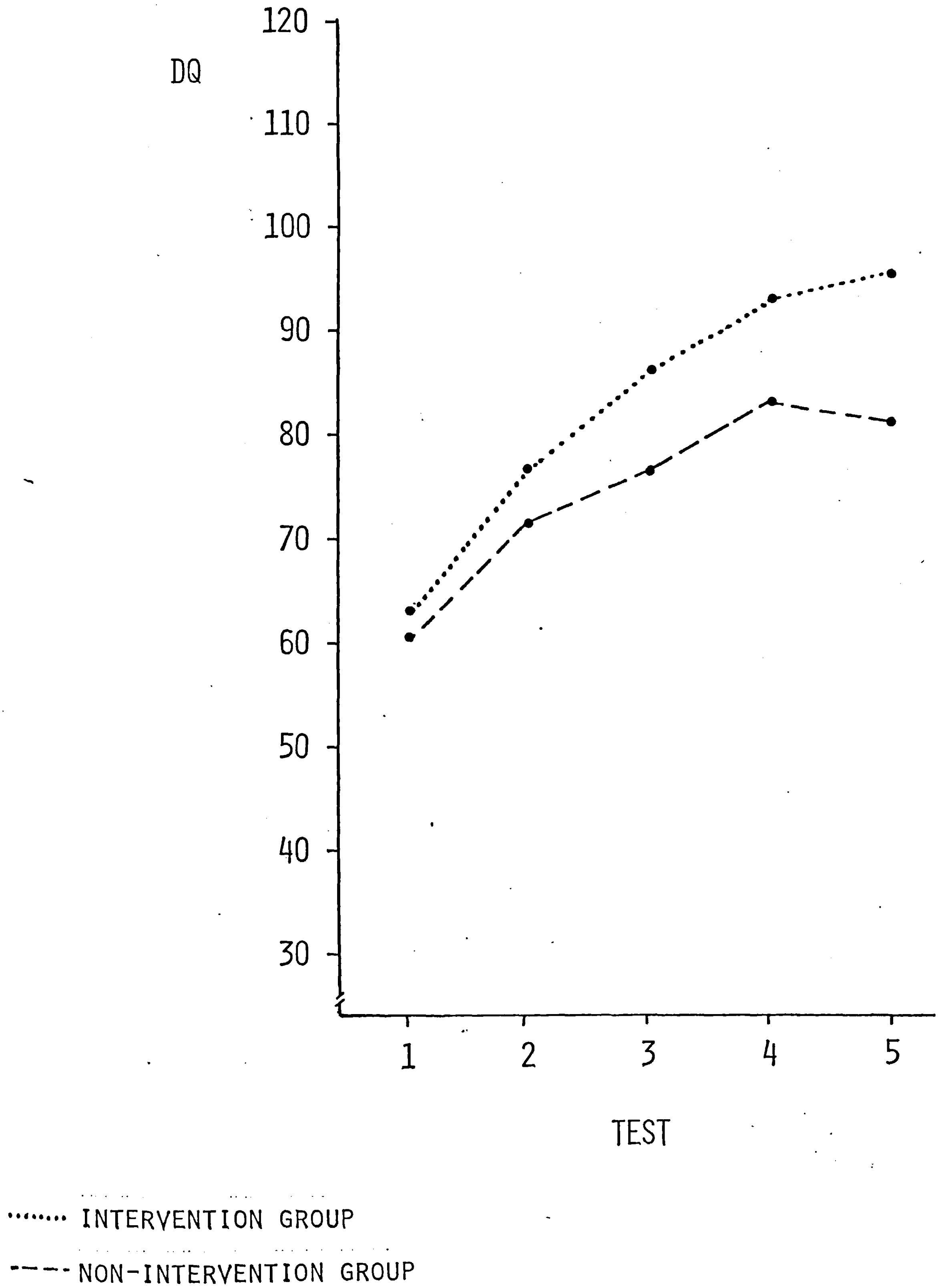


Table 9.1 Developmental Quotients

Comparison of the 2 Malnourished groups at each of the 3 tests in hospital and 2 tests after discharge from hospital.

Test	Malnourished Groups				F*	P
	Non-Intervention		Intervention			
	Mean	(SD)	Mean	(SD)		
Hospital Tests						
DQ1 Admission	61	(19.65)	64	(20.26)	0.2163	0.6446
DQ2 Adm + 1 week	72	(14.87)	77	(16.53)	1.1128	0.2983
DQ 3 Discharge	77	(12.01)	87	(12.73)	5.3912	0.0258
Post-Discharge						
DQ4 Disch + 1 month	83	(11.71)	93	(12.74)	7.1161	0.0113
DQ5 Disch + 6 months	82	(12.14)	96	(11.29)	14.5428	0.0005

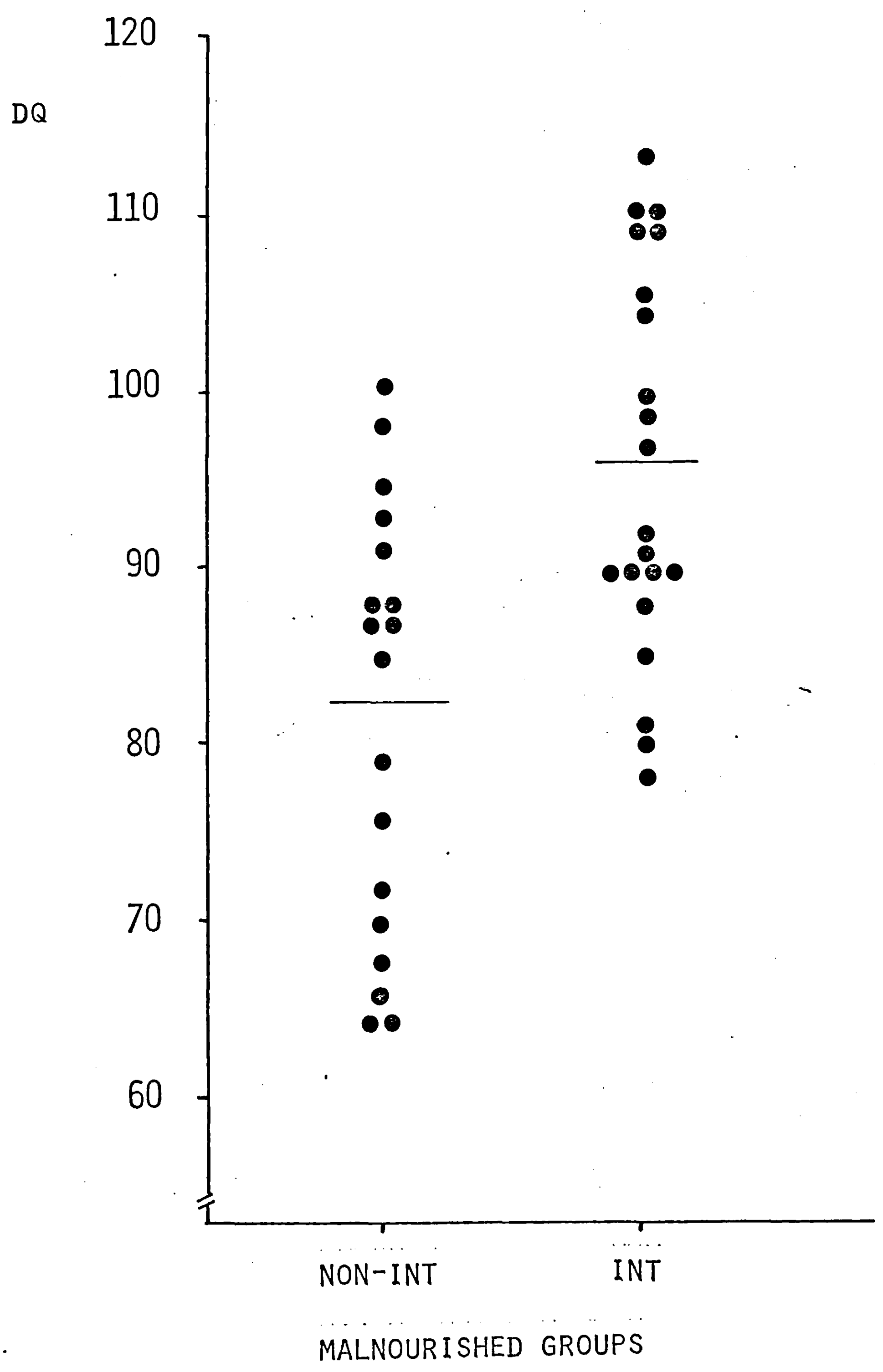
* One way analysis of variance at each test. (df = 1,37)

At the first test, although the mean DQ of the Intervention group is slightly higher than the mean of the Non-Intervention group, this difference is not statistically significant. Both groups' scores improved rapidly in hospital, but by the second test (approximately one week after the first), the Intervention group had begun to show a slight, though not significant, advantage over the Non-Intervention group. By discharge, this pattern is confirmed and at the third developmental assessment, the Intervention group's DQs are significantly ahead of the DQs of the Non-Intervention group.

In the period up to the first post-discharge test (approximately 1 month), the Intervention group gained only a few more points than the Non-Intervention group (Mean gain: Non-Intervention group = 5.45 points, Intervention group = 6.71 points), but nevertheless, consolidated their lead. At the 6 months post-discharge test, the differences between the DQs of the two groups were highly significant, the Intervention children having shown a mean gain of approximately 3 points, while the Non-Intervention group had a mean loss of 1 point.

Between the first and the fifth tests, while the Non-Intervention group had shown a mean gain of approximately 21 DQ points, the Intervention group gained 32 points. The superior performance of the Intervention group is further shown by the fact that whereas 8 children (38.1%) of that group scored 100 or more at the fifth test, with 5 of these scoring at least 110, only 1 Non-Intervention child had a score greater than 100 (Figure 9.2).

Figure 9.2 General DQ: Distribution of scores at 6 months test. Non-Intervention and Intervention groups.



● = 1 CHILD

—— = MEAN SCORE

Repeated measures analysis of variance was carried out on the DQs of the Non-Intervention and Intervention groups at the 5 sessions.* The groups were divided by sex. There was a significant main effect for group (F = 4.528, df=1.35, $p < 0.05$) and a highly significant test session effect (F=63.096, p=0.0000). The test session x group interaction was also statistically significant (F=2.519, $p<0.05$), but sex did not contribute significantly to the analysis.

Although not a statistically significant difference, the Intervention group appears to have a slight advantage over the Non-Intervention group at the first test in hospital. When the groups are subdivided by sex, it can be seen that the higher mean score for the Intervention group is largely due to the boys, who have slightly higher initial scores than the girls (F=2.2118, p=0.1534). See Fig. 9.3.

A comparison of tables 7.3 and 4.4 shows that the Intervention boys, as a group, were less severely ill on admission to hospital, as measured by the number of days in hospital before they were considered fit to be tested. The mean interval before the first test was 3.9 days for the Intervention boys, in contrast to 5.8 for Intervention girls, 5.0 for Non-Intervention boys and 9.3 for Non-Intervention girls. Although within the groups the sexes were not significantly different on this measure, in both Malnourished groups, the girls were apparently more ill on their arrival at hospital (Non-Intervention group: F=1.1337, p=0.3028; Intervention group: F=1.1614,

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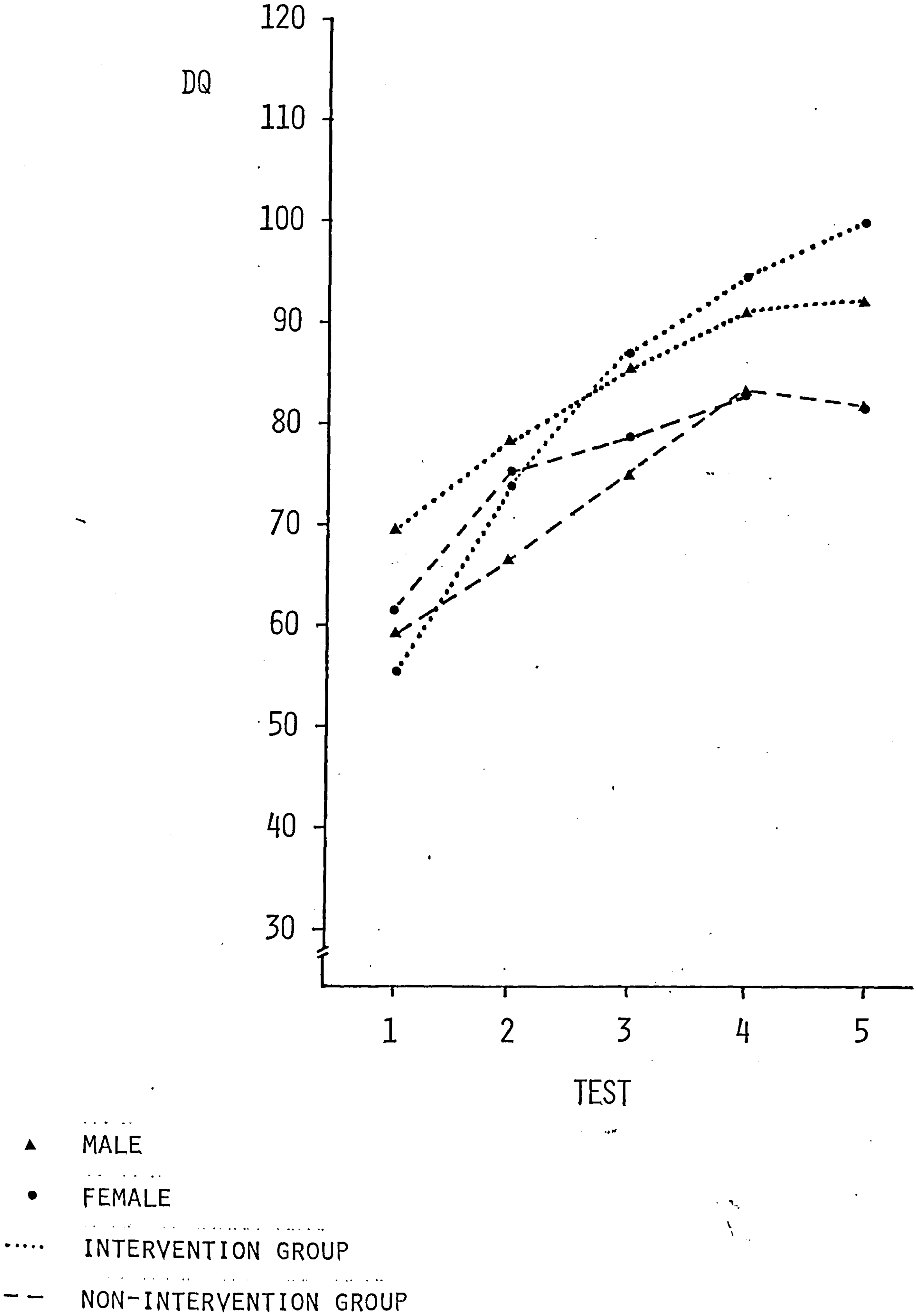
* Summary tables of the analyses of variance and covariance reported in this chapter are reproduced in Appendix III.

Figure 9.3 General DQ
Mean scores of Malnourished groups divided by sex.



p=0.2947). This slight difference in severity of initial illness could have contributed to any relative superiority shown by the Intervention group at the first test. The similarity of the scores of males and females in subsequent hospital tests would tend to support this suggestion.

There does however appear to be a sex difference in the effectiveness of the Intervention programme in accelerating development. The girls' general DQ scores at the 6 month post-discharge test were, on average, higher than the boys', though not significantly so (F=2.2072, p=0.1538). Although their initial scores tended to be lower than the boys, the Intervention girls had caught up by discharge from hospital and were ahead of the boys 6 months later.

Subscales of the Griffiths Test

9.1.2. Locomotor Scale

The patterns of gross motor development of the two groups were very similar. As shown in Table 9.2, the groups have very similar scores at each of the 5 test sessions, with differences between the means of less than 3 points in every case.

The similarity of the groups is confirmed in the repeated measures analysis of variance in which the main effect for group was not significant. Neither the main effect for sex, the group x sex interaction nor the group x test session interaction was significant. The main effect for test session was highly significant ($F=35.829$, $p<0.0000$). In addition, 2 interactions were significant. Test session x sex was significant at the 5% level, and test session x group x sex was significant at the 0.1% level.

Figure 9.4 shows the mean Locomotor DQs of the two groups subdivided by sex. The female Intervention children have the lowest mean score at the first test and the highest mean score at the fifth test, having gained 44 points, on average, between the tests. This mean gain contrasts with a mean gain of 12 points by the male Intervention children, 24 points by the Non-Intervention males and 16 by the Non-Intervention females. The Intervention girls' scores at the first test were lower than the Intervention boys ($F=4.0923$, $p<0.057$). Again, this may be explained by the slight differences between the sexes that were noted

Table 9.2 Locomotor Scale.

Non-Intervention and Intervention groups.

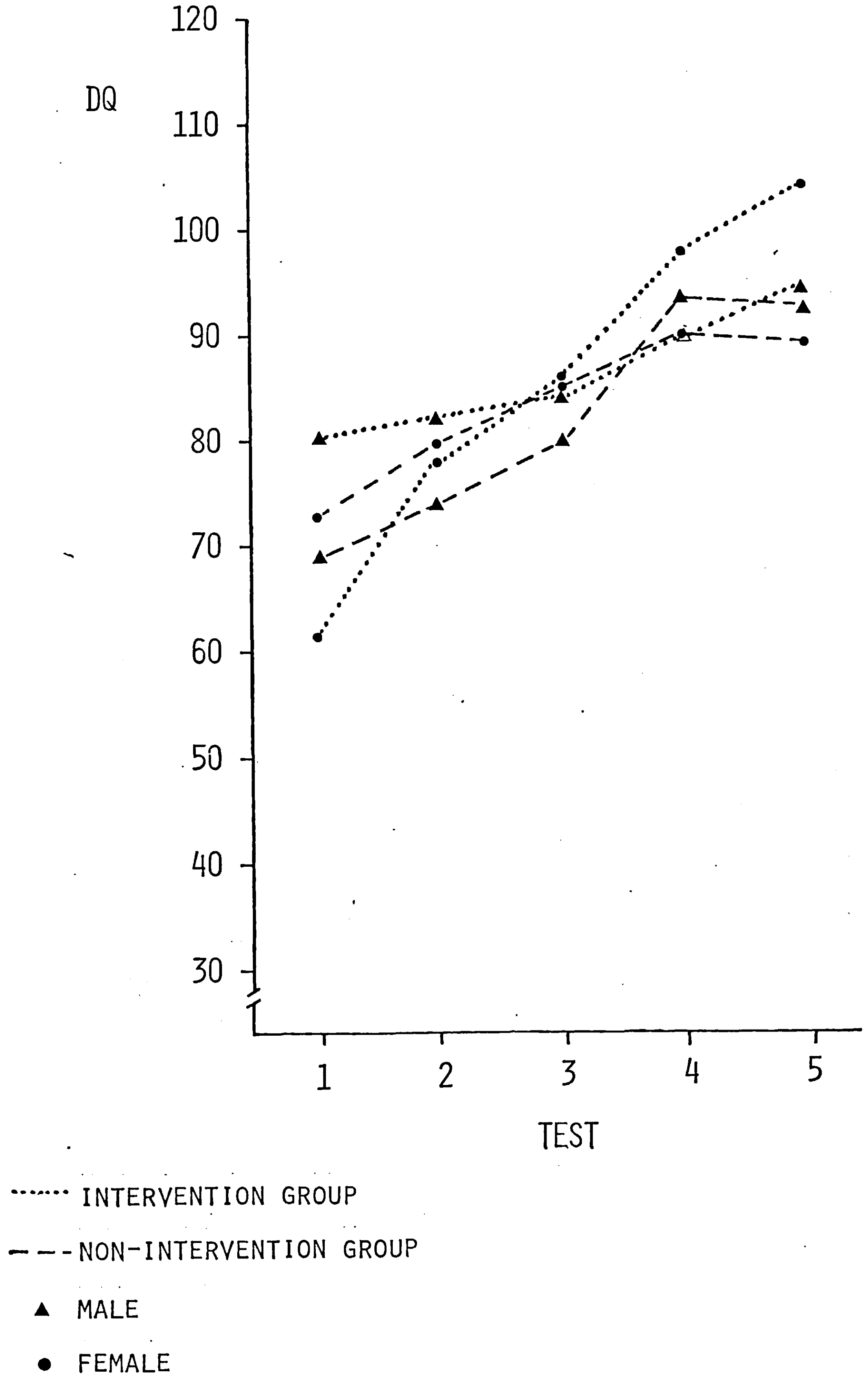
Mean and Standard Deviations.

Test	Non-Intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
1	72	(14.56)	72	(21.30)	0.0029	0.9577
2	77.4	(15.34)	80.2	(20.13)	0.2313	0.6334
3	82.5	(15.36)	84.9	(19.63)	0.1701	0.6824
4	91.2	(15.21)	92.9	(18.87)	0.0867	0.7701
5	89.8	(15.60)	97.5	(17.4)	2.0881	0.1569

Analysis of Variance

Test session $F= 35.829$, $p < 0.000$
Test x sex $F= 2.815$, $p < 0.05$
Test x group x sex $F= 6.631$, $p < 0.001$

Figure 9.4 Locomotor DQ
Mean scores of Malnourished groups divided by sex



with reference to the general DQ. This difference in Locomotor DQ had disappeared one week later (F=0.1708, p=0.6841) and at the 6 month post-discharge test, the girls had a mean lead of 14.2 over the boys (F=3.7470, p =0.068).

It would appear, therefore, that although the behavioural intervention programme produced higher general DQ scores in the Intervention group than had been achieved by the Non-Intervention group, gains were not made as rapidly in gross motor development.

As discussed in Chapter 5 with reference to the analysis of Locomotor scores of the Non-Intervention and Comparison groups, the recovery of muscle tissue after severe malnutrition appears to be a very slow process (Hansen-Smith, 1977). There is also evidence from the Colombian intervention study with moderately malnourished children (Sinisterra et al, 1979) that the acceleration of gross motor development is achieved through nutritional supplementation rather than behavioural intervention.

There is the suggestion from a comparison of the two malnourished groups in the two post-discharge tests that in the 5 months between the tests, the Intervention group were beginning to show an acceleration over the Non-Intervention group. Whereas the Non-Intervention group had a mean loss of 1.3 points between the two tests, the Intervention group gained a mean of 4.61 points, thus widening the difference between the groups.

This late improvement may reflect the course of recovery of the muscle tissues. It may be that the children are not able to use the gross motor activities to advantage until sufficient muscle regeneration has taken place, some time during the 6 months after the children leave hospital.

Table 9.3 Hearing and Speech Scale.

Non-Intervention and Intervention groups.
Mean and Standard deviations.

Test	Non-Intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
1	39.1	(23.95)	44.0	(21.29)	0.4555	0.5039
2	44.3	(18.49)	53.6	(18.52)	2.4157	0.1286
3	57.7	(16.70)	71.3	(14.19)	7.5245	0.0093
4	69.9	(13.62)	92.7	(15.27)	23.8983	0.0000
5	74.1	(13.46)	96.5	(17.56)	19.5797	0.0001

Analysis of Variance

Group F= 13.362, $p < 0.001$
Test F= 80.671, $p < 0.0000$
Group x test F= 3.325, $p < 0.025$

9.1.3 Hearing and Speech Scale

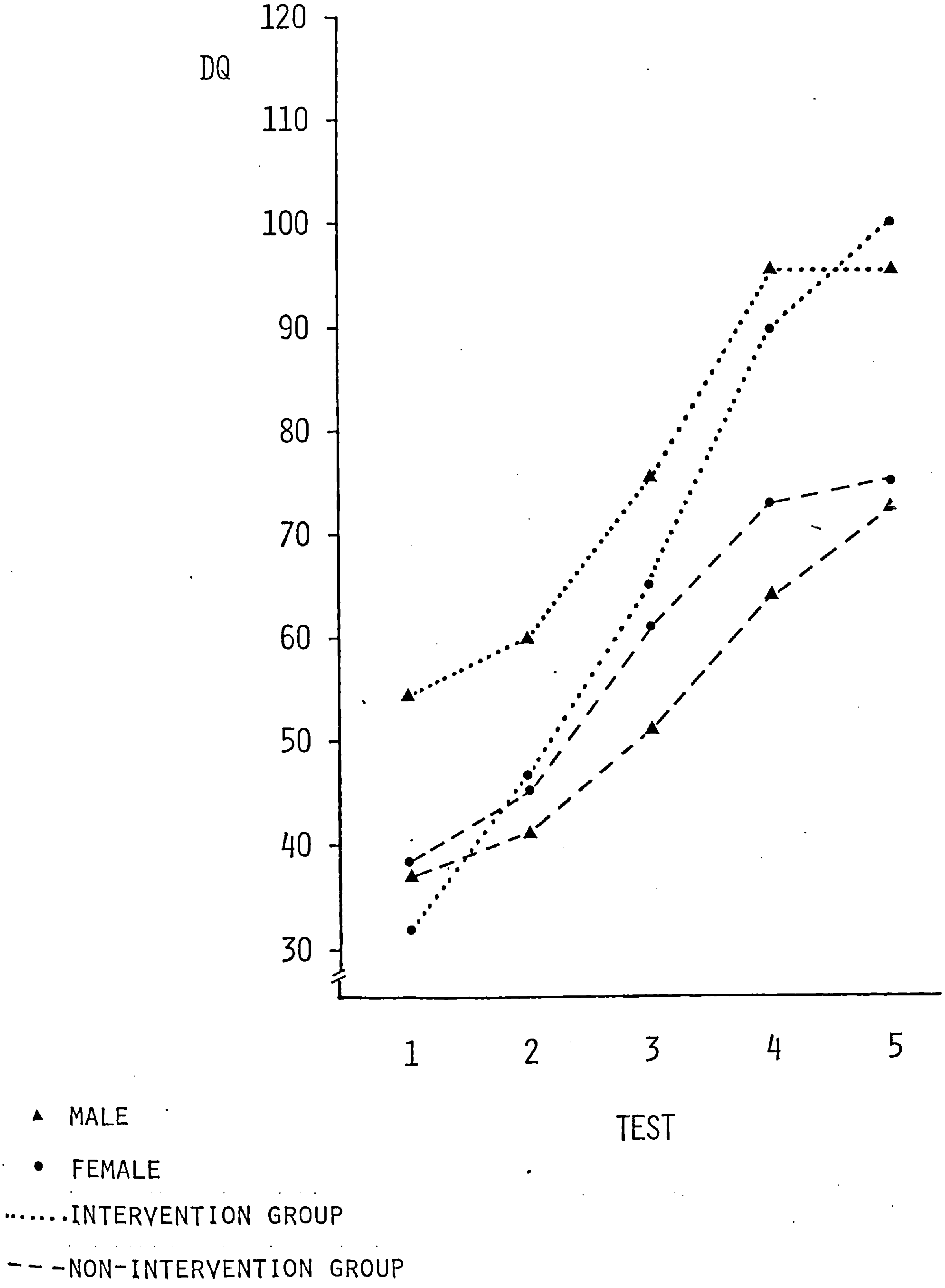
The intervention programme appears to have been particularly effective in enhancing development in the area of language. The mean scores of the 2 groups of malnourished children are compared in Figure 9.5 and Table 9.3.

In hospital, the Intervention children show an increasing lead over the Non-Intervention children. After a rapid initial gain on discharge from hospital, the Intervention children had a mean lead of 22.4 DQ points over the Non-Intervention children in Hearing and Speech at the second post-discharge test.

In the repeated measures analysis of variance on Hearing and Speech DQs at the 5 tests, there were significant main effects of group and test session, and the test session x group interaction was also significant. Sex did not make a significant contribution to this analysis. The initial differences between the sexes in favour of the boys in the Intervention group (test 1: F=6.3419, p 0.0209) were reduced by the second test, when they were no longer statistically significant (F=1.6833, p 0.2100) and the boys and girls had similar scores on Hearing and Speech thereafter.

6 months after the children left hospital, there was a marked difference between the groups on this scale of the Griffiths test. In both groups there was a gradual

Figure 9.5 Hearing and Speech DQ
Mean scores of Malnourished groups divided by sex.



improvement in scores over the period of the study, with a marked increase between the third and fourth tests. This improvement is probably due, in part, to the changed test conditions between the 2 tests. The presence of the child's mother at Test 4, one month after discharge from hospital, would have had its greatest effect on the Hearing and Speech scale as this has items which include mother's reports of the child's language, for example, about the number of words spoken by the child ("says 2 clear words" - 10.5 months) and the complexity of the child's speech ("uses sentences of 4+ syllables of clear speech" - 24 months). However, the Intervention children showed a greater gain in the first month after leaving hospital than the Non-Intervention children, and this was particularly so for the girls, who continued to increase their scores, gaining 10 points up to the 6 month test while the boys' mean score remained the same.

The Intervention programme placed special emphasis on language. The mothers were encouraged to talk to their children. They were advised that even the youngest children would benefit from speech directed to them as it enhanced the development of the social relationship between mother and child and taught the child the sounds and words of the language. In addition, mothers were encouraged to teach older children the names of familiar people and objects.

Although the Intervention children showed considerable improvement over the Non-Intervention children on this scale, at the 6 month post-discharge test, the mean score of the Intervention group was still less than 100. In fact, the mean score of the 8 Intervention girls was 100 (SD=18.88), but the 13 boys performed less well, with a mean DQ of 94 (SD=17.09), but this difference was not statistically significant (F=0.5307, p=0.4752). The girls' scores at the first test had been significantly lower than the boys on this scale (F=6.3419, p=0.0209), but this difference was no longer present at test 2 (F=1.6833, p=0.2100) and the sexes were similar thereafter.

Table 9.4 Eye and Hand Co-ordination.

Non-Intervention and Intervention groups.

Means and Standard deviations.

Test	Non-Intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
1	64.6	(25.48)	68.6	(22.17)	0.2771	0.6017
2	78.6	(17.93)	87.0	(13.72)	2.7716	0.1044
3	80.3	(14.39)	95.2	(13.18)	11.3193	0.0018
4	83.6	(11.56)	96.5	(14.13)	9.6224	0.0037
5	85.0	(14.60)	100.5	(10.43)	14.9075	0.0004

Analysis of Variance

group F = 8.153, $p < 0.01$
test F =27.315, $p < 0.000$

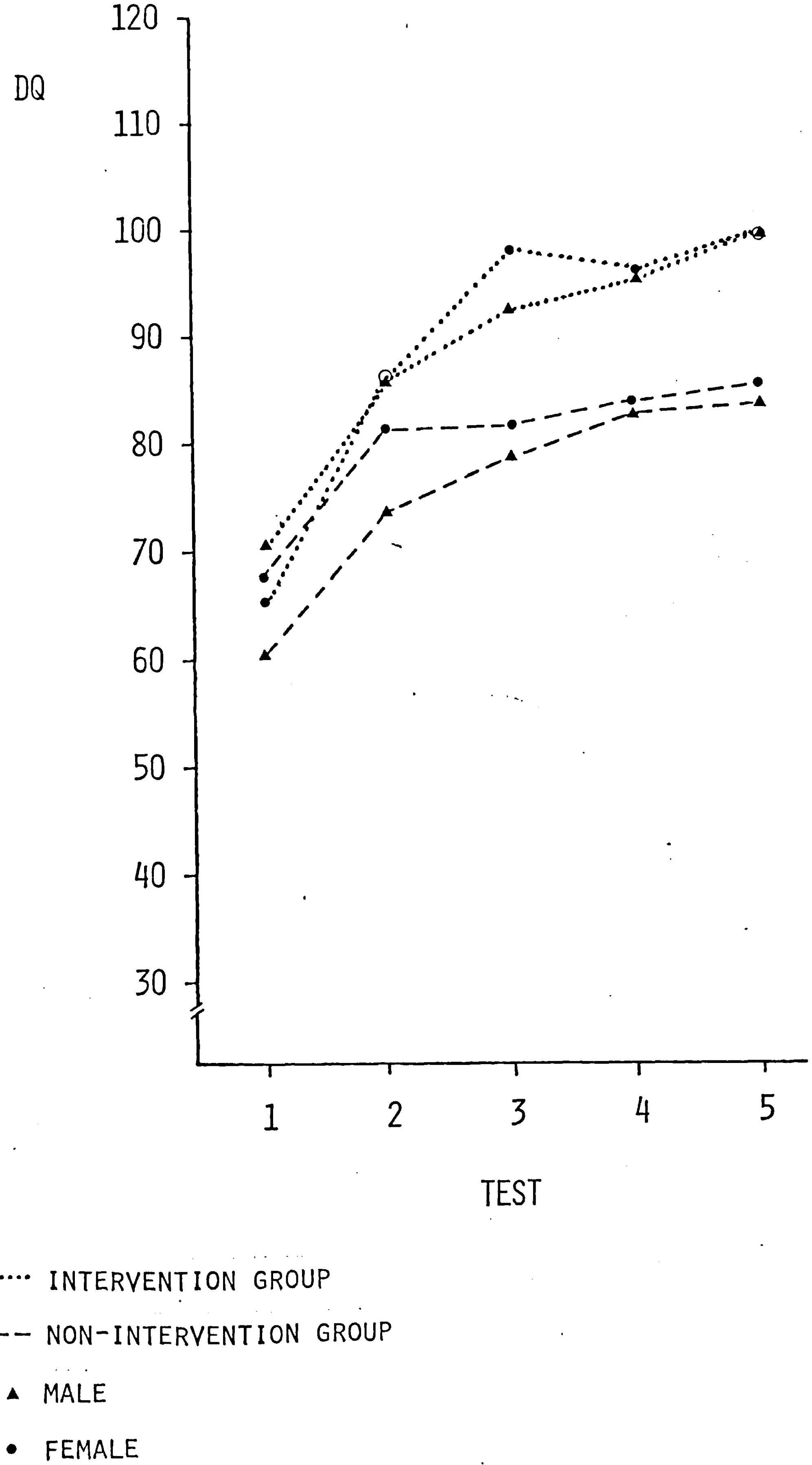
9.1.4 Eye and Hand Co-ordination

The Intervention group showed accelerated development when compared with the Non-Intervention group on the Eye and Hand Co-ordination scale of the Griffiths Test (Fig.9.6 and Table 9.4). The two groups had similar scores at the first test, but at discharge, there was a highly significant difference between them. The Intervention children maintained their lead in the 2 post-discharge tests and 6 months after their return home, their Eye and Hand Co-ordination DQs were, on average, 15.5 points above those of the Non-Intervention group.

In the repeated measures analysis of variance (5 test sessions), there was once again a highly significant test session effect and a significant group effect, but the group x test session effect was not significant. Boys and girls obtained similar scores (Fig.9.6) so the main effects and interactions with sex were not statistically significant.

At the 6 months test, the Intervention children achieved scores that were equivalent to the norms for the test on the Eye and Hand Co-ordination scale. The mean for the group was 101 with a standard deviation of 10.43. Boys and girls had very similar scores ($F=0.001$, $p=0.9937$), but there was less variability in the girls' scores than in the boys' scores (males: mean = 101, SD=12.49; females: mean=101, SD=6.57).

Figure 9.6 Eye and Hand Co-ordination DQ
Mean scores of the Malnourished groups
divided by sex.



The test items in this scale include measures of visually directed reaching and prehensile skills in the first year, and the use of a pencil and play with wooden cubes in the second year. In the intervention programme there were items specifically aimed at the development of prehensile skills (e.g. Scale II item 1 "reaching to grasp object", Scale VII item 2 "builds blocks") as well as activities involving the use of tools (e.g. Scale II items 3 - 6, 21 -25). In addition to the specific activities in this area, the opportunity to play with the material provided would also have helped to accelerate development in this area

Table 9.5 Performance Scale.

Non-Intervention and Intervention groups.

Means and Standard deviations.

Test	Non-Intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
1	67.0	(26.54)	70.1	(29.53)	0.1168	0.7344
2	85.5	(19.08)	84.5	(15.17)	0.0317	0.8597
3	87.9	(12.05)	94.8	(15.14)	2.4353	0.1271
4	85.9	(16.62)	90.6	(14.22)	0.8966	0.3498
5	78.2	(14.17)	90.5	(10.59)	9.6822	0.0036

Analysis of Variance

Test session $F= 17.749$, $p < 0.000$

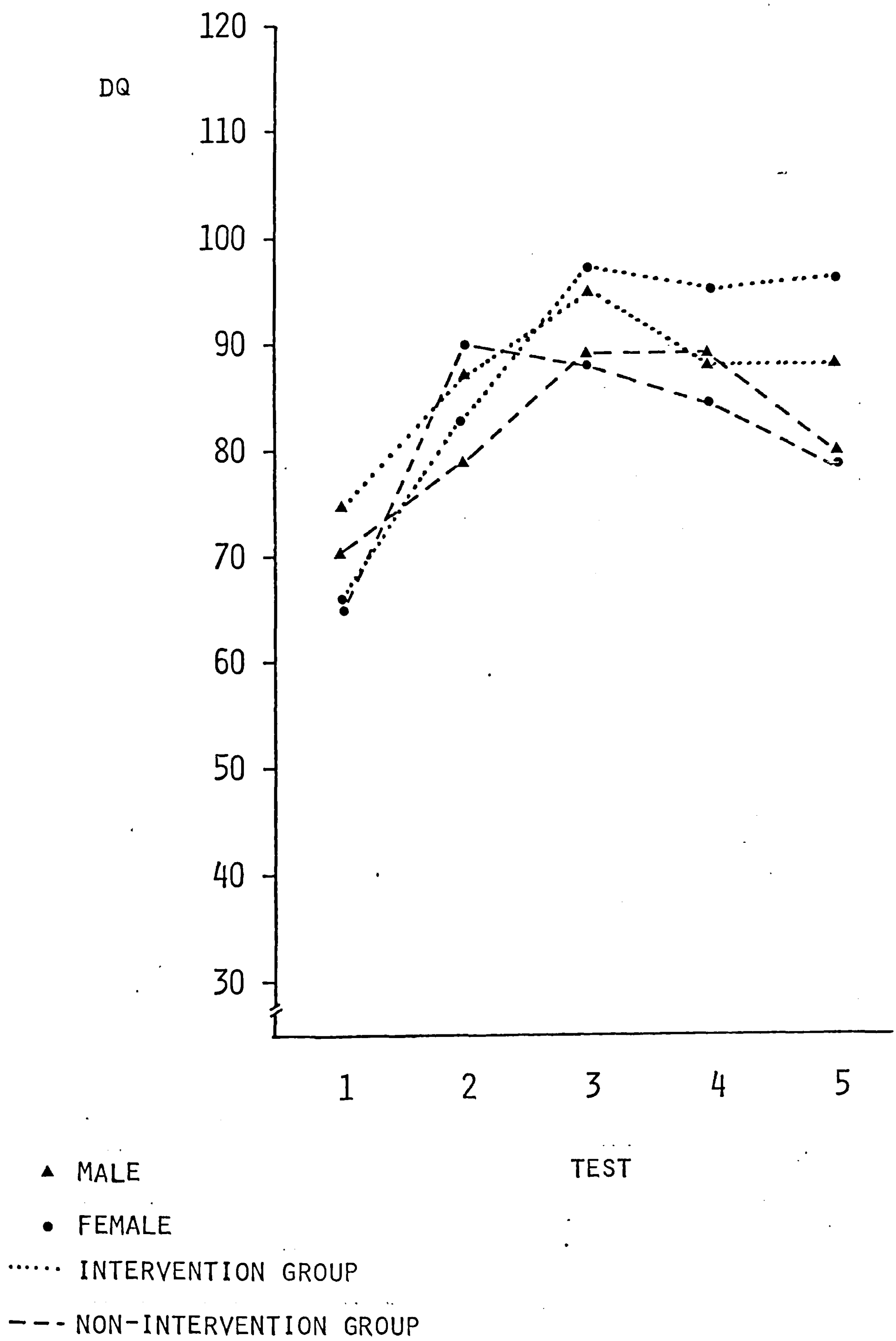
9.1.5 Performance Scale

The mean quotients of the Non-Intervention and Intervention groups on the Performance Scale are shown in Figure 9.7. The pattern of development of the children in both malnourished groups on the Performance scale was unlike the patterns shown in the other subscales of the Griffiths test. In Performance, the Non-Intervention group had a mean gain of approximately 21 points in hospital, but 6 months after discharge the group's mean quotient was only 11 points more than the score that they had achieved at admission. The Intervention children showed a similar pattern. They had a mean gain of approximately 25 DQ points in hospital, but were unable to maintain their scores at this level, losing on average, about 4 points in the 6 months after discharge.

Once the children left hospital, their rate of acquisition of new skills in this area was not sufficient to keep pace with increasing age, and they were thus unable to maintain their discharge developmental levels on returning home. As a group, the Intervention children were only significantly different from the Non-Intervention group at the 6 months post-discharge test, when there was a difference of 12.3 between the mean quotients of the groups ($F=9.6822$, $p=0.0036$).

In the repeated measures analysis of variance on the 5 test scores, the only significant effect was the test

Figure 9.7 Performance DQ
Mean scores of the Malnourished groups divided by sex.



session effect. The group effect was not significant and neither was the effect of sex as the males and females obtained very similar scores. The interactions between group, sex and test were not statistically significant.

The Non-Intervention children showed a gradual decline in their mean scores after discharge from hospital, losing 10 points between Test 3 and Test 5. The Intervention programme, therefore, appeared to have the effect of halting the decline in scores in the Intervention group. Between Tests 4 and 5, the children were developing at a rate equivalent to the test norms, but with a mean score of 91 at each test, the Intervention children were significantly below the standards for their ages. Compared with the Non-Intervention children, however, the Intervention children were showing an accelerated rate of development.

At the fifth test, the girls' performance was slightly better than the boys' (males: mean=88, SD=11.25; females: mean=95, SD=8.16), but this difference was not statistically significant (F=2.4793, p=0.1319).

The performance scale of the Griffiths test relies heavily on 2 sets of apparatus, 'brick-boxes' (3 small painted wooden boxes with lids, each containing 2 cubes of the same colour) and a set of form-boards (single circle and square insets, 2 circles together, circle and square together, and one board with a circle, a square and a triangle). In the second year, 18 of the 20 test items involve these 2 sets of apparatus. 11 of these use the form-boards and together they represent 6½ months of development.

It may be that the intervention programme placed insufficient emphasis on two-dimensional shapes in the earlier stages. In level one, the activities in Scale V Shape centred on sets of nesting cups of different shapes. Activities involving the matching of two-dimensional shapes were mainly concentrated in level two, for children aged 18 months and over.

9.1.6 Behaviour during tests

Co-operativeness with tester

Table 9.6a Cooperativeness with tester
Non-Intervention and Intervention groups.

Mean scores and standard deviations

Test	Non-Intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
1	2.28	(1.13)	2.86	(1.24)	2.3068	0.1373
2	3.56	(1.25)	3.76	(1.04)	0.3164	0.5771
3	4.67	(1.19)	5.43	(0.68)	6.2812	0.0167
4	4.33	(1.33)	4.91	(1.04)	2.2602	0.1412
5	4.56	(1.20)	4.33	(0.187)	0.4528	0.5052

The 2 groups of malnourished children were very similar in their levels of cooperativeness with the tester in all but the third test, the final test in hospital. In repeated measures analysis of variance on cooperativeness at the 5 tests, the only significant effect was that of test session ($F=37.170$, $p<0.000$). The main effects of group and sex were not significant and neither were the interactions.

The Intervention programme appeared to have the effect of making the children more willing to engage in activities suggested by the tester at the test session before the child was discharged from hospital. This is probably a generalised effect as a result of the extra attention given to the

Intervention children by the nurse and CHAs in their daily sessions as well as the possible effect of the increased social activity in the play groups on the wards. It is less likely to be the result of greater familiarity with the testers for the Intervention group than the Non-Intervention group, although it must be acknowledged that this is also a possible explanation.

After a month at home, the level of cooperation in both groups was reduced at the fourth test, though the Intervention boys were more cooperative than the Intervention girls at the 1 month test (F=3.6497, p=0.0721) and at the 6 month test (F=8.8615, p=0.0081).

Table 9.6b Co-operativeness with tester
Non-Intervention and Intervention groups.
Mean scores of groups divided by sex.

Test	Non-Intervention		Intervention	
	Boys	Girls	Boys	Girls
1	2.29	2.27	2.92	3.00
2	3.43	3.64	3.83	3.63
3	4.29	4.91	5.33	5.63
4	4.43	4.28	5.25	4.38
5	4.29	4.73	4.75	3.75

Interest in test materials

Table 9.7a Interest in test materials
Non-Intervention and Intervention groups
Mean scores and standard deviations.

Test	Non-Intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
1	2.50	(1.20)	3.24	(1.58)	2.6291	0.1134
2	3.83	(1.10)	4.24	(1.26)	1.1232	0.2961
3	5.50	(0.99)	5.62	(0.92)	0.1519	0.6989
4	5.44	(0.98)	5.38	(1.16)	0.0333	0.8562
5	5.11	(1.23)	5.33	(1.02)	0.3813	0.5407

The 2 groups of malnourished children were very similar in their levels of interest in the test materials. This was borne out in the repeated measures analysis of variance on scores at the 5 sessions in which the only significant effect was the test session effect ($F=44.729$, $p<0.000$), reflecting the improvement over the 5 sessions.

The Intervention children showed a (non-significant) advantage over the Non-Intervention children at the first test. Although the intervention programme was not started with these children until after the first test, there is the possibility that the changed environment on the wards which resulted from the addition of the play groups for the children could have affected the children's responsiveness to the test material. Once again, in this scale, the boys in the Intervention group and to a lesser extent, in the Non -Intervention group also, appeared to be less affected by the changes between the last hospital test and the first post-discharge test. While the girls' scores decreased between these tests, the boys' scores for interest in test materials increased in this period.

Table 9.7b Interest in test materials.
Non-Intervention and Intervention groups
Mean scores of groups divided by sex

Test	Non-Intervention		Intervention	
	Boys	Girls	Boys	Girls
1	2.71	2.36	3.25	3.50
2	3.86	3.82	4.25	4.00
3	5.14	5.73	5.50	5.75
4	5.71	5.27	5.83	5.88
5	5.14	5.09	5.67	4.88

Non-Intervention: Test 4. F=0.8549, p=0.3689
Intervention: Test 5. F=0.0072, p=0.9336

Vocalisation

Table 9.8a Vocalisation during test
Non-Intervention and Intervention groups
Mean scores and standard deviations

Test	Non-intervention		Intervention		F	P
	Mean	(SD)	Mean	(SD)		
1	1.83	(0.86)	1.91	(0.83)	0.0695	0.7935
2	2.00	(1.09)	2.29	(1.06)	0.6923	0.4107
3	2.78	(0.88)	3.14	(0.73)	2.0183	0.1638
4	2.72	(1.02)	3.19	(0.75)	2.7256	0.1072
5	2.72	(1.07)	2.91	(0.94)	0.3193	0.5754

The Non-Intervention and Intervention groups were also similar on the measure of the amount of vocalisation during the test sessions. There was a tendency for the Intervention children to vocalise more during the third and fourth tests, but neither difference was statistically significant.

In the repeated measures analysis of variance on the Vocalisation scores, as in the analysès on Cooperativeness and Interest in test materials, the test session effect was the only significant one ($F=16.296$, $p<0.001$).

When the groups are divided by sex (Table 9.8b), the Intervention boys show a slight advantage over the other children from the second test, though the differences between the scores of the 2 sexes in the Intervention group are not statistically significant (Test 2: $F=0.1176$; Test 3: $F=0.1479$; Test 4: $F=1.6822$; Test 5: $F=1.0809$; all NS).

Table 9.8b Vocalisation during test
Non-Intervention and Intervention groups
Mean scores of groups divided by sex

Test	Non-Intervention		Intervention	
	Boys	Girls	Boys	Girls
1	2.00	1.73	1.92	1.88
2	1.86	2.09	2.42	2.25
3	2.57	2.91	3.25	3.13
4	3.00	2.55	3.42	3.00
5	2.71	2.73	3.08	2.63

9.1.7 Discussion

In most of the areas that were measured by the Griffiths test, the Malnourished (Intervention) children demonstrated to some degree an accelerated rate of development when compared with the Malnourished (Non-Intervention) children. In general DQ, the Intervention group was significantly ahead of the Non-Intervention group 6 months after leaving hospital, having gradually increased their lead over the 5 test sessions.

In the subscales, the intervention programme was most effective in the Hearing and Speech scale and the Eye and Hand Coordination scale of the test. In the language measure, the Intervention children had a lead of more than 20 points over the Non-Intervention group at the 6 month test, while on the Eye and Hand Coordination scale, the Intervention children with a mean of 101, were 16 points ahead of the Non-Intervention group. In the Performance Scale, the Intervention children did not show the consistent improvement shown in the other 2 scales. However, in the 5 months before the second post-discharge test, the Intervention children achieved a faster rate of development than the Non-Intervention children, whose scores showed a marked decline in this period. Though they only managed to keep pace with the test norms, the Intervention children were significantly ahead of the Non-Intervention children at the 6 month test. Somewhat similarly, in the Locomotor scale, it was not until Test 5 at 6 months post-discharge that the Intervention children began to show a developmental advantage over the Non-Intervention children, but in this case the the difference between the groups was not statistically significant.

There was evidence of a sex difference in the children's response to the intervention. The Intervention girls started with lower scores than the Intervention boys at the first test. The sex difference had largely disappeared by the second test one week later, and it suggested that the poorer initial performance of the girls may be related to the differences in the number of days from admission to first test for the 2 sexes in the Intervention group. The boys in the Intervention group initially required less nasogastric feeding and had fewer of the symptoms that delayed the first developmental assessment of the girls.

The 2 malnourished groups did not differ significantly in the pattern of their physical recovery. In the standardised measures of weight for age (on which the diagnosis of severe malnutrition was made), height for age, head circumference for age and weight for height, the children followed very similar patterns of growth over the period of the study (Figures 7.1 to 7.4) . It is therefore unlikely that the differences between the groups in their Griffiths test performance were due to differences in nutritional status.

On the 3 measures of behaviour during the tests, the Intervention children showed some differences from the Non-Intervention children, particularly in the last test in hospital and the first post-discharge test. For example, as a group, they were more cooperative with the tester than the Non-Intervention children at test 3, and the Intervention boys had the highest scores for Cooperativeness in the 2 groups at test 4. The children in the 2 groups showed some sex differences in their responses to the test situation, though, in general, they were not statistically significant.

As the differences in the behaviour measures favour the Intervention children, there is the possibility therefore that the higher scores achieved by the Intervention group were merely reflecting that these children were more cooperative and interested in the test and vocalised more during the session rather than that their actual abilities and level of performance was of a higher standard. Further analyses were therefore carried out on the DQs of the children to test whether the differences between the developmental levels of the Non-Intervention and Intervention children remained when the differences in the children's responses to the test sessions were taken into account. The 3 measures of behaviour during the tests were used as covariates in analyses of covariance on general DQ and the 4 subscales of the Griffiths test for the 2 groups of malnourished children.

Table 9.9 shows the values of F for the analyses on the raw scores on the general DQ and adjusted for covariates which indicate that the covariates had an effect on the between subjects and the within subjects variance. The covariates reduced the group and the test session effects,

Table 9.9 General DQ

Non-Intervention and Intervention groups.
Analysis of Covariance : values of F.

Source	Raw scores		Adjusted scores	
	F	P	F	P
Group	4.528	0.05	1.162	NS
Sex	0.023	NS	1.353	NS
Group x sex	0.292	NS	0.285	NS
Test session	63.096	0.000	18.840	0.001
Test x group	2.519	0.05	4.700	0.01
Test x sex	1.875	NS	3.091	0.025
Test x group x sex	2.578	NS	5.089	0.001

but increased the interactions of group and sex with test session to significant levels.

In Table 9.10, the mean scores of the boys and girls in the Non-Intervention and Intervention groups have been adjusted for the covariates. The results of this analysis suggest that the advantage in the Intervention boys scores over the Non-Intervention children's scores is closely associated with their higher scores in the measures of their behaviour during the test. In all of the measures of behaviour during the test the boys tended to have higher scores at the post-discharge tests than the girls. In particular, the boys tended to show less fall-off in scores at the first test after discharge from hospital when compared with their last test in hospital.. In contrast, the Intervention girls' advantage in general DQ at the post-discharge tests remained after the scores were adjusted for the behaviour covariates.

Table 9.10 General DQ.

Mean scores adjusted for covariates
(3 measures of behaviour during test).

Test	Non-Intervention				Intervention			
	Boys	(7)	Girls	(11)	Boys	(13)	Girls	(8)
1	71	(+12)	73	(+12)	73	(+4)	65	(+9)
2	74	(+ 7)	80	(+ 5)	77	(-1)	77	(+3)
3	76	(+ 1)	76	(- 3)	76	(-10)	82	(-5)
4	81	(- 2)	83	(0)	82	(-10)	93	(-2)
5	83	(+ 1)	81	(- 1)	85	(- 8)	100	(0)

Change from raw scores is shown in parentheses.

In the analysis of covariance on Locomotor DQs (Table 9.11), the test session effect is decreased. The values of F for test session x sex and the test session x group x sex interaction are increased. In a similar pattern to the effects on general DQ, the covariates had the effect of reducing the mean scores of the Intervention boys, particularly at the discharge and post-discharge tests.

Table 9.11 Locomotor DQ

Non-Intervention and Intervention groups

Analysis of covariance: values of F

Source	Raw scores		Adjusted scores	
	F	P	F	P
Group	0.327	NS	0.166	NS
Sex	0.033	NS	0.624	NS
Group x sex	0.010	NS	0.205	NS
Test session	35.829	0.000	14.402	0.001
Test x group	0.945	NS	1.283	NS
Test x sex	2.816	0.05	3.447	0.025
Test x group x sex	6.631	0.001	8.340	0.001

When the covariates were introduced into the analysis of the Hearing and Speech DQs (Table 9.12), the initial advantage of the Intervention group is removed. When the scores are adjusted for covariates, both Non-Intervention and Intervention groups have a mean score of 49 at the first test. The significant group and test session effects and the significant test session x group interaction remain in the analysis of covariance, but in addition, the test x sex interaction reaches significant levels (F=2.398, df=4.137, p=0.05). The covariates have the effect of reducing the scores of the Intervention boys at tests 3 to 5, with little effect on the Intervention girls' scores at these tests. As a result , at test 5, the adjusted mean for the Intervention girls (100) is 14 points ahead of the Intervention boys (86). However, the boys are still ahead of the Non-Intervention boys at 74 and the Non-Intervention girls at 76.

Table 9.12 Hearing and Speech DQ
Non-Intervention and Intervention groups
Analysis of covariance: values of F

Source	Raw Scores		Adjusted scores	
	F	P	F	P
Group	13.362	0.001	8.438	0.001
Sex	0.115	NS	0.251	NS
Group x sex	2.759	NS	0.734	NS
Test session	80.671	0.000	38.837	0.001
Test x group	3.325	0.025	3.725	0.01
Test x sex	1.755	NS	2.398	0.05
Test x sex x group	1.176	NS	1.784	

In the analysis of covariance on the Eye and Hand Co-ordination DQs, the significant group effect is lost when the scores are adjusted for the behaviour covariates (Table 9.13). The test session effect is also reduced, though it is still highly significant.

Table 9.13 Eye and Hand Co-ordination
Non-Intervention and Intervention groups
Analysis of covariance: Values of F

Source	Raw scores		Adjusted scores	
	F	P	F	P
Group	8.153	0.01	3.902	NS
Sex	0.314	NS	2.842	NS
Group x sex	0.249	NS	0.501	NS
Test session	27.315	0.000	6.104	0.001
Test x group	1.431	NS	2.253	NS
Test x sex	0.198	NS	0.136	NS
Test x group x sex	0.493	NS	1.138	NS

In the analysis of the Performance DQs, adjusting the scores for the behaviour covariates raised the F value for the test x group interaction to statistically significant levels. The adjusted means show a steady improvement in the scores of the girls in the Intervention group from 76 at test 1 to 95 at test 5. The Intervention boys show a similar pattern to the children in the Non-Intervention group.

Table 9.14 Performance DQ

Non-Intervention and Intervention groups.
Analysis of covariance : Values of F

Source	Raw scores		Adjusted scores	
	F	P	F	P
Group	1.287	NS	0.051	NS
Sex	0.001	NS	0.831	NS
Group x sex	0.012	NS	2.065	NS
Test session	17.749	0.001	2.919	0.025
Test x group	1.362	NS	2.611	0.05
Test x sex	1.044	NS	1.566	NS
Test x group x sex	1.323	NS	2.413	NS

When the children's response to the test situation, as measured by the 3 ratings of their behaviour during the test, is taken into account in the analysis of the children's scores on the Griffiths test, the effect is to increase the differences between the girls and the boys on the development measures. It would appear therefore that the intervention programme was more successful with the girls than with the boys in this study. In the tests after the children left hospital, the boys were more cooperative and showed a slight advantage in the other measures. The assumption behind these analyses of covariance is that the 3 behaviour ratings at a given test would reflect a child's level of involvement in the test. If a child's rating for cooperativeness, interest in test materials and vocalisation at a given test were high, it is assumed that this test would provide a more favourable assessment of that child's development, probably with a higher score than on another occasion when the ratings of behaviour were lower. Similarly, if one child had high ratings at a given test, it is assumed that this child is likely to have a higher score than a child who had a poorer test, i.e. a child who had lower ratings for behaviour during the test. The consequence of this assumption is that at each test, the scores of a child with high behaviour ratings would be depressed in the analysis of covariance when compared to a child who had lower behaviour ratings. Because of the advantage shown by the boys on some of the ratings of behaviour during the test, the boys' DQs are therefore depressed relative to the girls' when the DQs are adjusted for the covariates.

In assessing the performance of the Intervention and Non-Intervention children on the Griffiths test, one must therefore conclude that the gain showed by the Intervention girls is probably a more accurate representation of their gains in development than is the case for the Intervention boys. In the case of the Intervention boys, the differences between their behaviour during the tests and the behaviour of the Non-Intervention children and the Intervention girls mean that one cannot be as certain that the higher scores completely represent improvements in developmental level. On the other hand, it can be argued that in the measures of behaviour during the test, a score of 4 or more on Cooperativeness and Interest in objects is likely to represent a good enough test to be an accurate representation of the child's level of ability and that differences above this level would affect the ease with which a test was conducted, but would not necessarily produce differences in the scores achieved. This latter argument would therefore tend to put less importance on differences in behaviour ratings above 4 on the Cooperativeness scale ("Responds to or accepts test materials - neither cooperative nor resistant") and on the Interest in test materials scale ("Interested and actively exploits more than half of test materials"). Since the Intervention children scored, on average, 4 or more from test 2, this would therefore minimise the importance of differences between the sexes in the behaviour ratings at the tests after discharge from hospital.

9.2 INTERRELATION OF SOCIAL BACKGROUND, HOSPITALISATION AND INTERVENTION VARIABLES AND DEVELOPMENTAL LEVELS

At test 5, 6 months after the children left hospital, the Intervention children's general DQs had a range of 36 points, from 78 to 114 with a mean of 96 (figure 9.2). Analyses were carried out on the general DQ scores of the Intervention group to identify those characteristics which best predicted the children's developmental levels at the 6 month test. 3 groups of variables were included in multiple regression analyses on DQ at test 5. These were measures of social background and hospitalisation and assessments of the children's participation in the intervention programme.

The social background measures were standard of housing and mothers' PPVT scores. Lowest weight for age in hospital was used as a measure of nutritional status on admission to hospital and 2 aspects of the child's hospital experience (days from admission to first test and total days in hospital) were also included. The children's participation in the intervention programme was assessed in 2 ways: number of home visits and 'home participation' rating (i.e. frequency of play between visits).

In the first stage of the analysis, the interrelation of these variables was assessed. Table 9.15 shows the correlations between home intervention and development scores in the Intervention group. Tables 9.16 and 9.17 show the interrelationships between social, hospital and development measures in the Intervention and Non-Intervention groups.

Table 9.15 Correlations[a] between home Intervention and development measures in Intervention group.

	DQ at discharge	DQ 6 mths post discharge	Change between tests
Number of visits	0.00	0.06	0.08
Participation rating	0.02	-0.02	-0.06

a Pearson correlation coefficients.

A multiple regression of the 7 variables and DQ at discharge on DQ at the 6 month test was carried out. The independent contributions of each variable and each group of variables was assessed. In further analyses, in addition to the assessment of the contributions to variance in DQ at the 6 month test, the variables were included in multiple regression analyses on the change in DQ after discharge.

Table 9.16 Correlations between DQs at admission, discharge and 6 months after discharge.

Non-Intervention and Intervention groups.

		DQ on admission	DQ at discharge	DQ 6 months post-discharge
DQ at discharge	NI	0.697***		
	I	0.510**		
DQ 6 months post-discharge	NI	0.648***	0.748***	
	I	0.243	0.743***	
DQ change after discharge	NI	-0.059	-0.341	0.368
	I	-0.430	-0.499*	0.210

* $p < 0.05$

** $p < 0.02$

*** $p < 0.01$

Table 9.17 Relationships[a] between social background and hospitalisation variables.

Non-Intervention and Intervention groups.

		DQ (6 mths post dis-charge)	Total days in hospital	Severity of initial illness	Lowest % Wt/ Age in hospital	Standard of housing
Mothers' PPVT	NI	0.480*	-0.267	-0.226	-0.087	-0.021
	I	0.199	-0.551**	0.186	-0.082	-0.142
Standard of housing	NI	0.075	-0.398	-0.061	-0.086	
	I	0.110	0.020	-0.242	0.044	
Lowest % Wt/age in hospital	NI	0.253	-0.451*	-0.146		
	I	0.426	-0.082	0.026		
Severity of initial illness	NI	-0.431	1.188			
	I	-0.066	-0.256			
Total days in hospital	NI	-0.395				
	I	0.066				

a Values of Pearson r

* $p < 0.05$

** $p < 0.02$

In the multiple regression analyses on DQ at 6 months and on DQ change, the most important variables contributing to the explained variance in the scores were DQ at discharge, length of hospital stay and mother's PPVT score. The only independent contribution to DQ variance at test 5 that was significant was DQ at discharge (partial R^2=0.302). Table 9.18 compares the beta weights for the social background, hospitalisation and developmental variables in the mutliple regression equation on DQ at test 5 and DQ change after discharge for the Intervention and Non-Intervention groups. The relative importance of length of hospital stay in both equations in the Intervention group contrasts with the situation in the Non-Intervention group where there are (non-significant) negative correlations between total days in hospital and DQ at test 5 and DQ change as well as low values for the partial regression coefficients in both analyses. This difference is difficult to interpret. Whereas total days in hospital is related to lowest per cent weight for age in the Non-Intervention group (r=0.451, p 0.05), this relationship is negligible in the Intervention group (r=0.082, NS). Conversely, total days in hospital is significantly related to mothers' PPVT scores in the Intervention group(r=-0.551, p 0.02), but not in the Non-Intervention group (r=-0.267, NS). Because the correlations are low and the number of subjects small, no definite conclusions can be made, but there is the suggestion from these analyses of the importance of the intervention during the hospital stay.

Table 9.18 Regression of social and hospitalisation variables and DQ at discharge on (a) DQ 6 months post-discharge and (b) DQ change after discharge.

Standardised partial regression coefficients (beta weights).

Independent Variable	Group	Dependent Variable: DQ (6 months post discharge)	Dependent Variable: DQ change
DQ (discharge)	NI	0.5875	- 0.5698
	I	0.6637	- 0.6012
Total days in hospital	NI	-0.1474	- 0.2088
	I	0.3398	0.4398
Mothers PPVT	NI	0.1047	0.1484
	I	0.2676	0.3464
Lowest Wt Age	NI	-	-
	I	0.1552	0.2009
Housing Standard	NI	-0.0299	-0.0424
	I	0.0957	0.1239
Days to first test	NI	-0.1927	-0.2730
	I	0.0448	0.0580

The measures of home participation did not contribute very much to the analyses. The measures of home intervention were not significantly related to developmental level at the 6 month test. The number of visits and the mean rating for home participation were not found to be related to either DQ at 6 months post-discharge or the change between discharge and the 6 months test. All produced correlation coefficients of less than 0.10.

Generally, the sexes did not differ significantly on the home intervention measures. The only significant difference was on the mean participation rating between discharge and the first post-discharge test. The boys had significantly higher scores than the girls and this may have contributed to any sex differences in behaviour during the first test after discharge. In number of visits, percentage with mother, percentage with nurse and the mean rating over the 6 month period the sexes were not significantly different from each other.

In the 6 months of intervention, the number of visits was significantly correlated with the percentage with mother ($r=0.41$, $p=0.034$) and both number of visits and the percentage with mother were significantly correlated with the participation rating (visits/rating: $r=0.45$, $p=0.022$; % with mother/rating: $r=0.52$, p 0.009). It therefore seems that the implementation of the programme was best when the child's mother was involved.

The absence of a consistent relationship between the number of visits, the ratings of participation and the development of the children was unexpected. It was hypothesised that a larger number of visits and more frequent play as reported to the home visitors would be associated with greater DQ gains. The sum of the participation ratings (in addition to the mean rating) over the period was also found to show no consistent relation to DQ at the 6 month test or DQ change.

There are 2 alternate explanations for this finding. The first is that the quality of the home participation had no effect on the child's performance. The absence of a group who only had intervention in hospital makes it impossible to evaluate this hypothesis in this study. The available evidence from the Lebanese study of McLaren, Yaktin <u>et al</u> (McLaren <u>et al</u>, 1973, McLaren, 1975), which tested such a group 1 year after they left hospital suggests a rapid fall-off in scores without continued intervention. However, because of the differences in the type of intervention as well as the differences between the 2 cultures, the data from the Lebanese study is of limited value on this issue.

Another possible explanation is that the measures of home participation were inadequate as an evaluation of the dynamics of the intervention process and therefore the assessment of the association between them and the children's development would be an insufficient test of the intervention at home. One is inclined to favour this explanation. Number of visits and the 3-point scale of the frequency of play sessions are crude measures. The rationale behind the model of intervention chosen for this study - i.e. home visiting with the family rather than alternatives such as nursery facilities - was based in part on the desire to alter the home environment in ways favourable to the child's development. The aim was to focus the parents' attention on aspects of child rearing and interpersonal relationships which would enhance the total development of the child. A more useful measure of the intervention programme's effects would therefore require a more subtle measure of a range of microenvironmental characteristics of the families. It is probable that a measure such as the HOME inventory (Caldwell, 1967) would have revealed such differences between the groups, but as stated in Chapter 7, it was not thought possible to carry out this assessment in a way that would have produced valid results. The absence of suitable conditions and facilities prevented the inclusion of mother-child interaction measures in this stage of the research project, although they were considered as a possible means of assessing some of the effects of the intervention programme.

It is notable that in the reports of intervention programmes in the United States, most report the assessment of the children on a variety of measures, but do not include assessment of the process of intervention or the means by which the intervention has its effects.

These analyses of the Intervention group's scores and the comparisons with the Non-Intervention group may tend therefore to stress the importance of the hospitalisation variables on the children's development, but to some extent because of the pattern of the children's improvement in development in the 6 month period after discharge from hospital, it must be concluded that the salient features of the home participation in the programme have not been sufficiently assessed. On the basis of these analyses therefore, it is not possible to make a clear prediction of characteristics associated with levels of development near the age norms 6 months after the children leave hospital.

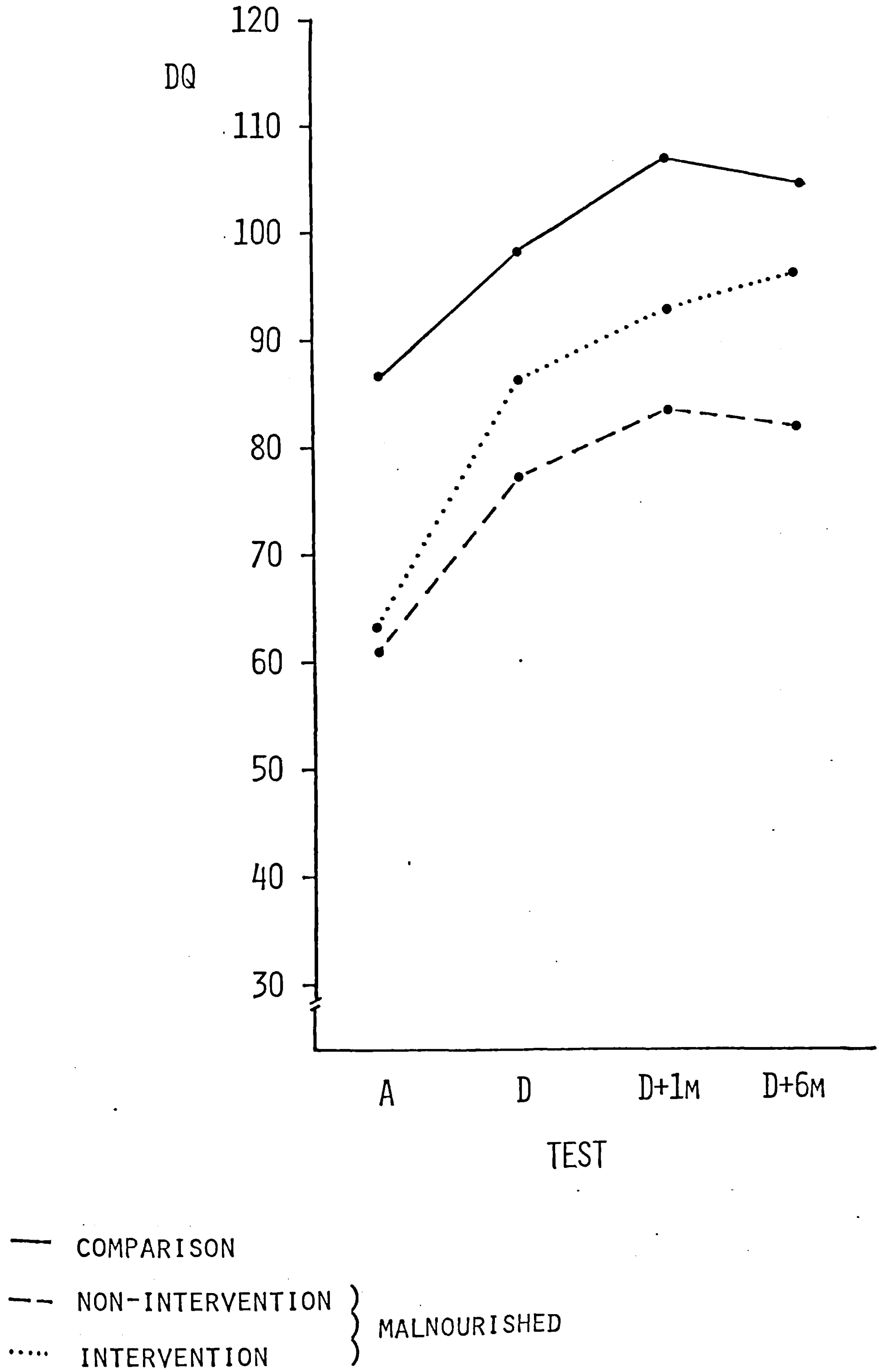
9.3 THE EVALUATION OF THE MALNOURISHED NON-INTERVENTION AND INTERVENTION GROUPS AGAINST THE DEVELOPMENT OF THE COMPARISON GROUP

The Intervention group showed some degree of acceleration in development on the 4 subscales of the Griffiths test and in the General DQ when compared with the malnourished children who had not taken part in the additional behavioural intervention programme. In the Eye and Hand Co-ordination and the Hearing and Speech scales in particular, the Intervention children were developing at a faster rate than the Non-Intervention children in the period after discharge from hospital, many of the Intervention children achieving scores at the levels of the test norms for their ages.

The next stage in the analysis was therefore to compare the 2 malnourished groups to the well-nourished Comparison group to evaluate whether the Intervention children were reaching developmental levels equivalent to the levels of children from similar socioeconomic status backgrounds who had not experienced severe malnutrition.

The 3 groups were compared at 4 test sessions: admission, discharge, 1 month after discharge and 6 months after discharge from hospital. The groups comprised 18 Non-Intervention children, 21 Intervention children and the 14 Comparison children who had at least 2 tests in hospital.

Figure 9.8 General DQs of the 3 groups at 4 tests



9.3.1 General Developmental Quotients

Figure 9.8 shows the mean DQs of the Non-Intervention, Intervention and Comparison groups at 4 test sessions. At the 6 month test, the DQs of the Intervention children were still significantly different from the Comparison children ($t=2.239$, $p=0.033$), but they were also significantly ahead of the Non-Intervention group ($t=3.792$, $p=0.001$).

In repeated measures analysis of variance on the general DQs of the 3 groups (Table 9.19) in addition to highly significant group and test session main effects, the test session x group and test session x sex interactions were significant at the 5% level. The Intervention group showed some catching up with the Comparison children, and the girls appeared to do better than the boys in the Intervention and Comparison groups in particular.

In the evaluation of the development of the 3 groups, further analyses involved the introduction of the measures of the children's behaviour during the test as covariates at each test. As in the previous analyses, the 3 covariates were Cooperativeness with tester, Interest in test material and Vocalisation.

Adjusted for the covariates, the effect of group on DQ variance remained statistically significant, as did the test effect, though the value of F in this case was greatly reduced. The main effect of sex was not significant and neither was the group x sex interaction, but the test

Table 9.19 General DQ

Non-Intervention, Intervention and Comparison groups.

Analysis of Covariance : values of F

SOURCE	Raw Scores		Adjusted scores	
	F	P	F	P
Group	14.036	<0.001	15.612	<0.001
Sex	0.002	NS	0.968	NS
Group x sex	0.057	NS	0.270	NS
Test session	96.216	<0.000	31.497	<0.000
Test x group	2.376	<0.05	3.389	<0.01
Test x sex	2.899	<0.05	6.126	<0.001
Test x sex x group	1.599	NS	3.025	<0.05

session x sex x group interaction (which was not previously significant), test x group and test x sex interactions were significant. The Intervention girls and the Comparison girls achieved higher scores after discharge than the boys in the 3 groups and the Non-Intervention girls, when their scores for behaviour during the test are taken into account (Table 9.20). The Intervention boys show an advantage of 4 points over the mean score of the Non-Intervention boys at the 6 month test, while the girls in the Intervention group are 20 points ahead of the girls in the Non-Intervention group when the scores are adjusted in this way.

Table 9.20 General DQ

Mean Scores adjusted for covariates*

Comparison, Non-Intervention and Intervention groups.

Test	Comparison			Non-Intervention			Intervention		
	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls
Adm.	90	92	86	74	72	74	72	76	66
Discharge	93	95	76	76	76	77	81	79	83
D + 1 mth.	102	99	106	83	82	84	89	85	95
D + 6 mths.	101	99	102	82	84	82	94	88	102

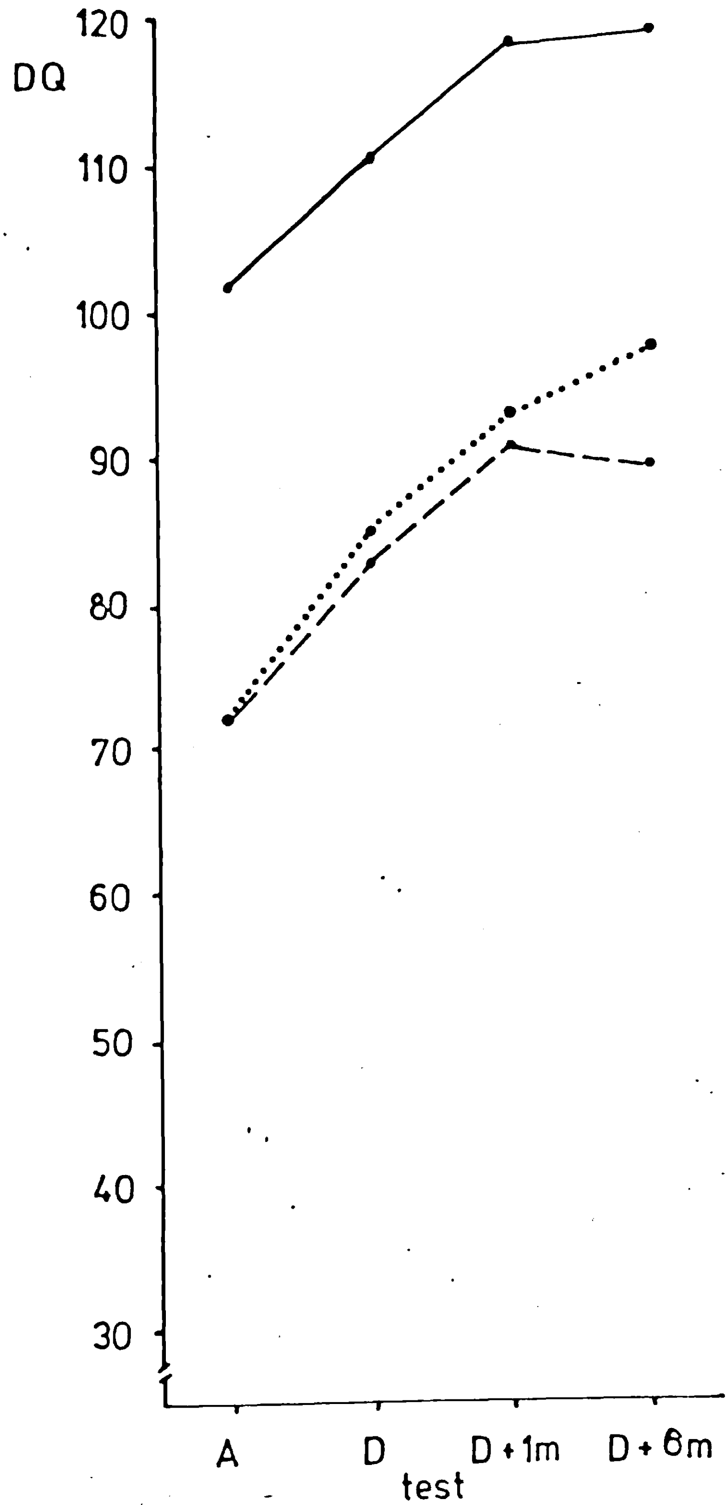
* Covariates at each test:

Cooperativeness with tester.

Interest in test material.

Vocalisation.

Figure 9.9 Mean Locomotor DQs of Comparison, Intervention and Non-Intervention children at 4 tests.



—— Comparison group

- - - Non-Intervention)
)Malnourished groups
······ Intervention)

9.3.2 Locomotor Scale

Figure 9.9 shows the mean DQs of the 3 groups on the Griffiths Locomotor scale at the 4 test sessions. Although there is some acceleration in the development of the Intervention children relative to the Non-Intervention children in the period between the last 2 tests, with a mean DQ of 98, the Intervention children are still significantly behind the Comparison children whose mean DQ on this scale at the 6 month test was considerably above the test norms at 120 (F=11.7073, p=0.0017).

In the repeated measures analysis of variance on the Locomotor DQs of the 3 groups at the 4 tests, the main effects of group and test session were highly significant (Table 9.21). The main effect of sex was not significant, neither was the interaction between group and sex. Test session x group was not significant, but test session x sex and the test session x group x sex interactions were significant, as the Intervention girls who had the lowest scores of all the groups at Test 1 achieved the highest mean score of the malnourished groups at the 6 month test, having gained 44 points between the first and last tests.

When the 3 measures of behaviour during the test are introduced as covariates in the analysis of the Locomotor DQs, the value of F for the test session effect was reduced, but it was still significant at better than the 0.1% level. The other main effects and the interactions

Table 9.21 Locomotor DQ

Non-Intervention, Intervention and Comparison groups.

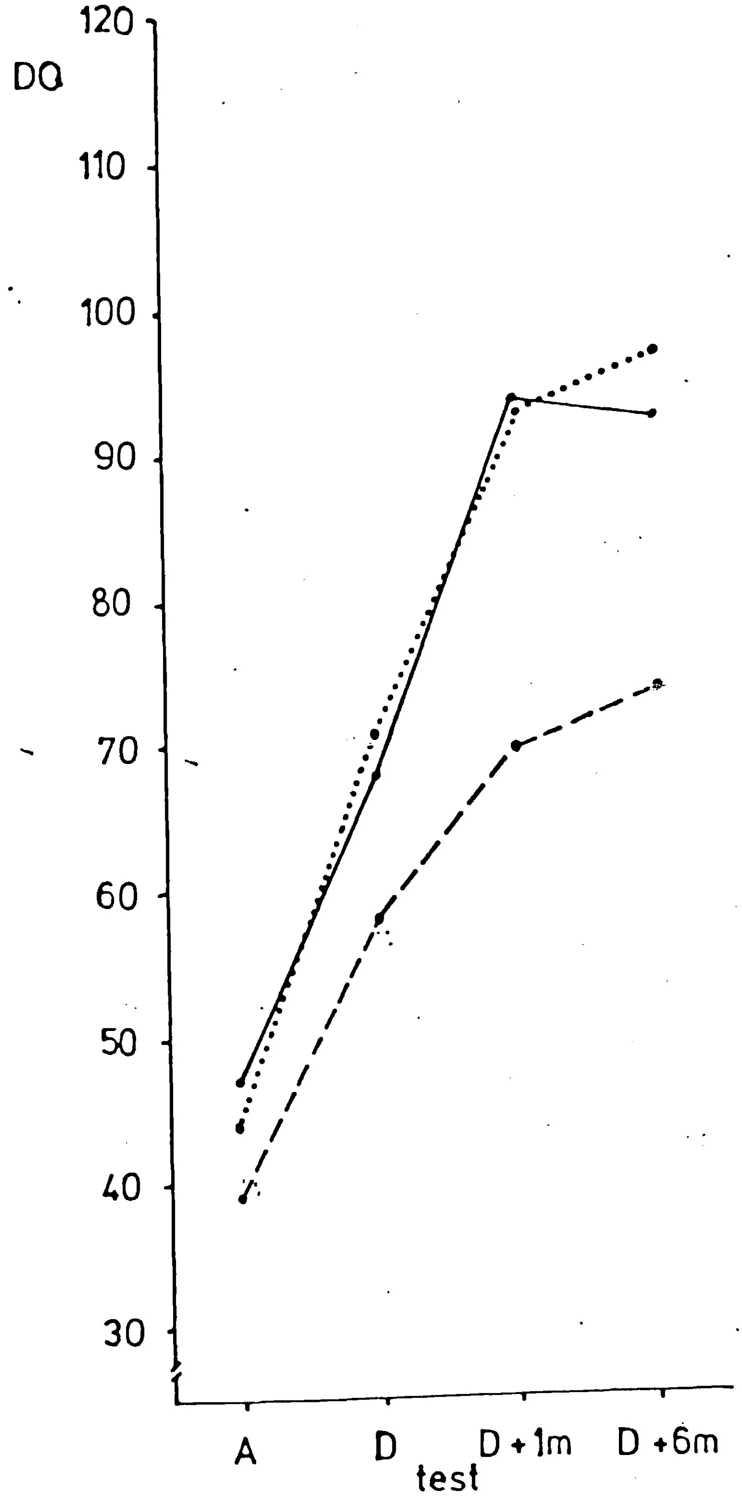
Analysis of Covariance: Values of F

SOURCE	Raw Scores		Adjusted Scores	
	F	P	F	P
Group	14.886	<0.001	13.293	<0.001
Sex	0.010	NS	0.340	NS
Group x sex	0.022	NS	0.372	NS
Test session	50.284	<0.000	21.733	<0.001
Test x group	0.700	NS	0.910	NS
Test x sex	3.224	< 0.05	4.434	<0.01
Test x sex x group	4.205	<0.001	4.893	<0.001

were not significantly affected by the covariates.

In the Comparison group, there were highly significant negative correlations between Locomotor DQ and age at both post-discharge tests as the children's scores declined with age (Test 4: Spearman's r=0.5812, p=0.015; Test 5: r=-0.8274, p=0.0010). This was also the case with the Non-Intervention group, though to a lesser extent (Test 4: r=-0.4549, p=0.029; Test 5: r=-0.3380, p=0.086), whereas in the Intervention group, there was also a negative correlation between Locomotor DQ and age at the first post-discharge test (Test 4: r=-0.3608, p=0.055), but there was a non-significant positive correlation between these measures at the 6 month test (Test 5: r=0.2812, p=0.109). These findings demonstrate further the effectiveness of the intervention programme in accelerating the development of gross motor skills in the Intervention children in the period between the second and sixth month after discharge from hospital, at a time when the scores of the other 2 groups were declining.

Figure 9.10 Mean Hearing and Speech DQs of Comparison, Intervention and Non-Intervention children at 4 tests.



— Comparison group

-- Non-Intervention)
)Malnourished groups
···· Intervention)

9.3.3 Hearing and Speech Scale

The mean scores of the 3 groups on Hearing and Speech at 4 tests are shown in Figure 9.10. The groups were not significantly different from each other at the first test. However, by discharge, the Comparison and Intervention groups were significantly different from the Non-Intervention groups (Groups C and I vs NI: t=2.247, p=0.031), a position main- ined up the 6 month test (t=5.388, p=0.000).

On the repeated measures analysis of variance on the Hearing and Speech DQs of the 3 groups at the 4 tests, the main effect of group was significant, as was the test session effect (Table 9.22). The only significant interaction was test session by group. This pattern was not altered significantly by the addition of the measures of behaviour during test sessions as covariates.

The Intervention children achieved a higher mean DQ on this scale than the Comparison children (I vs C at 6 month test: t=2.239, p=0.033)), but both had means below 100. All the children in the study came from particularly socially deprived homes and language development is an area in which poor children tend to perform at low levels on standardised tests (Chapter 2.6), so the Comparison children can be expected to have depressed scores. As Figures 5.3 and 5.4 show, in their developmental profiles at the 2 tests after discharge, both Non-Intervention and Comparison children have deficits in Hearing and Speech relative to the other subscales of the test. Thus, there

Table 9.22 Hearing and Speech DQ

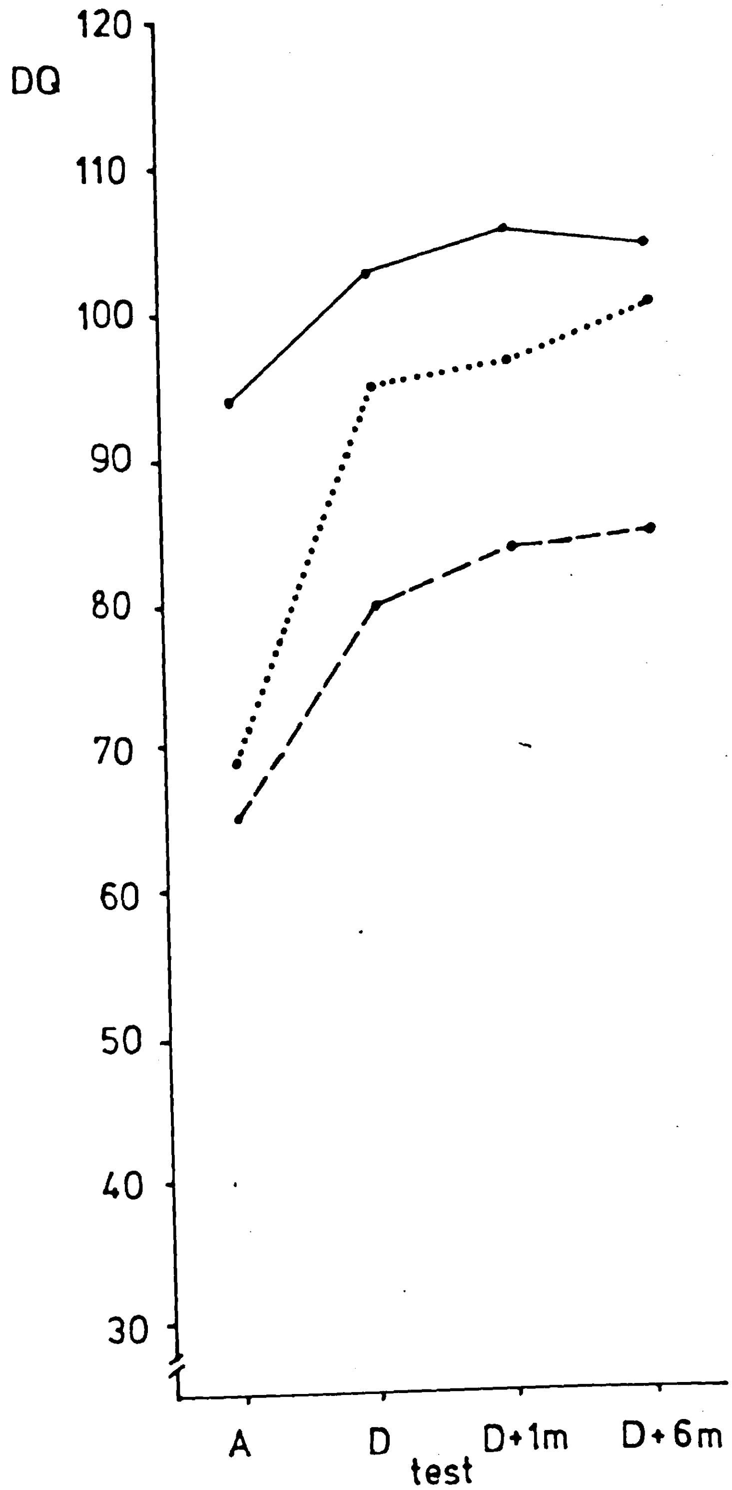
Non-Intervention, Intervention and Comparison groups

Analysis of Covariance: Values of F

SOURCE	Raw Scores		Adjusted Scores	
	F	P	F	P
Group	10.179	<0.001	8.557	<0.001
Sex	0.140	NS	0.547	NS
Group x sex	1.365	NS	0.499	NS
Test session	124.353	<0.0000	68.123	<0.000
Test x group	2.351	<0.05	2.886	<0.025
Test x sex	2.690	<0.025	4.082	<0.01
Test x sex x group	1.472	NS	1.481	NS

is still some room for improvement in the Intervention group although they show a considerable acceleration in language development relative to the Non-Intervention group.

Figure 9.11 Mean Eye and Hand Co-ordination DQs of Comparison, Non-Intervention and Intervention children at 4 tests.



—— Comparison group

--- Non-Intervention group

...... Intervention group

9.3.4. Eye and Hand Co-ordination Scale

Figure 9.11 shows the mean scores of the 3 groups on the Eye and Hand Co-ordination scale at 4 tests. The DQs of the Intervention group at the 6 month test are very similar to the DQs of the Comparison group (t=0.959, p=0.347) and these 2 groups are significantly different from the Non-Intervention group (t=4.360, p=0.000).

In the repeated measures analysis of variance on the DQs at the 4 tests, in addition to significant group and test session effects, there was a significant interaction between group and test session (Table 9.23). There were no significant sex differences within the groups on this measure and the main effect of sex and the interactions of sex with the other variables were not statistically significant.

In the analysis of covariance, this pattern was not significantly changed by the addition of behaviour during test as covariates.

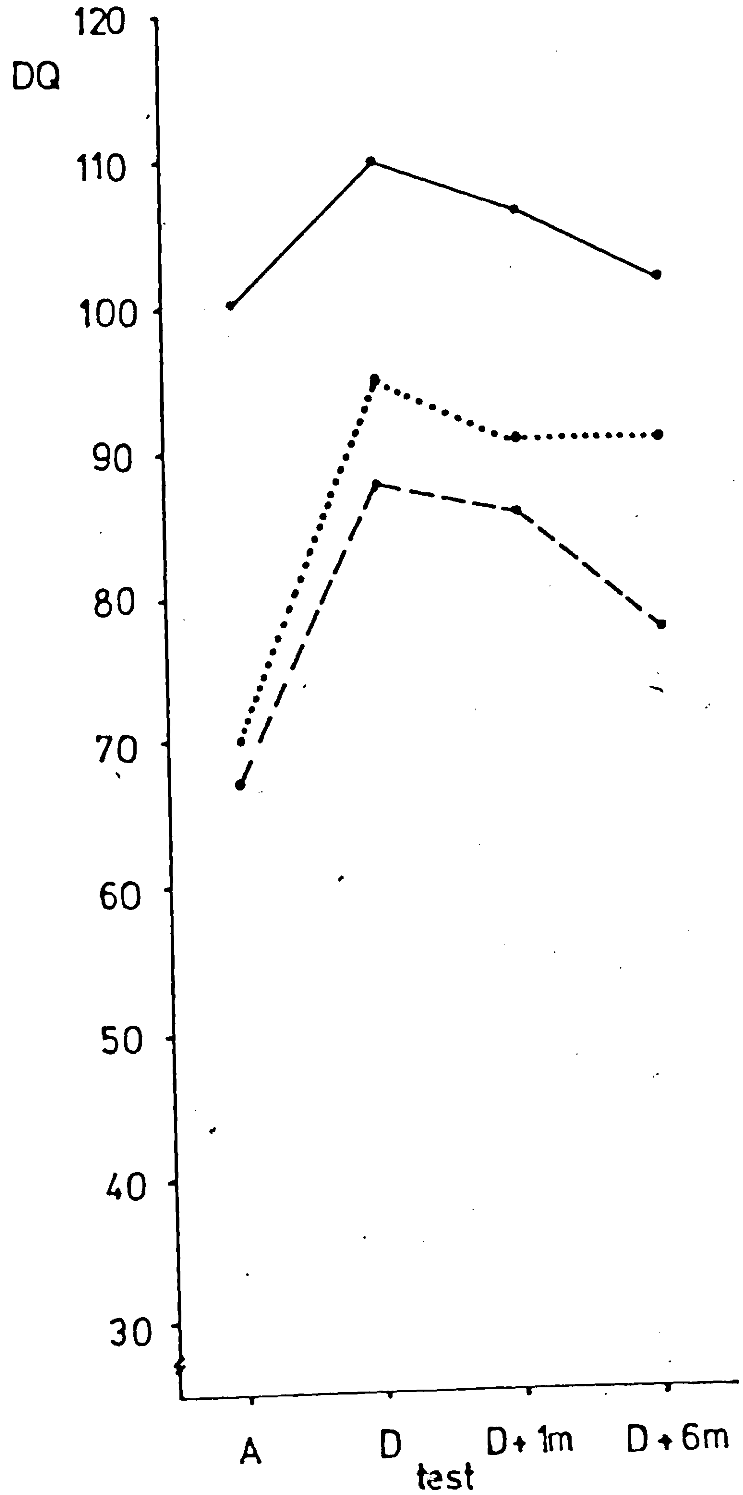
Table 9.23 Eye and Hand Coordination

Non-Intervention, Intervention and Comparison groups

Analysis of Covariance: values of F

SOURCE	Raw Scores		Adjusted Scores	
	F	P	F	P
Group	14.608	<0.001	16.867	<0.001
Sex	0.130	NS	2.164	NS
Group x sex	0.101	NS	0.227	NS
Test session	35.102	<0.000	5.096	<0.01
Test x group	2.358	<0.05	2.363	<0.05
Test x sex	0.272	NS	0.413	NS
Test x sex x group	0.308	NS	0.813	NS

Figure 9.12 Performance DQs of Intervention, Non-Intervention and Comparison children at 4 tests.



—— Comparison group

---- Non-Intervention)
)Malnourished groups
.... Intervention)

9.3.5 Performance Scale

Figure 9.12 shows the mean scores for the 3 groups on the Performance scale for the Griffiths test. By the 6 months test, the gap between the mean scores of the Intervention and Comparison groups had narrowed, but with a mean difference of 11 points, the groups were still significantly different (t=2.966, p=0.006). However, as the Intervention group was also significantly different from the Non-Intervention group (t=3.043, p=0.005), the Intervention programme can be seen to have had an effect.

Both Non-Intervention and Comparison children show a decline in scores after discharge and the narrowing of the gap between the scores of the Intervention and the Comparison children from 15 at discharge to 11 at the 6 month test is a result of a greater loss in the Comparison group (8 points) than in the Intervention group (4 points).

In the analysis of variance on the Performance DQs at the 4 tests, the main effects of group and test session were significant (Table 9.24). The main effect of sex and the interactions were not significant.

When the scores for behaviour during test were used as covariates, the effect of test session was removed though the group effect remained. The value of F for the test x group interaction was very close to significant levels, and the interaction between test x sex was significant in this analysis. Table 9.25 shows the mean Performance DQs adjusted for the 3 covariates for the 3 groups.

Table 9.24 Performance Scale

Non-Intervention, Intervention and Comparison groups.

Analysis of Covariance: Values of F

SOURCE	Raw Scores		Adjusted Scores	
	F	P	F	P
Group	13.498	<0.001	14.230	<0.001
Sex	0.011	NS	0.283	NS
Group x sex	0.143	NS	1.456	NS
Test session	23.455	<0.001	1.301	NS
Test x group	1.854	NS	2.111	NS
Test x sex	1.996	NS	3.523	<0.025
Test x sex x group	0.328	NS	1.243	NS

Table 9.25 Performance DQ

Comparison, Non-Intervention and Intervention groups.

Mean scores adjusted for covariates*

Test	Comparison			Non-Intervention			Intervention		
	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls
Adm.	106	111	99	86	88	83	82	85	79
Discharge	105	101	111	85	89	82	87	85	89
D + 1 mth.	100	98	101	85	87	84	86	80	94
D + 6 mths.	97	94	100	77	81	76	88	82	97

*Covariates at each test = ratings of behaviour during test.

9.3.6. Discussion

Assessed on the Griffiths test 6 months after leaving hospital, the malnourished children who had taken part in the intervention programme were significantly ahead of the malnourished children who had only received the standard nutritional rehabilitation, although they were still significantly different from the well-nourished Comparison group. The performance of the Intervention Children varied across the constituent subscales of the test. The Comparison and Intervention groups had significantly higher scores than the Non-Intervention group by discharge in Hearing and Speech and at the 6 month post-discharge test in the Eye and Hand Co-ordination scale. By the 6 month test, the Intervention children had begun to improve their position relative to the other 2 groups in Locomotor development and in the Performance scale. On the Locomotor scale, possibly because of slow recovery of muscle tissue, the Intervention children did not show accelerated development until after the 1 month post-discharge test. On the Performance scale, the Intervention group failed to show the decline in scores that was demonstrated by the other two groups, but they were unable to improve their scores relative to the norms of the test.

There is some evidence of a cumulative effect in that over the period of the study the Intervention children have gradually improved their position, moving further away from the Non-Intervention group and nearer to the Comparison group in their developmental quotients. In one subscale of the test, Hearing and Speech, the mean score of the Intervention group is higher than that of the Comparison group at the 6 month test.

There is also some evidence of a sex difference in the response of the Intervention children to the programme. When the children's behaviour during the test was taken into account, analysis of covariance had the effect of depressing the scores of the boys in the Intervention group on some of the subscales. This needs further investigation.

The effects of the intervention programme varied across the areas of development that were assessed by the Griffiths test. In general DQ up to 6 months after discharge, the Intervention group gradually increase their lead over the Non-Intervention group as shown in Figure 9.1. By the 6 month test, development in all areas of the test appears to be enhanced in the Intervention group, with the Hearing and Speech and the Hand-Eye Co-ordination scales being the first to show improvement. These results can be compared with 2 other intervention studies with malnourished children which also used the Griffiths test.

Yaktin and McLaren (1970) assessed their study children on the Griffiths scales in their evaluation of behavioural intervention with severely malnourished Lebanese children.[a] They also report that Hearing and Speech and Eye-Hand Co-ordination were the first scales on

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a Chapter 2.4.4

which significant differences between Experimental and Comparison children were obtained, with significant differences at one test on the Personal-Social scale. However, these gains proved to be "envanescent" (McLaren, 1975).

In a recent report on the Bogotá intervention programme with moderately malnourished children (Mora et al, 1979), Griffiths DQs between 4 and 18 months are reported.[b] Here, behavioural intervention had most effect on Hearing and Speech, also affecting the Personal-Social scale, while nutritional supplementation significantly affected 4 of the 5 subscales - particularly Locomotor and Performance, with Personal-Social and Eye and Hand Co-ordination affected to a lesser extent.

The present study did not include systematic nutritional supplementation for the malnourished children after they left hospital. All children, malnourished and well-nourished, received any food supplements that were available from the clinics. For the 2 groups of malnourished children, the programme of nutritional rehabilitation was terminated when the child was discharged from hospital, although the mothers were given nutrition advice by the medical staff. Mora's team found that supplementation appeared to affect all but the language scale of the test, but was particularly effective in enhancing Locomotor development, a scale on which the Intervention group in the present study were slow to show gains over the Non-Intervention group. The Intervention children's gains in Hearing and Speech are consistent with the other studies.

b. Chapter 2.4.7

The Intervention programme emphasised the development of language, an area shown to be particularly at risk.

The longitudinal study continues and will provide further data on the development of the 3 groups. It will also be important to monitor the development of the Intervention group after the termination of intervention programme.

CHAPTER 10. CONCLUSIONS

This study of the development of malnourished and well-nourished Jamaican children contributes to our understanding of the aetiology of the mental retardation that has been reported in the survivors of malnutrition. It also offers a model for the addition of behavioural intervention to the existing pattern of physical and nutritional rehabilitation of severely malnourished children in hospital.

In Chapter 2, research was reviewed which provided evidence of distortion and deficit in the brains of malnourished individuals as well as aberrant behaviour in currently malnourished and previously malnourished animals and humans. It is often difficult to disentangle nutritional and non-nutritional influences on development, but in the studies of malnutrition in humans, it has been a fairly consistent finding that previously malnourished individuals perform poorly on tests of development or cognitive ability when compared with other groups within their communities.

In the first phase of this study, malnourished children receiving standard nutritional rehabilitation were compared with well-nourished children being treated in the same hospital. In developmental assessments on the Griffiths Mental Development Scales, the main finding was that the malnourished and well-nourished children were significantly different from each other in the levels of their DQs, but that they followed similar patterns of change in DQ while in hospital and in the 6 months after discharge. In hospital, both groups showed a marked increase in scores, leading to the conclusion that it was not improvement in nutritional status <u>per se</u> that caused these changes in DQ, but factors common to both groups such as the more general recovery from illness, with changes in responsiveness to the test situation playing a part. The Malnourished (Non-Intervention) children were of similar ages to the Comparison children, but the former group consistently performed at levels well below their chronological ages. After discharge however, the Non-Intervention children were able to keep pace with the Comparison children in the rate of development. The Comparison group's scores began to fall off relative to the test norms as the children got older, a pattern which was also followed by the Non-Intervention children. It is suggested that this decline in scores reflects the effects of the deprived homes in which the children live. The 2 groups of children's scores on the HOME inventory indicated that all of the children came from homes deficient in the kind of activities and amenities which are thought to facilitate optimal development.

One theory about the aetiology of mental retardation in formerly malnourished children, originating in the animal research of Levitsky and Barnes at Cornell University (Levitsky and Barnes, 1972; Levitsky, 1979a), proposes that it may not necessarily be that structural damage to the brain prevents adequate learning, but rather that malnutrition interferes with the developmental progress of the individual by reducing the opportunities for such learning. Distortion and deficit in brain tissue may be the cause of this interference which 'functionally isolates' the malnourished individual from his environment, but other factors such as the more direct effects of energy deficits may also be responsible.

The finding that the malnourished children in the Non-Intervention group showed developmental progress equivalent to the well-nourished Comparison children would tend to suggest that the actual learning capacity of the children may not have been reduced to any great extent. This conclusion must however be tentative as the children in the Comparison group are apparently functioning at sub-optimal levels themselves. Both groups returned home to environments lacking many of the characteristics that would facilitate optimal development. The malnourished children showed a generalised retardation across the 4 subscales of the Griffiths test, and there was no evidence of any area being particularly affected.

The observations of the children's behaviour in hospital provided some information about their interaction with the environment. The qualifications due to the hospitalisation on the behaviour of young children cannot be ignored. However, there is no reason to expect that hospitalisation should affect the 2 groups of children differently. Differences in their behaviour in response to hospitalisation are therefore of some value and one can speculate that initial differences in behaviour may be related in some consistent way to the behaviour of the children in the period immediately preceding admission to hospital. For reasons already explained (see Chapter 6), it is unlikely that more direct information about the behaviour of severely malnourished children before nutritional rehabilitation will ever be obtained.

The evidence from the behaviour observations is that the patterns of play shown by the malnourished and the well-nourished children are significantly different in ways which support the hypothesis that the malnourished child's interaction with the environment is reduced. The malnourished children performed fewer play actions on fewer toys than the well-nourished children. The malnourished children also used smaller repertoires of actions when they played with the toys. The differences in play were not merely a reflection of differences in developmental level between the groups. The inference from these results is that the malnourished children were less thorough in their investigation of the play material. The assumption is that a child who played with a larger number of the toys and performed a wider range of actions would be in a position to gain more information from the period of play than a child who performed fewer actions on fewer toys. The general picture that emerges from the data presented in Chapter 6 is of a malnourished child who is less demanding than the well-nourished child, with reduced interaction with the objects in his environment. If this is assumed to be representative of the behaviour of the children in the period at home before admission to hospital, it seems a reasonable hypothesis that the malnourished child's behaviour could have contributed to his relative retardation. Furthermore, with nutritional rehabilitation many of the differences in play disappeared and the recovered malnourished child could progress at a rate that was normal for his/her social class.

The findings from the first phase of the study suggest that behavioural intervention during nutritional rehabilitation and the months thereafter could be of some value to the malnourished children and could help to reduce the developmental deficits between them and the well-nourished group. The intervention programme's curriculum was designed in an attempt to provide for the participating children a range of experiences structured to facilitate accelerated progress in cognitive development (Chapter 8.1). The results up to 6 months after discharge from hospital show that participation in this type of behavioural intervention as a part of the treatment of malnutrition can produce rates of development in formerly severely malnourished children which enable them to catch up in some areas with their well-nourished peers by 6 months after discharge.

10.1 LONG-TERM FOLLOW-UP OF NON-INTERVENTION AND COMPARISON GROUPS: IMPLICATIONS FOR INTERVENTION GROUP.

During the period of phase 2 of the study, the Comparison and Non-Intervention children were tested at 12, 18 and 24 months after they left hospital. Mean scores are shown in Table 10.1. The Comparison children show a decline in scores over the 2 year period. In approximately 24 months between the first and fifth test after discharge, the Comparison group's mean general DQ fell from 107 to 94, a loss of 13 points. In the same period, the mean DQ of the Non-Intervention group only declined by 4 points, from 83 to 79. The Non-Intervention children's scores change little between the third and the fifth post-discharge test, and in both groups there appears to be a levelling off of scores during the second year of the follow-up period. It would seem therefore, that although the initial mean difference between the groups is reduced in the 2 years after the children leave hospital, the evidence suggests that the 2 groups will remain significantly different in DQ. The long-term follow-up of the groups continues, so further information will be available about the development of the children.

6 months after discharge from hospital, the mean general DQ of the Intervention group was 96. If the Intervention children are able to maintain a rate of development equivalent to the norms of the test for the

Table 10.1 General Developmental Quotient.

Mean scores of Malnourished (Non-Intervention) and Comparison groups after discharge from hospital.

Time of test (Mths. after discharge)		Non-Intervention* Mean	(SD)	Comparison Mean	(SD)
1 month	Age**	15.3	(4.52)	14.1	(4.76)
	DQ	82.7	(11.7)	106.5	(11.4)
6 months	Age	20.7	(4.54)	19.3	(4.76)
	DQ	81.8	(12.1)	104.8	(11.2)
12 months	Age	26.6	(4.45)	25.3	(4.84)
	DQ	80.5	(10.4)	98.4	(10.3)
18 months	Age	33.0	(4.47)	31.6	(4.57)
	DQ	78.0	(8.6)	94.7	(8.6)
24 months	Age	39.9	(4.07)	38.1	(4.13)
	DQ	79.1	(10.5)	94.3	(11.2)

* In Non-Intervention group, sample size is reduced from 18 to 17 from the 12 month test because of the unavailability of 1 child for subsequent tests. Comparison group N= 14.

** Ages are expressed in months.

succeeding 12 months, they would not be significantly different from well-nourished children of the same age and social class. In other words, if the intervention programme achieves nothing more than to prevent the decline of scores that is shown by the Comparison children and to a more limited extent, the Non-Intervention children, it would have the effect of making formerly malnourished children indistinguishable from the well-nourished Comparison children in general DQ. In fact, in Hearing and Speech, Eye and Hand Co-ordination and Performance, the Intervention children had higher mean scores at 6 months post-discharge than the Comparison children achieved 6 months later, though these differences were not statistically significant (see Table 10.2).

The question remains about the performance of well-nourished children equivalent to the Comparison group with behavioural intervention. Unfortunately, this project did not include intervention with well-nourished children. The original design included 2 groups of children in phase 2, with behavioural intervention for all the children during their stay in hospital and terminating at discharge. Because of the short duration of hospitalisation characteristic of the well-nourished children in phase 1, it was decided to omit this group in phase 2 before it was known that further research funds to continue the project and Community Health Aides from the Ministry of Health would make an extension to include home visiting possible.

The absence of a well-nourished Intervention group means that there is no information about how a group

Table 10.2 Subscales of the Griffiths Test.

Mean scores of Malnourished (Non-Intervention) and Comparison groups after discharge from hospital.

Test	Group	Locomotor	Hearing & Speech	Eye-Hand	Performance
1 month	NI	91	70	84	86
	C	119	94	106	107
6 months	NI	90	74	85	78
	C	120	93	105	102
12 months	NI	84	70	76	74
	C	113	92	96	90
18 months	NI	85	71	74	65
	C	113	93	93	81
24 months	NI	88	73	73	65
	C	117	90	88	81
Intervention group at 6 months post discharge					
		98	97	101	91

equivalent to the Comparison group would have performed with behavioural intervention. It must be assumed that the scores of such a group would also have been higher than those of the comparable group in Phase 1. In the long-term therefore, for behavioural intervention with the malnourished children to be completely successful, the Intervention group will have to achieve higher scores than the Comparison group. From data from the previously reported intervention programme with 3 year old children in Kingston (Grantham-McGregor and Desai, 1975) and the decline in scores shown by the Comparison group in the follow-up period in this study, one may speculate that the performance of the Comparison group could be improved by behavioural intervention. Socioeconomic data from the previous study are not presented in a form that allows comparison, so one cannot be certain of the groups' similarity. However, when the DQs on the 4 sub-scales of the Griffiths test used in both studies for the Comparison group and the previous Kingston sample are compared, they are found to be very similar. Before intervention, the Kingston sample had mean DQs of 90 and 92 in the 2 study groups compared to the mean of 88 for the Comparison group in this study at a similar mean age. Grantham-McGregor and Desai's programme produced a mean DQ gain of 10 points,[a] so this figure may be taken as an indication of the possible effects of intervention with well-nourished children similar to the Comparison group in the present study.

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a See Chapter 3.2.1

10.2 SUGGESTIONS FOR FUTURE RESEARCH

The developmental data obtained on these 3 groups of children in this four year study are consistent with theories of the aetiology of mental retardation in malnourished children which stress the role of the individual's interaction with his environment. With the introduction of a comparatively limited programme of play activities, the severely malnourished children in the Intervention group begun to achieve levels of development similar to well-nourished children from similar homes. As far as the programme for the Intervention children is concerned, these early results suggest that if the pattern of development achieved up to 6 months after leaving hospital can be maintained, the survivors of malnutrition may not be developmentally inferior to their peers at school age as has been the case with other children with similar nutritional histories who received the standard treatment.

This study is only a preliminary investigation of the effects of behavioural intervention on severely malnourished children. Developmental quotients on the Griffiths test are in fact relatively crude measures of psychological development of the children. In chapters 2 and 4, the limitations inherent in the use of standardised tests such as the Griffiths scales in studies of malnourished children were discussed. Recent papers, notably by Pollitt and Thomson (Pollitt and Thomson, 1977; Thomson and Pollitt, 1977) and Irwin and colleagues (1979), have stressed the need for the use of tests in which the construct and normative validity within a given community have been established. The construct validity of the test is probably less of an issue when standardised tests of development are used with young children than when older children are being tested, although it is known that the norms may be inappropriate when used cross culturally. As the children get older, however, it will probably be of more value to investigate more specific cognitive processes than to assess the children on general scales of development.

From the earlier study of survivors of severe malnutrition in Jamaica, Richardson (1976) concluded retrospectively that children who "had a life history which (was) favourable for intellectual development" could perform at school age at levels equivalent to children who had not experienced severe malnutrition.* Furthermore, survivors of malnutrition from the most favourable homes could perform at levels superior to the comparison children from the most unfavourable homes. Further elaboration of this issue was not possible from Richardson's study as no data were available on the developmental levels or home environments of the children during or immediately after the acute episode of malnutrition.

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* See Chapter 2.4.3.

There are other areas in which the present study can be developed, including as it does a well-nourished Comparison group with experience of hospitalisation as well as 2 groups of malnourished children with and without the experience of behavioural intervention. One area of the development of the Intervention group up to 6 months particularly requires clarification. The improvement in the scores of the Intervention group was not as rapid in the Locomotor and Performance scales as in the other 2 scales. It has been suggested, based on the work of Hansen-Smith (1977), that the slow recovery of muscle tissue could be responsible for the delay in Locomotor development progress. The delay in Performance is more difficult to explain, though it might be related to the curriculum of the intervention programme. There is the possibility, however, that the delay in the response on the Performance scale is due to a specific deficit in the children. There is the suggestion in the literature that visuo-spatial skills are adversely affected by malnutrition, though alternative explanations stressing perceptual and/or attentional deficits have been proposed. The subsequent development of the Intervention children on the Performance scale is being monitored, and this may clarify the issue, but additional assessment of visuo-spatial skills in the 3 groups would be of particular value.

Level 2 of the curriculum of activities includes activities involving the integration of information from different sensory modalities (see Appendix II: second level scale III Problem solving). These groups also offer the opportunity to investigate the suggestion by Cravioto and DeLicardie (1970) and others that formerly malnourished children are deficient in the development of cross-modal integration.

Although in perceptual tasks with young children it is frequently difficult to discern the precise cause of a child's failure on a given task, as has been demonstrated by Bryant's series of experiments (e.g. Bryant, 1974), it would be useful to try to disentangle such factors as response speed, attention and short term memory from the children's ability to make perceptual discriminations and recognition.

The introduction of behaviour during tests as covariates in the analyses of the DQs of the Intervention group had a differential effect on the scores of boys and girls. This type of differential effect has been previously reported in intervention programmes. For example, from Gordon's Florida study, Scott and Lally (1969) reported significant sex differences in the response to behavioural intervention in children tested on the Griffiths Scales. They found that female infants showed improvement in more of the Griffiths subscales than did male infants, a finding which is in line with the present study. This suggestion of a sex difference in the response to intervention is another area which requires further investigation.

If reduced interaction with the environment during the period of nutritional deprivation is an important factor in the poor cognitive development of severely malnourished children, the Intervention children should be significantly different from the Non-Intervention children and similar to the Comparison children in their performance on cognitive tasks at school age. The data reported here support the theory that severely malnourished children are not necessarily unable to develop normally, but that the experience of malnutrition slows down this process. If no extra effort is made to help the children to make up the "lost learning time" (Latham, 1974) they will develop normally after their recovery from malnutrition, but will remain significantly behind children who did not have this early interference in the course of their development. Formerly malnourished children generally appear to show what Lavallée et al (1979) termed "a slight delay in development rather than a qualitative change in the cognitive structure". These data should move us further along the road away from the rather simplistic theories of brain damage directly resulting in intellectual deficit.

In this study, even within the narrow limits of the socioeconomic selection criteria, the well-nourished children showed certain advantages over the malnourished children. This brings us back to the issues raised at the beginning of this thesis. Both groups of children - malnourished and well-nourished - were living in conditions known to be associated with poor development. The malnourished children had the additional disadvantage of an insufficient supply of the nutrients that they need for healthy development. The study of malnourished children provides much information about the way young children develop physically and psychologically and about the environmental influences on such development. However, this is a line of investigation that one would wish to see come to an end, not because of lack of interest on the part of psychologists, but because of the absence of a population to study. As stated earlier, malnutrition is neither a medical nor a psychological problem, it is a political one. In addition to making every effort to improve the treatment of malnourished children, everyone working in this area has the obligation to also work towards the eradication of what has been known for some time to be the largest preventable health problem facing the world.

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APPENDIX I

Rating of standard of housing

		SCORE
CROWDING -	Number of people per room.	
	1 - 3	3
	4 - 5	2
	6 or more	1
TYPE OF LAVATORY		
	inside flush toilet	3
	outside flush toilet	2
	pit latrine	1
TYPE OF WATER SUPPLY		
	Exclusive use, indoor tap	3
	shared, indoor tap	2
	outside tap	1
STATE OF REPAIR OF BUILDING		
	satisfactory	3
	poor	1

Jamaican modification of Bettye Caldwell's Home Observation for Measurement of the Environment.

Date.............. Home Inventory Study No.

Child's name Sex

Child's D.O.B. Age

Name of Mother/Guardian

			Correct	Incorrect
1.	(i)	Does mother live with child.		
2.	(i)	When mother or guardian is away who looks after child (If more than 2 regular adults or child under 14 years Score No).		
3.	(vii)	Does baby see a lot of another grown-up person, other than mother or guardian, father, sibling, and is he fond of them.		
4.	(vii)	Does any grown-up person visit you at home. If yes how often. (At least once every other week) Score Yes.		
5.	(vii)	How many grown up people have visited here in the week, while baby was awake (2 or more Score Yes).		
6.	(v)	Have you attended church in the last 3 months?		
7.	(v)	Are you a member of an association or have you attended a meeting of any level in the last 3 months?		
8.	(i)	Have you moved in the last 12 months. (If more than once score No - once or less score Yes).		
9.	(i)	Has child been separated from mother or guardian for more than 3 weeks, (excluding recent hospitalisation) on more than 1 occasion.		
10.	(i)	How often does father or father figure help with looking after child (if less than 4 days a week score - No).		

			Correct	Incorrect
11.	(i)	Does family eat together with mother and father and is child included at least once a day, on most days (one-parent families - No).		
12.	(iii)	Does parent chat (make conversation) with child while she is doing her household work. e.g. washing.		
13.	(i)	Does child have a special place to keep play things (not clothes). Can count a place shared with other children.		
14.	(v)	Do you have a radio? How often do you have it on? (No radio, or on most of time Score No).		
15.	(v)	Family buys at least one magazine frequently. (Comics, love books, Jehovahs Witness).		
16.	(v)	Parents buy a newspaper at least twice a week and read it.		
17.	(ix)	3 children's books are in the homes (if siblings present) 1 children's book if only child. (Do not count school books).		
18.	(vi)	How often do you love up baby. (If at least 15 mins. per day - Score Yes).		
19.	(ii)	Does mother show and comment on pictures in magazines or books at least once weekly.		
20.	(ii)	Do you often teach child to call the name of things.		
21.	(ix)	Do you have any musical instrument or toy (tambourine, drum, guitar, bells).		
22.	(iii)	Do you sing to child.		
23.	(ii)	Do you play "clap hands" with child.		
24.	(ix)	Is there anything at all that you give the child to play with other than toys. e.g. talc tin.		

			Correct	Incorrect
25.	(ii)	Do you teach child to wave bye bye.		
26.	(ii)	Do you play hide and seek (peek a boo) with child.		
27.	(ix)	Do you have any building toys (Blocks, home made wood offcuts boxes, lego, stacking, nesting toys).		
28.	(ix)	Do you have any plaything which requires baby to use his hands (shaker , under 12 months, squeezy doll, crayons, pencils, beads, items to go in and out of receptacle).		
29.	(iv)	Do you let child play with messy things - water, dough, dirt, sand (not count bath time).		
30.	(iv)	Is there a small table, chair, stool, playpen or other substitute for child in home.		
31.	(ii)	Does parent play any finger and toe game.		
32.	(ii)	Does mother let child "help" her when she is doing household work i.e. washing, polishing.		
33.	(ii)	Does mother spend time playing with child's toys with child (include junktoys) if no toys - Score No.		
34.	(iv)	Family has at least one pet (count fish, fowl).		
35.		________		
36.	(ix)	Child has push along or pull along toy, doll's prams.		
37.	(ix)	Child has a large muscle toy like big ball, swing, climbing object or bicycle.		
38.	(ix)	Do you have any toys with small sized wheels - trucks, train, car?		

			Correct	Incorrect
39.	(ix)	Is there a cuddly toy (stuffed animal or doll), or dressing-up toy, in the home?		
40.	(iv)	How many times has the child been physically punished in the past week? (One or none: Score yes. More: score no).		
41.	(vii)	Does someone take child to grocery shop? If so how often? (If at least twice a week, score yes.)		
42.	(vii)	Does family member ever take child on an outing (eg. Hope Gardens, Seaside, picnic, shopping excursion). If so how often? (If at least once every other week score yes.)		
43.	(vii)	Has child been taken by family member to the airport within the past year?		
44.	(vii)	For a trip of more than 25 miles from his home.		
45.	(v)	Family visits or receives visits from a relative at least once a month.		

<u>The following items are to be observed in the home during the interview:</u>

46.	(iii)	Mother begins conversation with visitor, asks questions, makes spontaneous comments.		
47.	(iv)	Mother does not interfere with child's actions or restrict child's movement more than once during visit.		
48.	(iii)	Mother answers questions well.		
49.	(iii)	Mother's speech is distinct, clear and audible.		
50.	(iii)	Mother spontaneously talks to or vocalises to child at least twice during visit. (Commands and scolding - not counted).		

			Correct	Incorrect
51.	(iii)	Mother usually responds verbally to child's talking or babbling.		
52.	(iv)	When speaking of or to the child, mother's voice conveys affection and warmth.		
53.	(ii)	Did mother provide toys or other interesting activity or in other way structure the situation for child during visit when her attention will be elsewhere? (To score yes, mother must make an active, guiding gesture or suggestion to structure child's play).		
54.	(iii)	Mother tells child the name of something or event or person during visit in a teaching style.		
55.	(vi)	Mother introduces Interviewer to child.		
56.	(vi)	Mother keeps tabs on child's whereabouts by brief physical checks while he is playing in another room or looks at him often if nearby.		
57.	(vi)	Mother appears pleased when visitor praises child.		
58.	(vi)	Mother kisses and cuddles child or strokes head at least once during visit.		
59.	(iv)	Mother does not express over-annoyance with or hostility toward child, complain, say child is 'bad' or trouble-some or won't hear. (If she does any of these, score no).		
60.	(iv)	Does mother threaten or give intense commands, or shout at children during visit? (If yes, score no).		

			Correct	Incorrect
61.	(iv)	Does mother scold or derogate child during visit? (If yes score no).		
62.	(iv)	Does mother slap or spank children during visit? (If yes, score no)		
63.	(vi)	Does mother spontaneously praise child's qualities or behaviour once during visit?		
64.	(viii)	All visible rooms are reasonably clean and tidy.		
65.	(viii)	Is the child reasonably clean and tidy.		
66.	(viii)	Is the building or yard potentially dangerous to child? Include kitchen. (If yes, score no).		
67.	(viii)	Is the yard reasonably clean and tidy?		
68.	(viii)	Apartment has at least two pictures or other type of art work on wall.		
69.	(viii)	Family has at least one house plant, or plastic flowers.		
70.	(viii)	At least four books are present and visible in apartment.		

This inventory was developed after the piloting and modification of the fourth version of the Home Observation for Measurement of the Environment (Caldwell, 1970). Modifications were made because of the ages of the children being studied, or because they were inappropriate for the culture (e.g. restrictive clothing) or the social class of the families (e.g. telephone and television ownership, number of books in the home).

DATE:

SCORING FOR QUESTIONNAIRE

Child:........................No.........Address:..............

Age.............Sex.........Name of Mother/Guardian............

I.	1	2	8	9	II.	23	25	26	31
	10	11	13			32	33	53	
	Total:					Total:			
III.	12	19	20	22	IV.	29	30	34	40
	46	48	49	50		47	52	59	60
	51	54				61	62		
	Total:					Total:			
V.	6	7	14	15	VI.	18	55	56	57
	16	45				58	63		
	Total:					Total:			
VII.	3	4	5	41	VIII.	64	65	66	67
	42	43	44			68	69	70	
	Total:					Total:			
IX.	17	21	24	27					
	28	36	37	38					
	39								
	Total:					GRAND TOTAL:			

Rating scale for behaviour during tests

Cooperation with the Tester

1 Resists nearly all suggestions or requests.

2 Refuses to cooperate during part of session or resists several test items.

3 Resists one or two specific tests.

4 Responds to or accepts test materials - neither cooperative nor resistant.

5 Seems to enjoy the give and take with examiner during one or two specific tests.

6 Seems to enjoy the give and take with examiner during part of session.

7 Very readily and enthusiastically enters into nearly all suggested games.

Rating scale for behaviour during tests

Interest in test materials

1 Glances and holds briefly, but does not exploit.

2 Looses interest after brief reaction most of time.

3 Interested and actively exploits less than half of materials.
(Move sustained interest in materials than 2, but only exploits less than half of test materials.)

4 Interested and actively exploits more than half of test materials.

5 Interested and actively exploits more than half of test materials, reluctantly relinquishing some materials.

6 Sustained interest and manipulation of materials throughout test.

7 Sustained interest and manipulation of materials throughout test, reluctantly relinquishing most (more than half) materials; or enthusiastically or with excitement manipulates materials most of the time.

Rating scale for behaviour during tests

Vocalisations

1 None

2 5 or less vocalisations.

3 Intermediate between grades 2 and 4.

4 Frequent vocalisations through most of test.

UNSTRUCTURED OBSERVATIONS

Definitions of Behaviour categories

(a) Position:	Supine (SUP)	-	Child lying on back.
	Prone (PR)	-	Child lying on abdomen and chest or abdomen or chest, legs and arms extended or flexed.
	Side (SID)	-	Child lying on side.
	Stand (ST)	-	Child upright, weight on one foot or both feet. Holding on to something or not.
	Sit (SIT)	-	Sitting alone or propped up.
	Hands & Knees (HK)	-	Child up on hands and knees.
	Squat or crouch (SQ)	-	Weight on feet with knees and hips flexed and buttocks below knees.
	Kneel (K)	-	Child on knees.

(b) Change of position: (CH)

Any change from one of the above positions to another. OR

Any progression forward, backward or sideways for at least two alternate foot, knee or arm movements in the same direction.

(c) Activity:	Extremeties (EXT)	-	Movement of arms and/or legs.
	Body (B)	-	Movement of the trunk - e.g. twisting, flexing or bending. Body movement during changes of position are not recorded in this column.

O = no activity or just a flicker of movement.

\+ = movement occurred in that part of body.

(d) <u>Exploration</u> (EXP)

O = no manipulation with hands or passive holding.

\+ = any manipulation with one hand, or manipulation with both hands, but not involving looking at the activity.

++ = activity manipulating with both hands and child looking at what he/she is doing.

(e) <u>Regard</u> (R) i.e. visual exploration.

O = eyes closed or looking into space.

\+ = actively looking.

++ = head movement while exploring with eyes.

(f) <u>Expression of emotion</u>

Laugh (L) - Characteristic noise with mouth open expressing pleasure; includes <u>giggle</u>, when mouth may be closed.

Smile (S) - Raising of mouth corners; teeth and gums may be visible; expressing pleasure.

Frown, Grimace (F) - Marked contortion of the face associated with displeasure.

Cry or scream (C) - High pitched loud noise, wail or shout, accompanied by tears. Also includes <u>whimper</u>, <u>groan</u> or <u>moan</u> ("negative vocalisation").

(g) <u>Affective state</u>

Assessment of predominant affect in 5 sec. period.

Happy (H): Happy or excited.

Alert (AL): Bright facial expression, taking interest in surroundings.

Apathetic (AP): Blank, expressionless.

Unhappy (UN): Displeasure, with or without protest.

(h) Vocalisation (V): Any vocalisation other than those mentioned above. ("positive vocalisation" - including babbling/ speech in monologue or in communication.)

(i) Stereotyped Movement (ST) :

Repetitive, monotonous movements.

Rocking: Transference of weight from one foot to another in oscillatory motion remaining on one spot. If seated, this can also be done with body - swaying trunk.

Head shaking: Repeated shaking or rocking of head. If this is done when child is near rail of crib or wall this may result in head banging when child repeatedly hits his head against a stationary object.

(j) "Autoerotic" activity (A) :

e.g. Non-nutritive sucking - of object or part of body;

Rubbing stomach;

Pulling hair.

UNSTRUCTURED OBSERVATIONS

Scoring for 'Activity' and 'Exploration'.

Activity		Score
CH	O	O
	+	2
EXT	O	O
	+	1
B	O	O
	+	1
R	O	O
	+	O
	++	1
Maximum score for 5 sec observation period		5

(Maximum per session = 300)

Exploration		Score
Exp	O	O
	+	1
	++	2
R	O	O
	+) ++)	1
Maximum score for 5 sec observation period		3

(Maximum per session = 180)

Structured Behaviour Observations (Toys)

Toys

B	Blocks
Bo	Box
C	Cars
D	Doll
Dc	Dolls clothes
Bp	Parts of body
R	Rattle
Sq	Squeezy toy that makes noise
Oth	Other.

Actions

0	Holding
1	Touching
2	Manipulation
3	Dropping, throwing
4	Pounding
5	Oral contact
6	Shaking
7	Pushing, Pulling
8	Objects in & out of box
9	Picking up, putting down, toy from hand to hand
10	Regard to properties, no combination
11	Regard to properties, combination
12	Other.

0 Holding

(1) "passive" holding; hand stationary.

(2) Holding with one or 2 hands; hand may be moving, but not involved in picking up & putting down (9), moving hand over surface (2), shaking (6), etc.

(3) If child is holding toys & moves fingers against toy - open & closing fingers etc - code as activity (2).

1 Touching

Child brings hand into contact with toy, but does not engage in other activity (manipulation, picking up, etc.)

Includes 'patting' (repeated touching).

Also includes holding with one hand & touching with the other (coded as Play ++).

2 Manipulation

(i) Exploratory movements of hands over surface of toy.

(ii) Moving movable parts of toys eg. wheels.

(iii) Using one toy to do (ii) (Code as manipulate 2nd toy with a check under the toy being used.)

(iv) Moving one toy over surface of another (code as in (iii)).

(v) Holding toy & moving fingers or opening & closing hand around toy.

(vi) Passing toy from hand to hand.

3 Dropping or Throwing

Toy is released from the hand some distance from the crib surface or floor. This may be a directed throw in the older children, but direction of movement by child is not a criterion for inclusion in this category. Any action which allows the toy to fall is included in this category.

(Do not include accidental dropping).

4 Pounding

Hitting of toy or part of body against crib, toy or body.

(Note: This is the pounding of an object against a surface, therefore:

a) if toy is stationary & child pounds toy - Bp 4.

b) if child hits one toy,eg. doll, with another toy, eg. block, code B4 and D.

c) if child hits 2 toys together code 4 for one toy and check the second, with Play ++. (From the records it will therefore not be possible to distinguish between (c) and (b) if the child holds the block with 2 hands in the latter activity.)

5 Oral Contact

Toy or part of body is taken to mouth. This need not involve sucking.

6 Shaking

Object is held in the hand & shaken without bringing the object into contact with any other toy or surface or part of body. If toy makes contact with surface, code as pounding (4).

7 Pushing or pulling

Child causes toy to move along a surface - this may be achieved by holding toy & pushing or pulling, or by using one toy to move another. In the latter case, the action would be recorded under the second toy - eg using R to push C - C7 R.

7 is used if pushing/pulling is the primary activity in which child is engaged. If child is engaged in one activity and the toy moves along the surface this would not be coded as 7 unless during the observation period the child became interested in the movement & then started to push or pull the toy. If this happened both activities would be recorded.

8 Puts objects in & out of box

Child places toys in box or removes them from box. If child carries toy to box, but does not release toy from grasp or has not done so in the observation period this is also counted as Action 8.

Remember hand in box Bp8.

9 (Picking up toy from surface
(Putting toy down

If these occur without activities 2-8, 10, 11 code as activity 9.

If these occur with activities 0, 1 & 12, code as activity 9.

If during the observation period child grasps toy but does not raise it from surface, or rests toy on surface but does not release grasp, code as activity 9.

If only the release of a toy is observed during observation period code as 9.

10 <u>Some regard to properties - no combination of objects.</u>

Child performs action on one toy which demonstrates a knowledge of the properties of the object or of the object that toy represents - eg. kisses doll, pushes car on wheels.

11 <u>Some regard to properties - combination of objects.</u>

Child combines 2 toys in play in a way which demonstrates knowledge of properties of the object or of object that toy represents - eg. builds wall with blocks.

12 <u>Other</u>

Including object held by child for visual inspection.

Rules for administering Structured Behaviour Observations (Toys)

a) Time sampling:

First 3 secs. of each 30 secs. for 5 mins.

2 min. break.

Repeat until 3-5 min. periods completed.

b) Record all activities that occur in 3 second period.

c) If something happens to upset child or child appears sleepy discontinue & return later.

d) Start observations 1 minute after presenting last toy.

e) Standard presentation of toys:

"Hello baby, Look - here are some toys for you to play with."

Arrange toys in semi circle in front of child.

Do not shake or squeeze toys.

f) Coding for PLAY columns :

O = (i) hands not engaged in activities 1-12

(ii) Bp5/Autoerotic with no other activity (see note (g))

\+ = (i) One hand engaged in activities 1-12

(ii) one hand engaged in action 1-12 & the other hand engaged in holding (O) which is not associated with any other activity.

++ = (i) both hands engaged in activities 1-12 separately or together.

(ii) one hand holding toy as part of one of activities 1-12 eg. holding toy to facilitate manipulation, holding box for action 8.

g) sucking body part = autoerotic & play 0.
sucking object = activity 5.

h) If child is playing with a toy in box but observer is unable to see the toy, code Bp8.

i) If child uses one toy to explore another toy, code "manipulates 2nd toy".

j) If child hits body part on toy which is stationary, code Bp4 and Toy.

k) If toy falls or is thrown out of cot during 5 min. observation period return the toy at the end of that period. If several toys fall out return them 30 secs. after the 4th toy falls out.

If toy falls/is thrown out during the 2 min. break return immediately.

Toys are returned without observer making any overtures or response to child.

l) Regard:
0 = eyes closed, blank stare.
\+ = looking around.
++ = looking at toys at anytime during 3 secs.

m) When coding activity 8 it is not necessary to record holding box if this occurs, but play ++ would be recorded.

Appendix II

C H I L D D E V E L O P M E N T S T U D Y

INTERVENTION PROGRAMME

MANUAL

CHILD DEVELOPMENT STUDY - INTERVENTION PROGRAMME

THE CHILD IN HOSPITAL

During 1st week in hospital - after 1st test - Playleader should concentrate on forming a good relationship with child.

During 1st few days this will mainly involve close physical contact with child - child at this stage is usually either too sick or too unhappy to cooperate in teaching situation. If child is very weak and cannot manipulate actively, gradually introduce toys - soft toy and then small objects that he can hold. (Lower mobile over cot and attach crib toy in such a way that he can easily reach suspended objects.). The lengths of this introductory period will vary, depending on the child's response to playleader.

Towards the end of this period, assess the child's position on the scales of activities to determine level at which to start intervention programme. Also try to identify activities that child particularly enjoys -to be used as rewards in the teaching sessions.

Select a suitable range of teaching activities (about 4 different games to play) which should be carried out every day, varying the toys used and the sequence of presentation of tasks.

When child has mastered one task, go on to the next task in that scale. However, in each session one should always include activities that the child has already mastered, so he can experience success as well as the challenge of a new task.

When a new activity is being taught, remember to reward child for improvements in his performance even if he has not completely learned the task.

Playleader should spend 60 minutes each day with each child. This will usually be 2 periods of 30 mins. In some cases (particularly during the first week) it may be necessary to have shorter periods - eg. 4 periods of 15 minutes.

Encourage mothers to visit the child in hospital and to join in with the play sessions. Do not give medical information, but tell mother how well child is doing in the play programme.

TEACHING PROCEDURE

The general rule for teaching the children should be to reward progress in any of the activities being taught. Rewards should be identified during the first days of contact with child and recorded in his record book.

e.g. some children like to clap hands when they have succeeded or others respond to a smile accompanied by words such as "Good boy".

HOME VISITS

The home visitors should get to know the child that they will be visiting while the children are in hospital. The home visitors should also get to know the mothers before the children leave hospital.

The playleader should make a record of toys and instructions given to mother when child is discharged. It is preferable that home visitor should be present for playleader's last session with mother before child leaves hospital, but this may not always be possible.

All home visits should be carried out in accordance with Dr. McGregor's guidlines in Department of Social & Preventive Medicine Newsletter - Vol V No.2. The idea of the visit is to help mother in her play with the child - to support her and give her new ideas for appropriate tasks for her child.

At each visit, Mother should be asked to evaluate the previous week -

How many times did she work with child?
How did she think child was getting on? etc.
It must be stressed that the idea is that mother spends time playing with child and that sessions should be enjoyable to both mother and child.

Mother should be asked to demonstrate what she has been doing with child. Playleader should evaluate child's performance and show mother an extension of that activity, if necessary.

On each visit, 4 activities should be left for the following week. These would not all be new activities - in fact, in most cases <u>only one</u> should be completely new. One of these activities should be a motor activity as these children usually need extra help in this area.
Mother's ideas about games to play should be encouraged and where appropriate should be included in the programme.
Where possible, play with objects available in the home should be encouraged.

Each child has a book for a record of home visits. Home visitor should take book with her on each visit and record evaluation of visit on the spot.

After each visit, record rating 1, 2 or 3.

Rating by Home Visitor

1. Adult did not play with child during previous week.

2. Adult spent some time playing with child, but not every day or regularly.

3. Adult played with child regularly - throughout week.

LEVEL ONE: Activities for children aged 6-24 Months

This curriculum has been developed for use with children in hospital and for work with mothers when the children return home. It has been designed to provide a wide range of activities for children from the age of 6 months. Activities have been chosen to stimulate the overall development of the child - physical, social and intellectual development, and to encourage the development of a positive mother-child relationship to foster good emotional development.

The curriculum is summarised in the following pages. The curriculum is divided into several different areas, listed in columns of the summary sheets. These areas are numbered I, II, III, etc.

Under the heading for each area there are listed a number of activities, in most cases graded in order of difficulty. (Where not graded, this will be stated.) The easiest activities are level A, with D being the most difficult.

Please note that little reference is made to age in this curriculum. The reason for this is that although the age of the child is a guide to what is appropriate for the child, many of the children with whom we are working are slow in their development and this programme is designed to help them to catch up.

LEVEL ONE

A–D	I GROSS MOTOR		II GRASPING OBJECTS	III SEARCHING FOR OBJECTS	IV SOUNDS & WORDS	V SHAPE	VI SORTING & MATCHING	VII FINE MOTOR
	Sits alone Crawls Pulls self to stand Walks (holding on) Stands (without holding	*A Easiest*	1. Reaching to grasp object 2. Taking 3rd object		Responds to adult 1."Cooing" 'Oo' or 'ah' 2."Babbling" 'Ba' or 'ba-ba'			1 Clap hands
	Steps off (without holding) Throws ball Climbs Walks with 'push along' or 'pull along'	*B*	Use of other objects 3. Use of supporting object 4. Pulling string-across 5. Pulling string-up	1. Partially hidden toy 2a)Completely hidden - 1 cover 2b)Completely hidden - one of 2 covers	3. Imitation of sounds		1. Objects into/out of container	2 Build blocks
	Kicks Ball	*C*	6. Use of stick	3. 3 covers:series of hidings	4. Names of people & objects		2. Sorting into piles	Build blocks
		D Most difficult		4."Invisible" hiding		1.Matching shapes	3. Sorting into boxes	3 'Posting' bottles

LEVEL ONE for children aged 6 months to 24 months

The curriculum for this level is divided into the following main areas:

I	GROSS MOTOR ACTIVITIES
II	GRASPING OBJECTS AND USING TOOLS
III	SEARCHING FOR OBJECTS
IV	SOUNDS AND WORDS (LANGUAGE)
V	SHAPES
VI	SORTING AND MATCHING
VII	FINE MOTOR ACTIVITIES
	ACTIVITIES WITH BOOKS.

I GROSS MOTOR ACTIVITIES

1. SITS ALONE

2. CRAWLS AFTER 'ROLL-ALONG TOY'

3. PULLS SELF TO STAND - HOLDING ON TO FURNITURE

4. WALKS - HOLDING ON

5. STANDS WITHOUT HOLDING

6. STEPS OFF - WITHOUT HOLDING ON

7. THROWS BALL

8. CLIMBS ON CHAIR OR BED

9. WALKS WITH 'PUSH-ALONG TOY' OR 'PULL-ALONG TOY'

10. KICKS BALL

11. RUNS AFTER ADULT

12. JUMPS UP AND DOWN ON THE SPOT - IMITATES ADULT

II GRASPING OBJECTS AND USING TOOLS

1. REACHING AND GRASPING OBJECTS.
2. LETTING GO OF ONE OBJECT IN ORDER TO GET ANOTHER.
3. USE OF SUPPORTING LARGER OBJECT TO GET TOY.
4. USE OF STRING - PULLING ACROSS.
5. USE OF STRING - PULLING UP.
6. USE OF STICK TO REACH TOY.

1. REACHING OUT AND GRASPING OBJECTS

Infant may be lying on back or in a sitting position, as long as both arms are free to reach out.

OBJECTS: Small bright object ,as least a part of which is small enough for infant to grasp.

DIRECTIONS:

Hold toy about 12 ins. from child's face for at least 30 secs.

If child does not grasp toy, move toy slowly towards child's hand. Hold toy a few inches from hand for a short time.

If child still does not grasp toy, touch hand with toy.

CHILD TO REACH OUT AND GRASP TOY.

2. LETTING GO OF ONE OBJECT IN ORDER TO GET ANOTHER.

Infant in sitting position.

OBJECTS: 2 small toys that child can hold one in each hand (eg. small cotton reels or small blocks).

1 toy - attractive and different from the other two.

DIRECTIONS:

Offer the two toys, one to each hand simultaneously. Once child has two hands full, quickly offer the third toy, holding it up in front of child within his reach.

CHILD TO PURPOSEFULLY DROP ONE TOY TO FREE HIS HAND TO GET THIRD TOY.

3. USE OF SUPPORTING LARGER OBJECT TO GET TOY.

Infant in sitting position.

OBJECTS: Any toy in which child shows strong interest.
A larger object such as pillow or cloth on which toy can be rested.

DIRECTIONS:

Give toy to child and while he is playing with it, place larger object just within child's reach.
Take toy from child and place it in centre of pillow or cloth, out of child's reach.
Encourage child to get toy, but do not allow him to crawl after toy.

CHILD TO PULL LARGER OBJECT TO REACH TOY.

4. USE OF STRING - PULLING ACROSS.

OBJECTS: Any toy in which child shows a strong interest.
String approx. 36" long tied to toy.
(eg. a stuffed doll with string tied to arm; don't tie string around neck - we are superstitious!!)

DIRECTIONS:

Place toy way beyond infant's reach where he can see it, and extend other end of string toward child's hand. Encourage him to get toy, but do not allow him to crawl off after it.

CHILD TO GET TOY BY PULLING STRING.

5. USE OF STRING - PULLING UP.

Child sitting on chair.

OBJECTS: Toy (eg. stuffed doll) with string attached.

DIRECTIONS:

Holding end of the string, slowly lower toy to the floor on one side of child, calling child's attention to the process. (Child should be able to see toy on the floor). Leave end of string near to child's hand.

CHILD TO GET TOY BY PULLING STRING UP.

6. USE OF STICK TO REACH TOY.

Child sitting on floor.

OBJECTS: Any attractive toy.

Stick (about 12" to 18" long)

DIRECTIONS:

Place toy on the floor out of child's reach.

Put stick near child's hand.

Encourage child to get toy, but do not allow him to crawl after it.

CHILD TO USE STICK TO PULL TOY TO HIM.

III SEARCHING FOR OBJECTS

1. FINDING AN OBJECT WHICH IS PARTIALLY HIDDEN.
2. A. FINDING AN OBJECT WHICH IS COMPLETELY HIDDEN UNDER A SINGLE COVER.

   B. FINDING AN OBJECT WHICH IS COMPLETELY HIDDEN UNDER ONE OF TWO COVERS.
3. FINDING AN OBJECT AFTER A SERIES OF HIDINGS.
4. FINDING OBJECT AFTER 'INVISIBLE HIDING'.

1. FINDING OBJECT WHICH IS PARTIALLY HIDDEN.

OBJECTS: Small object (eg. scoop or spoon).
Plain cloth.

DIRECTIONS:

Place object on surface in front of child.
While child is watching, place toy on surface within his reach and partially cover it with cloth.

CHILD TO PULL COVER TO GET TOY.

2a) FINDING AN OBJECT WHICH IS COMPLETELY HIDDEN UNDER ONE COVER.

<u>OBJECTS</u>: Small toy (eg. scoop or small block)

Plain cloth.

<u>DIRECTIONS</u>:

Hold toy out to child.
When he starts to reach for it, place it in front of him within his reach and cover it completely with cloth. (Bunch cloth up so contours of object do not show).

CHILD TO PULL OFF COVER TO GET TOY.

2b) FINDING AN OBJECT WHICH IS COMPLETELY HIDDEN UNDER ONE OF TWO COVERS.

<u>OBJECTS</u>: Small toy (as in 2a)

2 plain cloths of different colours.

<u>DIRECTIONS</u>:

Place 2 cloths (bunched up), one on either side of child. Hide toy under one cloth for 3 successive pres tations, then under other cloth for 3 presentations, then under first cloth.

CHILD TO SEARCH UNDER CORRECT COVER EACH TIME.

3. FINDING OBJECT AFTER SERIES OF HIDINGS.

OBJECTS: Small toy (eg. scoop or small block)
3 cloths of different colours.

DIRECTIONS:

(Make sure child watched the complete hiding procedure)
Hide toy successively under each of the 3 covers moving hand holding to from L to R or R to L.
Toy is hidden under first cover then reappears, and then becomes hidden under second, is seen again and is then hidden under third cover.

CHILD TO GO DIRECTLY TO LAST COVER TO SEARCH FOR TOY.

4. FINDING OBJECT FOLLOWING 'INVISIBLE' HIDING.

OBJECTS: Small toy (small enough to fit in palm of hand).
3 distinctly different covers.

DIRECTIONS:

While child watches, place toy in palm of one hand and hide it by closing hand.
Move hand from under first to under second and then third cover. Do not open hand between covers.
(Encourage child to point to where hand is at each stage)
Leave object under last cover and show child that hand is empty.

CHILD TO SEARCH FOLLOWING PATH OF ADULT'S HAND, OR TO SEARCH UNDER LAST COVER.

IV SOUND AND WORDS

1. "COOING" SOUNDS IN RESPONSE TO ADULT. (EG. 'OO' OR 'AH').

2. 'BABBLING' SOUNDS IN RESPONSE TO ADULT. (EG. 'BA' OR 'BA-BA').

3. IMITATION OF FAMILIAR SOUNDS.

4. CALLING THE NAMES OF FAMILIAR PEOPLE AND OBJECTS.

5. NAMING PICTURES.

1. 'COOING' SOUNDS IN RESPONSE TO ADULT.

DIRECTIONS:

When child is making sounds, Adult should imitate one of the sounds that child is making. eg. 'OO' or 'AH'.

ENCOURAGE CHILD TO MAKE SOUND IN RESPONSE TO ADULT.

2. 'BABBLING' SOUNDS IN RESPONSE TO ADULT.

DIRECTIONS:

If child is making sounds with consonants (eg. 'BA' or 'GA' or 'BA-BA'), Adult should choose one sound to imitate.

CHILD TO MAKE SOUNDS IN RESPONSE TO ADULT.

3. IMITATION OF FAMILIAR SOUNDS.

DIRECTIONS:

Encourage child to make increasingly complex sounds.

4. CALLING THE NAMES OF FAMILIAR PEOPLE & OBJECTS.

DIRECTIONS:

Teach child to say the names of the people in the family and living in the yard.

Teach child the names of familiar objects in the home - objects that he knows.

5. NAMING PICTURES

OBJECTS: simple picture (handdrawn or cut from magazine stuck on cards or in a book.)

DIRECTIONS:

Once child is able to name a number of objects around the house, show him pictures of objects WHICH HE CAN ALREADY NAME.

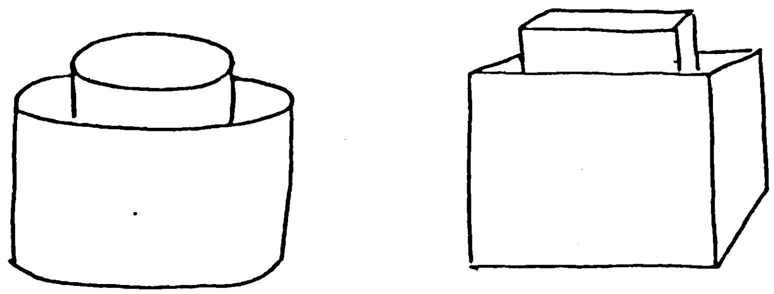
Point to the object and ask him "What is this?"

CHILD TO NAME OBJECT IN PICTURE.

V SHAPE

1. MATCHING SHAPES.

OBJECTS: 2 sets of nesting cups. Eg. one circular and one square.



DIRECTIONS:

Present child with small cups inside larger cups of the same shape.

Remove small cups.

Child to replace cups, matching shapes.

(Use 3 shapes when child can solve problem with 2).

VI SORTING AND MATCHING

1. OBJECTS INTO/OUT OF CONTAINER.

2. SORTING INTO PILES.

3. SORTING INTO BOXES.

1. OBJECTS INTO/OUT OF CONTAINER.

OBJECTS: 3 or 4 identical scoops or blocks
box (e.g. cut from milk carton).

DIRECTIONS:

CHILD TO REMOVE AND REPLACE OBJECTS.

2. SORTING INTO PILES

OBJECTS: 4 identical scoops

4 identical blocks.

DIRECTIONS:

CHILD TO GROUP SCOOPS TOGETHER AND BLOCKS TOGETHER.

3. SORTING INTO BOXES

When child can do 2 (above), sort objects into boxes.

VII FINE MOTOR

1. CLAP HANDS

2. BUILD BLOCKS

3. 'POSTING' BOTTLE

1 CLAP HANDS

Adult to encourage child to clap hands.

Adult should clap hands together and encourage child to imitate.

2 BUILD BLOCKS

OBJECTS Small wooden blocks

DIRECTIONS:

Start with 2 blocks. Demonstrate putting one block on top of the other.

WHEN CHILD CAN PUT ONE BLOCK ON TOP OF ANOTHER, demonstrate making a tower.

Later, encourage child to build with the blocks, balancing them to make 'houses', etc.

3. 'POSTING' BOTTLE

OBJECTS: Plastic bottle (preferably transparent - e.g. syrup bottle).
Object that can easily be put into bottle (e.g. needle case or smooth stick about 3 inches long).

DIRECTIONS:

CHILD TO PUT OBJECT INTO BOTTLE AND SHAKE IT OUT.

VIII BOOKS

BOOK HELD BY ADULT

1 Child looks at pictures while adult points to individual objects.

BOOK HELD BY CHILD

2 Child turns pages.

3 Child points to pictures named by adult.

4 Child names objects.

LEVEL TWO for children aged 24 months +

The cirriculum for this level is divided into the following main areas (continuing from Level One):

I	GROSS MOTOR ACTIVITIES
II	USE OF TOOLS
III	PROBLEM SOLVING
IV	LANGUAGE
V	SHAPE
VI	SORTING AND MATCHING
VII	FINE MOTOR ACTIVITIES

GIVE A MOTOR ACTIVITY EVERY WEEK:

	Gross Motor Activities		Fine Motor Activities
A–E	Locomotion Sits alone Crawls Pulls self up to stand Walks - holding on Stands without holding Steps - without holding Climbs on chair, bed Walks Runs	*C–D*	Building Blocks 'Posting' objects
 D *E* *F*	With Ball Throw ball Kick ball Run to kick ball Tries to catch Catch	*E*	Screw top jars, bottles Threading beads Writing lines
 E	Jumping and Hopping Jump up and down Jump off Hop Jump over		
		F	Using scissors

GIVE ONE OF THESE EVERY WEEK:

LANGUAGE	SHAPE	SORTING & MATCHING
E Naming objects Naming pictures	*E* Shape inset Shape matching	*E* "the same as" Object-object matching Picture-object matching
F Talk about pictures	*F* 2 pc. jigsaw Simple 3 piece jigsaw Simple 4 piece jigsaw	*F* Picture-picture match Sort by colour
G Touch and name Picture story		"different"

I GROSS MOTOR ACTIVITIES (continued)

THROWS BALL TO ADULT 4 FEET AWAY

BALANCES - STANDING ON ONE FOOT

JUMPS OFF STEP

CATCHES BALL (ADULT 4 FT AWAY)

JUMPS OVER OBJECT ON FLOOR

JUMPS OFF BED

HOPS - BOTH FEET

HOPS ON ONE FOOT

II USE OF TOOLS (follows Grasping & Use of tools)

21 USE OF CRAYON TO WRITE LINES

22 COPYING LINES

23 COPYING PATTERNS (simple patterns)

24 USES SPOON TO FEED SELF

25 USE OF SCISSORS - CAN CUT PAPER

21. USE OF CRAYON TO WRITE LINES.

MATERIAL: Plain paper (newsprint, wrapping paper or paper bags opened up.

Crayon or short pencil.

DIRECTIONS:

When child is able to scribble freely on paper, teach him to make more controlled marks on paper.
Demonstrate drawing vertical or horizontal lines and guide child's hand for his first attempts.

CHILD TO DRAW SINGLE STRAIGHT LINES.

22. COPYING LINES.

MATERIAL: Plain paper

Crayon or short pencil.

DIRECTIONS: When child can draw straight lines.

CHILD TO COPY LINES DRAWN BY ADULT.

vertical

horizontal

oblique (slanting)

23. COPYING PATTERNS

MATERIALS: Plain paper.

Crayon or short pencil.

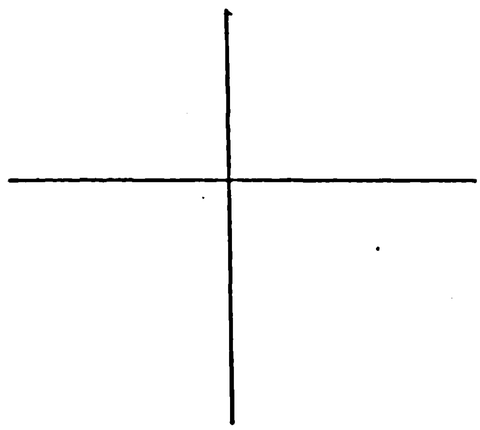
DIRECTIONS:

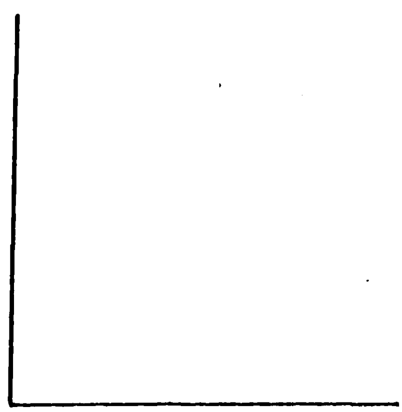
When child can copy lines

CHILD TO DRAW CIRCLE AS DRAWN BY ADULT.

(First, guide child to trace over pattern)

When child can copy circle, other shapes and patterns):





24. USE OF SPOON TO FEED SELF.

Using SMALL SPOON child should be taught to feed himself from dish or plate.

25. USE OF SCISSORS.

MATERIALS: Newspaper

Small scissors with rounded ends.

DIRECTIONS:

Teach child how to hold scissors correctly, guiding hand to cut paper.

III PROBLEM SOLVING (follows III Searching..)

21 IDENTIFYING PARTIALLY CONCEALED PICTURE.

22 IDENTIFYING HIDDEN OBJECT.

23 IDENTIFYING MISSING OBJECT.

24 IDENTIFYING BY TOUCH.

21. IDENTIFYING PARTIALLY CONCEALED PICTURE.

Recognising part of picture and naming it.

MATERIALS: Series of pictures of familiar objects.
Plain paper to cover picture.

DIRECTIONS:

Cover one picture with paper.

Gradually reveal a portion of picture asking child 'What is this?'.

Repeat until child can name object.

Show him complete picture.

22. IDENTIFYING HIDDEN OBJECT.

"Hidden Object Problem"

MATERIALS: Box with cover or large paper bag.

3 small familiar objects which child can name.

DIRECTIONS:

a) Use only one object at a time.

b) Show object to child. Ask "What is the name of this?".

c) When you are sure that child can name the object put it into the box or bag.

Ask: "What is in here?"

d) Open and reveal object to check if he is correct.

23. IDENTIFYING MISSING OBJECT.

"Missing object problem"

MATERIAL: 4 familiar objects which child can name with ease.

eg. spoon
doll's chair
toy cup
block.

DIRECTIONS:

a) Allow child to play with objects and to name them.

b) Remove one object (without child seeing which one).

c) Ask child which one has been hidden.

d) Show child the object that had been hidden to check if he is correct.

e) Hide a different object for each presentation.

24. IDENTIFYING BY TOUCH,

"Touch and Name Game"

MATERIAL: Small familiar objects with distinctive shapes/texture..... which child can name.
eg. plastic cup
spoon
comb
brush

DIRECTIONS:

a) Put one object into bag while child watches, saying eg. "I am putting the brush in the bag".

b) Let child put his hand into bag - "can you feel the brush?".

c) Repeat this with all the objects.
Focus the child's attention on the feel of the objects.

d) When child is familiar with activitity, test him by not letting him see which toy i put into bag.
Ask him to tell you what is in the bag.

IV LANGUAGE (Follows IV Sounds & Words)

21 NAMING OBJECTS

22 NAMING PICTURES

23 DESCRIBES PICTURES

24 NAMING ACTIONS.

21. NAMING OBJECTS.

Using any of the following -

<u>MATERIALS</u>: Everyday objects around the home.

Familiar toys.

Toy farm animals (plastic or wood).

22. NAMING PICTURES

Use any of the following -

<u>MATERIALS</u>: Book with pictures of everyday objects.
Pictures mounted individually on cards, given as a set in a box - "picture box".

NB: Pictures should be simple -hand drawn or cut from magazines or books.
Pictures should be of objects with which child is familiar.

23. DESCRIBES PICTURES

<u>MATERIALS</u>: Use any of the following -

Book.

'Talk about Picture set' Individual pictures mounted on cardboard.

'Picture story' Sequence of pictures which tell a story.

These pictures should be more complicated than those used for naming - more than one person or object.

CHILD REQUIRED TO DO MORE THAN NAME OBJECT

eg. "Girl is sitting on chair".

CHILD TO DESCRIBE ACTIVITY IN PICTURE.

24. NAMING ACTIONS

"What am I doing? game"

(to teach child words for actions)

DIRECTIONS:

Adult demonstrates an action and asks child "What am I doing?".

Suggested actions:

- standing
- sitting
- eating
- lying down/sleeping
- marching
- jumping
- hopping

V SHAPE (continued)

21 MATCHES SHAPES

22 JIGSAW PUZZLES - 1 PIECE

23 2 PCS. JIGSAW PUZZLE

24 3 PCS. JIGSAW PUZZLE

21 MATCHING SHAPES

SUGGESTED)
)
MATERIALS) 1. Shape matching set
)
FOR THIS) 2. Shape board.
)
STAGE .)

GIVE EITHER 1 OR 2

1. "SHAPE MATCHING SET"

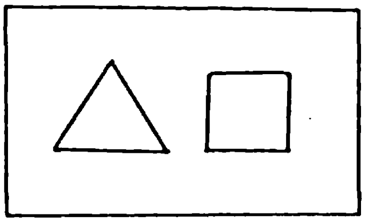
Set of pairs of blocks of different shapes, packed in a box.

DIRECTIONS:

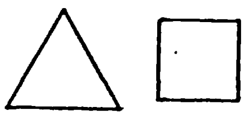
a) Child is required to unpack and pack blocks in box.

b) Starting with 2 pairs of blocks, CHILD TO MATCH SHAPES.

2. "SHAPE BOARD"



cardboard with 2 or 3 shapes drawn in the same colour.



+ identical shapes cut out of card-board - same colour.

DIRECTIONS: CHILD TO MATCH SHAPES.

22 1 PC, JIGSAW PUZZLE

MATERIALS: Picture mounted on cardboard with 1 pc. cut out.

either: Cut a triangle out of picture or Cut out an irregular shape around a complete object.

23 2 PCS. JIGSAW PUZZLE

24 3 PCS. JIGSAW PUZZLE

MATERIALS: Picture stuck on cardboard, cut into 2 or 3 pieces.

VI SORTING & MATCHING (continued)

21 MATCH PICTURE AND OBJECT.

22 MATCH PICTURE TO PICTURE (SIMPLE PICTURES).

23 SORT BY COLOUR

24 CLASSIFICATION OF PICTURES.

25 PICTURE MATCHING - 2.

21 MATCHING PICTURE AND OBJECT

ALTERNATIVE MATERIALS FOR THIS ACTIVITIY:

1. Picture - Object finding set.
2. Picture - Object Matching set.

GIVE EITHER 1 or 2.

1. "PICTURE —OBJECT FINDING SET"

MATERIALS: Set of pictures of individual objects which are present in child's home.

DIRECTIONS:

One at a time, give picture to child.
He is required to name the object and to find the object depicted.

2. "PICTURE OBJECT MATCHING SET"

MATERIALS: Box containing selection of objects and pictures (mounted individually on cards) of those objects.

DIRECTIONS:

Child is required to match pictures to objects.

22 MATCH PICTURE TO PICTURE.

This is the earliest stage of matching pictures.

MATERIALS: Either 1. "2 the same Game"

Or 2. "Picture matching set".

1. "2 THE SAME GAME"

MATERIALS: Give child sets of pairs of pictures.

e.g.

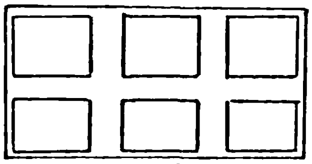
2 identical pictures of faces and 2 of spoons.

DIRECTIONS:

Child to MATCH PICTURES. Ask "Which is the same as this?".

2. "PICTURE - MATCHING SET"

MATERIALS: Large card with 4 or 6 pictures pasted on.



+ identical pictures mounted on individual small cards.

DIRECTIONS:

Child to match pictures, covering pictures on large card.

23 SORT BY COLOUR

MATERIAL: Objects which can be provided in different colours.

E.g. Red bottle tops + blue bottle tops or
Red blocks + yellow blocks + blue blocks

\+ Boxes or other containers in the appropriate colours.
(colour inside of milk box with crayons).

DIRECTIONS:

Child is required to put objects into containers of the same colour.

Red blocks ⟶ Red box
Blue blocks ⟶ Blue box
Yellow blocks ⟶ Yellow box

24 CLASSIFICATION OF PICTURES

MATERIALS: Pictures (from magazines or drawn and coloured) pasted to individual cards. Try to have all the pictures about the same size. Only one object in each picture.

e.g. One set could include:

3 pictures of shoes.

2 pictures of chairs.

DIRECTIONS:

Let child look at all the pictures and make sure that he can name the objects.

Then ask him to put all the pictures of one type of object together. e.g. "Give me the pictures of the shoes". Later, "Put the shoes pictures together and put the chair pictures together".

25 PICTURE MATCHING - 2

MATERIALS: "Picture matching set" like 22, but with more difficult pictures.

Large card with 6 or more pictures pasted on.

\+ pictures of similar objects (but not identical pictures) mounted on individual small cards.

DIRECTIONS:

Child to match pictures, covering pictures on large card.

VII FINE MOTOR ACTIVITIES

OPENS SCREW-TOP BOTTLE/JAR

CLOSES SCREW-TOP BOTTLE/JAR

THREADING BEADS/COTTON REELS

ADDITIONAL ACTIVITIES

Alphabetical listing.

Car + roadway

Doll + bed

Doll's house
Doll's house furniture
Large Doll's house

Farm animals

Farm village

Flashlight

Puppets

Push along toy
Pull along toy

Playdough and board

Water play

APPENDIX III

Repeated measures analysis of variance: summary tables

Non-Intervention and Comparison groups:

Intervention and Non-Intervention groups:

Page

ANALYSIS OF VARIANCE: COOPERATIVENESS WITH TESTER

Non-Intervention and Comparison groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	2.0636	2.0636	0.638	NS
Sex	1	0.2007	0.2007	0.062	NS
Group.Sex	1	3.7311	3.7311	1.153	NS
Residual	28	90.6218	3.2365	3.545	
Total	31	96.6172	3.1167	3.413	
Subj.Time Stratum					
Time	3	85.5859	28.5286	31.244	<0.001
Time. Group	3	7.3764	2.4588	2.693	<0.05
Time. Sex	3	0.6284	0.2095	0.229	NS
Time. Group.Sex	3	1.4599	0.4866	0.533	NS
Residual	84	76.6994	0.9131		
Total	96	171.7500	1.7891		
Grand Total	127	268.3672			

ANALYSIS OF VARIANCE: INTEREST IN TEST MATERIAL

Non-intervention and Comparison groups

SOURCE	DF	SS	MS	F	P
Sub Stratum					
Group	1	7.444	7.444	4.307	<0.05
Sex	1	0.087	0.087	0.050	NS
Group.sex	1	0.005	0.005	0.003	NS
Residual	28	48.395	1.728	1.513	
Total	31	55.930	1.804	1.579	
Subj Time stratum					
Time	3	123.898	41.299	36.156	<0.000
Time.Group	3	11.687	3.896	3.410	<0.025
Time.Sex	3	1.192	0.397	0.348	NS
Time.Group.Sex	3	3.522	1.174	1.028	NS
Residual	84	95.951	1.142		
Total	96	236.250	2.461		
Grand Total	127	292.180			

ANALYSIS OF VARIANCE : VOCALISATION DURING TESTS

Non-Intervention and Comparison groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	0.0061	0.0061	0.005	NS
Sex	1	2.4743	2.4743	2.051	NS
Group Sex	1	1.4885	1.4885	1.234	NS
Residual	28	33.7733	1.2062	1.539	
Total	31	37.7422	1.2175	1.554	
Subj Time Stratum					
Time	3	15.8359	5.2786	6.737	<0.001
Time Group	3	0.6026	0.2009	0.256	NS
Time Sex	3	0.4213	0.1404	0.179	NS
Time Group Sex	3	3.5762	1.1921	1.521	NS
Residual	84	65.8140	0.7835		
Total	96	86.2500	0.8984		
Grand Total	127	123.9922			

ANALYSIS OF VARIANCE: GENERAL DQ

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	16865.36	16865.36	26.825	0.001
Sex	1	13.50	13.50	0.021	NS
Group.Sex	1	47.27	47.27	0.075	NS
Residual	28	17603.85	628.71	10.109	
Total	31	34529.97	1113.87	17.911	
Subj.Time Stratum					
Time	3	9223.09	3074.36	49.434	0.000
Time.Group	3	78.04	26.01	0.418	NS
Time.Sex	3	66.38	22.13	0.356	NS
Time.Group.Sex	3	165.46	55.15	0.887	NS
Residual	84	5224.02	62.19		
Total	96	14757.00	153.72		
Grand Total	127	49286.97			

ANALYSIS OF VARIANCE (Adjusted for covariates):

GENERAL DQ.

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	8675.25	8675.25	29.262	0.001
Sex	1	0.36	0.36	0.001	NS
Group.Sex	1	3.23	3.23	0.011	NS
Covariates	3	10192.19	3397.40	11.460	
Residual	25	7411.66	296.47	6.494	
Total	31	26282.69	847.83	18.570	
Subj.Time Stratum					
Time	3	1773.28	591.09	12.947	0.001
Time.Group	3	54.35	18.12	0.397	NS
Time.Sex	3	122.36	40.79	0.893	NS
Time.Group.Sex	3	210.29	70.10	1.535	NS
Covariates	3	1525.93	508.64	11.141	
Residual	81	3698.10	45.66		
Total	96	7384.30	76.92		
Grand Total	127	33666.99			

ANALYSIS OF VARIANCE: LOCOMOTOR DQ

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	26227.54	26227.54	25.304	0.001
Sex	1	1.96	1.96	0.002	NS
Group.Sex	1	7.52	7.52	0.007	NS
Residual	28	29022.36	1036.51	13.350	
Total	31	55259.37	1782.56	22.958	
Subj.Time Stratum					
Time	3	6932.96	2310.99	29.764	0.001
Time.Group	3	25.43	8.48	0.109	NS
Time.Sex	3	66.52	22.17	0.286	NS
Time.Group.Sex	3	369.34	123.11	1.586	NS
Residual	84	6522.00	77.64		
Total	96	13916.25	144.96		
Grand Total	127	69175.62			

ANALYSIS OF VARIANCE (Adjusted for covariates): LOCOMOTOR DQ.

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	13776.76	13776.76	20.935	0.001
Sex	1	112.18	112.18	0.170	NS
Group.Sex	1	3.58	3.58	0.005	NS
Covariates	3	12570.49	4190.16	6.367	
Residual	25	16451.86	658.07	9.364	
Total	31	42914.88	1384.35	19.699	
Subj.Time Stratum					
Time	3	2353.10	784.37	11.161	0.001
Time.Group	3	41.71	13.90	0.198	NS
Time.Sex	3	73.56	24.52	0.349	NS
Time.Group.Sex	3	352.46	117.49	1.672	NS
Covariates	3	829.64	276.55	3.935	
Residual	81	5692.36	70.28		
Total	96	9342.84	97.32		
Grand Total	127	52257.71			

ANALYSIS OF VARIANCE: HEARING AND SPEECH DQ.

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	7413.7	7413.7	13.044	0.01
Sex	1	186.4	186.4	0.328	NS
Group.Sex	1	503.1	503.1	0.885	NS
Residual	28	15914.2	568.4	2.979	
Total	31	24017.4	774.8	4.061	
Subj.Time Stratum					
Time	3	33172.1	11057.4	57.960	0.000
Time.Group	3	1388.5	462.8	2.426	NS
Time.Sex	3	484.2	161.4	0.846	NS
Time.Group.Sex	3	753.5	251.2	1.317	NS
Residual	84	16025.1	190.8		
Total	96	51823.5	539.8		
Grand Total	127	75840.9			

ANALYSIS OF VARIANCE (Adjusted for Covariates) :
HEARING AND SPEECH DQ

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	4459.0	4459.0	11.579	0.01
Sex	1	308.9	308.9	0.802	NS
Group.Sex	1	41.3	41.3	0.107	NS
Covariates	3	6287.0	2095.7	5.442	
Residual	25	9627.2	385.1	2.108	
Total	31	20723.4	668.5	3.659	
Subj.Time Stratum					
Time	3	16195.2	5398.4	29.548	0.000
Time.Group	3	1676.2	558.7	3.058	0.05
Time.Sex	3	615.3	205.1	1.123	NS
Time.Group.Sex	3	444.3	148.1	0.811	NS
Covariates	3	1226.7	408.9	2.238	
Residual	81	14798.4	182.7		
Total	96	34956.0	364.1		
Grand Total	127	55679.4			

ANALYSIS OF VARIANCE: EYE AND HAND COORDINATION.

Non-Intervention and Comparison groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	17469.4	17469.4	24.537	0.001
Sex	1	104.3	104.3	0.146	NS
Group.Sex	1	93.5	93.5	0.131	NS
Residual	28	19935.2	712.0	4.922	
Total	31	37602.3	1213.0	8.386	
Subj.Time Stratum					
Time	3	5658.6	1886.2	13.040	0.001
Time.Group	3	401.1	133.7	0.924	NS
Time.Sex	3	47.1	15.7	0.108	NS
Time.Group.Sex	3	120.9	40.3	0.279	NS
Residual	84	12150.5	144.6		
Total	96	18378.3	191.4		
Grand Total	127	55980.6			

ANALYSIS OF VARIANCE (Adjusted for covariates):
EYE AND HAND COORDINATION DQ

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	7929.5	7929.5	27.507	0.001
Sex	1	18.8	18.8	0.065	NS
Group.Sex	1	9.1	9.1	0.032	NS
Covariates	3	12728.3	4242.8	14.718	
Residual	25	7206.9	288.3	2.398	
Total	31	27892.6	899.8	7.484	
Subj.Time Stratum					
Time	3	430.2	143.4	1.193	NS
Time.Group	3	75.6	25.2	0.210	NS
Time.Sex	3	58.2	19.4	0.161	NS
Time.Group.Sex	3	392.0	130.7	1.087	NS
Covariates	3	2412.0	804.0	6.687	
Residual	81	9738.6	120.2		
Total	96	13106.5	136.5		
Grand Total	127	40999.1			

ANALYSIS OF VARIANCE: PERFORMANCE DQ.

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	19491.1	19491.1	26.824	0.001
Sex	1	92.0	92.0	0.127	NS
Group.Sex	1	78.6	78.6	0.108	NS
Residual	28	20345.8	726.6	5.439	
Total	31	40007.5	1290.6	9.661	
Subj.Time Stratum					
Time	3	5119.4	1706.5	12.774	0.001
Time.Group	3	702.2	234.1	1.752	NS
Time.Sex	3	371.6	123.9	0.927	NS
Time.Group.Sex	3	133.7	44.6	0.334	NS
Residual	84	11221.3	133.6		
Total	96	17548.3	182.8		
Grand Total	127	57555.7			

ANALYSIS OF VARIANCE (Adjusted for covariates): PERFORMANCE DQ.

Non-Intervention and Comparison Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	9695.07	9695.07	28.841	0.001
Sex	1	237.21	237.21	0.706	NS
Group.Sex	1	234.14	234.14	0.697	NS
Covariates	3	11941.81	3980.60	11.841	
Residual	25	8403.97	336.16	3.470	
Total	31	30512.21	984.26	10.160	
Subj.Time Stratum					
Time	3	1199.95	399.98	4.129	0.01
Time.Group	3	163.53	54.51	0.563	NS
Time.Sex	3	329.34	109.78	1.133	NS
Time.Group.Sex	3	429.94	143.31	1.479	NS
Covariates	3	3374.33	1124.78	11.610	
Residual	81	7846.99	96.88		
Total	96	13344.08	139.00		
Grand Total	127	43856.29			

ANALYSIS OF VARIANCE: COOPERATIVENESS WITH TESTER

Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	p
Subj stratum					
Group	1	6.974	6.974	3.382	NS
Sex	1	1.240	1.240	0.601	NS
Group.Sex	1	5.899	5.899	2.860	NS
Residual	35	72.175	2.062	2.054	
Total	38	86.287	2.721	2.262	
Subj.Time stratum					
Time	4	149.251	37.313	37.170	0.000
Time.Group	4	5.961	1.490	1.485	NS
Time.Sex	4	3.146	0.787	0.784	NS
Time.Group.Sex	4	1.501	0.375	0.374	NS
Residual	140	140.540	1.004		
Total	156	300.400	1.926		
Grand Total	194	386.687			

ANALYSIS OF VARIANCE: INTEREST IN TEST MATERIAL

Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	p
Subj stratum					
Group	1	3.912	3.912	1.651	NS
Sex	1.	1.303	1.303	0.550	NS
Group.Sex	1	0.467	0.467	0.197	NS
Residual	35	82.933	2.370	2.099	
Total	38	88.615	2.332	2.066	
Subj.Time stratum					
Time	4	201.979	50.495	44.729	0.000
Time.Group	4	3.611	0.903	0.800	NS
Time.Sex	4	6.287	1.572	1.392	NS
Time.Sex.Group	4	0.876	0.219	0.194	NS
Residual	140	158.046	1.129		
Total	156	370.800	2.377		
Grand Total	194	459.415			

ANALYSIS OF VARIANCE: VOCALISATION

Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	p
Subj. stratum					
Group	1	3.6543	3.6543	1.998	NS
Sex	1	2.1840	2.1840	1.194	NS
Group.Sex	1	1.4235	1.4235	0.778	NS
Residual	35	64.0099	1.8289	2.912	
Total	38	71.2718	1.8756	2.986	
Subj.Time stratum					
Time	4	40.9436	10.2359	16.296	0.000
Time.Group	4	0.9263	0.2316	0.296	NS
Time.Sex	4	1.3518	0.3380	0.538	NS
Time.Group.Sex	4	1.6407	0.4102	0.653	NS
Reisual	140	87.9377	0.6281		
Total	165	132.8000	0.8513		
Grand Total	194	204.0718			

ANALYSIS OF VARIANCE : GENERAL DQ

Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	3428.50	3428.50	4.528	<0.05
Sex	1	17.74	17.74	0.023	NS
Group.Sex	1	220.91	220.91	0.292	NS
Residual	35	26502.74	757.22	9.681	
Total	38	30169.89	793.94	10.151	
Subj.Time Stratum					
Time	4	19740.54	4935.14	63.096	<0.000
Time.Group	4	788.08	197.02	2.519	0.05
Time.Sex	4	581.03	145.26	1.857	NS
Time.Group.Sex	4	806.45	201.61	2.578	NS
Residual	140	10950.30	78.22		
Total	156	32866.40	210.68		
Grand Total	194	63036.29			

ANALYSIS OF VARIANCE (Adjusted for Covariates) : GENERAL DQ.

Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	428.37	428.37	1.162	NS
Sex	1	498.92	498.92	1.353	NS
Group.Sex	1	104.99	104.99	0.285	NS
Covariates	3	14704.32	4901.44	13.294	
Residual	32	11798.41	368.70	6.627	
Total	38	27535.01	724.61	13.023	
Subj.Time Stratum					
Time	4	4192.96	1048.24	18.840	<0.001
Time.Group	4	1046.10	261.53	4.700	<0.01
Time.Sex	4	687.94	171.98	3.091	<0.025
Time.Group.Sex	4	1132.57	283.14	5.089	<0.01
Covariates	3	3327.74	1109.25	19.936	
Residual	137	7622.56	55.64		
Total	156	18009.86	115.45		
Grand Total	194	45544.87			

ANALYSIS OF VARIANCE: LOCOMOTOR DQ

Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	389.04	389.04	0.327	NS
Sex	1	39.14	39.14	0.033	NS
Group.Sex	1	11.46	11.46	0.010	NS
Residual	35	41594.83	1188.42	13.141	
Total	38	42034.47	1106.17	12.231	
Subj.Time Stratum					
Time	4	12960.99	3240.25	35.829	<0.001
Time.Group	4	341.76	85.44	0.945	NS
Time.Sex	4	1018.82	254.71	2.816	<0.025
Time.Group.Sex	4	2398.83	599.71	6.631	<0.001
Residual	140	12661.19	90.44		
Total	156	29381.60	188.34		
Grand Total	194	71416.07			

ANALYSIS OF VARIANCE (Adjusted for covariates) :
LOCOMOTOR DQ.

Non-Intervention and Intervention Groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	133.78	133.78	0.166	NS
Sex	1	503.10	503.10	0.624	NS
Group.Sex	1	165.51	165.51	0.205	NS
Covariates	3	15791.64	5263.73	6.528	
Residual	32	25803.64	806.36	9.925	
Total	38	42397.23	1115.72	13.732	
Subj.Time Stratum					
Time	4	4680.62	1170.16	14.402	0.001
Time.Group	4	417.05	104.26	1.283	NS
Time.Sex	4	1120.12	280.03	3.447	0.025
Time.Group.Sex	4	2710.58	677.65	8.340	0.001
Covariates	3	1530.02	510.01	6.277	
Residual	137	11131.17	81.25		
Total	156	21589.56	138.39		
Grand Total	194	63986.79			

ANALYSIS OF VARIANCE : HEARING AND SPEECH DQ

Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	10325.6	10325.6	13.362	<0.001
Sex	1	88.7	88.7	0.115	NS
Group.Sex	1	2132.3	2132.3	2.759	NS
Residual	35	27045.7	772.7	4.180	
Total	38	38592.3	1041.9	5.636	
Subj.Time Stratum					
Time	4	59656.7	14914.2	80.671	< 0.000
Time.Group	4	2458.9	614.7	3.325	<0.025
Time.Sex	4	1298.0	324.5	1.755	NS
Time.Group.Sex	4	869.6	217.4	1.176	NS
Residual	140	25882.7	184.9		
Total	156	90166.0	578.0		
Grand Total	194	129758.3			

ANALYSIS OF VARIANCE (Adjusted for covariates) :
HEARING AND SPEECH DQ

Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	3802.3	3802.3	8.438	<0.001
Sex	1	113.2	113.2	0.251	NS
Group.Sex	1	330.8	330.8	0.734	NS
Covariates	3	12626.4	4208.8	9.340	
Residual	32	14419.3	450.6	2.731	
Total	38	31291.9	823.5	4 .992	
Subj.Time Stratum					
Time	4	25628.2	6407.0	38.837.	<0.001
Time.Group	4	2457.9	614.5	3.725	<0.01
Time.Sex	4	1582.3	395.6	2.398	<0.05
Time.Group.Sex	4	1177.5	294.4	1.784	NS
Covariates	3	3281.7	1093.9	6.631	
Residual	137	22601.0	165.0		
Total	156	56728.6	363.6		
Grand Total	194	88020.5			

ANALYSIS OF VARIANCE : EYE AND HAND COORDINATION

Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	6037.7	6037.7	8.153	<0.01
Sex	1	232.2	232.2	0.314	NS
Group.Sex	1	184.6	184.6	0.249	NS
Residual	35	25919.9	740.6	4.634	
Total	38	32374.4	852.0	5.331	
Subj.Time Stratum					
Time	4	17462.4	4365.6	27.315	<0.001
Time.Group	4	914.9	228.7	1.431	NS
Time.Sex	4	126.7	31.7	0.198	NS
Time.Group.Sex	4	315.3	78.8	0.493	NS
Residual	140	22375.6	159.8		
Total	156	41194.8	264.1		
Grand Total	194	73569.2			

ANALYSIS OF VARIANCE (Adjusted for Covariates) : EYE AND HAND COORDINATION.

Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	1489.3	1489.3	3.902	NS
Sex	1	1084.6	1084.6	2.842	NS
Group.Sex	1	191.1	191.1	0.501	NS
Covariates	3	13706.2	4568.7	11.970	
Residual	32	12213.7	381.7	2.954	
Total	38	28684.9	754.9	5.843	
Subj.Time Stratum					
Time	4	3154.6	788.7	6.105	<0.001
Time. Group	4	1164.5	291.1	2.253	NS
Time.Sex	4	70.2	17.5	0.136	NS
Time.Group.Sex	4	588.1	147.0	1.138	NS
Covariates	3	4676.4	1558.8	12.066	
Residual	137	17699.2	129.2		
Total	156	27353.1	175.3		
Grand Total	194	56037.9			

ANALYSIS OF VARIANCE : PERFORMANCE DQ

Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	1317.6	1317.6	1.287	NS
Sex	1	1.0	1.0	0.001	NS
Group.Sex	1	12.0	12.0	0.012	NS
Residual	35	35834.5	1023.8	5.932	
Total	38	37165.1	978.0	5.666	
Subj.Time Stratum					
Time	4	12254.0	3063.5	17.749	<0.001
Time.Group	4	940.5	235.1	1.362	NS
Time.Sex	4	720.5	180.1	1.044	NS
Time.Group.Sex	4	913.4	228.3	1.323	NS
Residual	140	24164.9	172.6		
Total	156	38993.2	250.0		
Grand Total	194	76158.3			

ANALYSIS OF VARIANCE (Adjusted for Covariates) : PERFORMANCE DQ

Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	1	24.6	24.6	0.051	NS
Sex	1	404.1	404.1	0.831	NS
Group.Sex	1	1004.5	1004.5	2.065	NS
Covariates	3	20271.6	6757.2	13.894	
Residual	32	15563.0	486.3	3.626	
Total	38	37267.8	980.7	7.312	
Subj.Time Stratum					
Time	4	1566.0	391.5	2.919	<0.025
Time.Group	4	1400.7	350.2	2.611	<0.05
Time.Sex	4	840.0	210.0	1.566	NS
Time.Group.Sex	4	1294.4	323.6	2.413	NS
Covariates	3	5789.4	1929.8	14.388	
Residual	137	18375.5	134.1		
Total	156	29265.9	187.6		
Grand Total	194	66533.7			

ANALYSIS OF VARIANCE: COOPERATIVENESS WITH TESTER

Comparison, Non-Intervention and Intervention groups.

Source	DF	SS	MS	F	P
Subj Stratum					
Group	2	6.9577	3.4788	1.446	NS
Sex	1	3.7392	3.7392	1.554	NS
Group Sex	2	6.5142	3.2571	1.353	NS
Residual	47	113.1098	2.4066	2.790	
Total	52	130.3208	2.5062	2.905	
Subj. Time Stratum					
Time	3	156.6179	52.2060	60.513	<0.000
Time.Group	6	13.9634	2.3272	2.698	<0.025
Time.Sex	3	1.9346	0.6449	0.747	NS
Time.Group.Sex	6	2.5899	0.4317	0.500	NS
Residual	141	121.6441	0.8627		
Total	159	296.7500	1.8664		
Grand Total	211	427.0708			

ANALYSIS OF VARIANCE: VOCALISATION DURING TESTS

Comparison, Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	3.9229	1.9615	1.754	NS
Sex	1	5.6390	5.6390	5.042	<0.05
Group.Sex	2	1.6710	0.8355	0.747	NS
Residual	47	52.5690	1.1185	1.641	
Total	52	63.8019	1.2270	1.800	
Subj.Time Stratum					
Time	3	36.3160	12.1053	17.760	<0.001
Time.Group	6	2.8367	0.4728	0.694	NS
Time.Sex	3	0.9184	0.3061	0.449	NS
Time.Group.Sex	6	4.0740	0.6790	0.996	NS
Residual	141	96.1049	0.6816		
Total	159	140.2500	0.8821		
Grand Total	211	204.0519			

ANALYSIS OF VARIANCE: INTEREST IN TEST MATERIAL

Comparison, Non-Intervention and Intervention groups.

Source	DF	SS	MS	F	P
Subj Stratum					
Group	2	7.530	3.765	1.923	NS
Sex	1	1.345	1.345	0.687	NS
Group.Sex	2	0.926	0.463	0.237	NS
Residual	47	92.000	1.957	1.718	
Total	52	101.802	1.958	1.718	
Subj.Time Stratum					
Time	3	201.472	67.157	58.949	0.000
Time.Group	6	11.768	1.961	1.722	NS
Time.Sex	3	4.356	1.452	1.275	NS
Time.Group.Sex	6	4.270	0.712	0.625	NS
Residual	141	160.633	1.139		
Total	159	382.500	2.406		
Grand Total	211	484.302			

ANALYSIS OF VARIANCE ; GENERAL DQ

Comparison, Non-Intervention and Intervention groups

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	16902.30	8451.15	14.036	<0.001
Sex	1	0.96	0.96	0.002	NS
Group.Sex	2	68.59	34.29	0.057	NS
Residual	47	28298.87	602.10	7.995	
Total	52	45270.72	870.59	11.560	
Subj.Time Stratum					
Time	3	21738.23	7246.08	96.216	<0.000
Time.Group	6	1073.62	178.94	2.376	<0.05
Time.Sex	3	654.90	218.30	2.899	<0.05
Time.Group.Sex	6	722.44	120.41	1.599	NS
Residual	141	10618.82	75.31		
Total	159	34808.00	218.92		
Grand Total	211	80078.72			

ANALYSIS OF VARIANCE (Adjusted for Covariates*) :
GENERAL DQ

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	9195.23	4597.61	15.612	0.001
Sex	1	285.15	285.15	0.968	NS
Group.Sex	2	158.97	79.49	0.270	NS
Covariates	3	15341.39	5113.80	17.365	
Residual	44	12957.49	294.49	5.622	
Total	52	37938.22	729.58	13.929	
Subj.Time Stratum					
Time	3	4949.17	1649.72	31.497	<0.000
Time.Group	6	1064.92	177.49	3.389	0.01
Time.Sex	3	962.53	320.84	6.126	0.001
Time.Group.Sex	6	950.77	158.46	3.025	0.05
Covariates	3	3390.68	1130.23	21.578	
Residual	138	7228.13	52.38		
Total	159	18546.20	116.64		
Grand Total	211	56484.43			

* Covariates at each test: Cooperativeness with tester.
Interest in test material.
Vocalisation.

ANALYSIS OF VARIANCE: LOCOMOTOR DQ

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	31079.40	15539.70	14.886	<0.001
Sex	1	10.24	10.24	0.010	NS
Group.Sex	2	45.39	22.69	0.022	NS
Residual	47	49064.15	1043.92	10.926	
Total	52	80199.19	1542.29	16.143	
Subj.Time Stratum					
Time	3	14412.64	4804.21	50.284	<0.000
Time.Group	6	448.26	74.71	0.782	NS
Time.Sex	3	924.10	308.03	3.224	<0.05
Time.Group.Sex	6	2410.69	401.78	4.205	<0.001
Residual	141	13471.31	95.54		
Total	159	31667.00	199.16		
Grand Total	211	111866.19			

ANALYSIS OF VARIANCE (Adjusted for covariates*) : LOCOMOTOR DQ.

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	18530.99	9265.49	13.292	0.001
Sex	1	236.79	236.79	0.340	NS
Group.Sex	2	519.21	259.60	0.372	NS
Covariates	3	18395.35	6131.78	8.797	
Residual	44	30668.80	697.02	7.989	
Total	52	68351.14	1314.45	15.066	
Subj.Time Stratum					
Time	3	5688.37	1896.12	21.733	0.001
Time.Group	6	476.25	79.37	0.910	NS
Time.Sex	3	1160.68	386.89	4.434	0.01
Time.Group.Sex	6	2561.56	426.93	4.893	0.001
Covariates	3	1431.15	477.05	5.468	
Residual	138	12040.17	87.25		
Total	159	23358.16	146.91		
Grand Total	211	91709.30			

* Covariates = behaviour during test.

ANALYSIS OF VARIANCE : HEARING AND SPEECH DQ

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	11729.4	5864.7	10.179	<0.001
Sex	1	80.9	80.9	0.140	NS
Group.Sex	2	1572.6	786.3	1.365	NS
Residual	47	27079.0	576.1	3.131	
Total	52	40462.0	778.1	4.229	
Subj.Time Stratum					
Time	3	68647.1	22882.4	124.353	<0.000
Time.Group	6	2595.3	432.6	2.351	<0.05
Time.Sex	3	1485.2	495.1	2.690	<0.025
Time.Group.Sex	6	1625.1	270.9	1.472	NS
Residual	141	25945.5	184.0		
Total	159	100298.3	630.8		
Grand Total	211	140760.2			

ANALYSIS OF VARIANCE (Adjusted for covariates*) : HEARING AND SPEECH

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	6049.9	3024.9	8.557	<0.001
Sex	1	193.4	193.4	0.547	NS
Group.Sex	2	352.9	176.4	0.499	NS
Covariates	3	11524.6	3841.5	10.867	
Residual	44	15554.4	353.5	2.177	
Total	52	33675.2	647.6	3.988	
Subj.Time Stratum					
Time	3	33185.2	11061.7	68.123	<0.000
Time.Group	6	2811.5	468.6	2.886	<0.025
Time.Sex	3	1988.7	662.9	4.082	<0.01
Time.Group.Sex	6	1443.2	240.5	1.481	NS
Covariates	3	3537.3	1179.1	7.261	NS
Residual	138	22408.3	162.4		
Total	159	65374.2	411.2		
Grand Total	211	99049.3			

* Covariates at each test = behaviour during test.

ANALYSIS OF VARIANCE : EYE AND HAND COORDINATION

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	17589.4	8794.7	14.608	0.001
Sex	1	78.3	78.3	0.130	NS
Group.Sex	2	121.6	60.8	0.101	NS
Residual	47	28295.3	602.0	3.691	
Total	52	46084.6	886.2	5.433	
Subj.Time Stratum					
Time	3	17176.8	5725.6	35.102	0.001
Time.Group	6	2307.7	384.6	2.358	0.05
Time.Sex	3	132.9	44.3	0.272	NS
Time.Group.Sex	6	301.0	50.2	0.308	NS
Residual	141	22999.1	163.1		
Total	159	42917.5	269.9		
Grand Total	211	89002.1			

ANALYSIS OF VARIANCE (Adjusted for covariates) :
EYE AND HAND COORDINATION.

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	9375.6	4687.8	16.867	0.001
Sex	1	601.4	601.4	2.164	NS
Group.Sex	2	154.1	77.0	0.277	NS
Covariates	3	16066.6	5355.5	19.270	
Residual	44	12228.8	277.9	2.097	
Total	52	38426.4	739.0	5.575	
Subj.Time Stratum					
Time	3	2026.5	675.5	5.096	0.01
Time.Group	6	1879.2	313.2	2.363	0.05
Time.Sex	3	164.1	54.7	0.413	NS
Time.Group.Sex	6	646.4	107.7	0.813	NS
Covariates	3	4705.6	1568.5	11.833	
Residual	138	18293.5	132.6		
Total	159	27715.3	174.3		
Grand Total	211	66141.7			

ANALYSIS OF VARIANCE : PERFORMANCE DQ

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	20352.4	10176.2	13.498	<0.001
Sex	1	7.9	7.9	0.011	NS
Group.Sex	2	216.4	108.2	0.143	NS
Residual	47	35433.8	753.9	4.511	
Total	52	56010.5	1077.1	6.445	
Subj.Time Stratum					
Time	3	11760.5	3920.2	23.455	<0.001
Time.Group	6	1858.9	309.8	1.854	NS
Time.Sex	3	1000.6	333.5	1.996	NS
Time.Group.Sex	6	329.2	54.9	0.328	NS
Residual	141	23566.4	167.1		
Total	159	38515.5	242.2		
Grand Total	211	94526.0			

ANALYSIS OF VARIANCE (Adjusted for Covariates) : PERFORMANCE DQ

Comparison, Non-Intervention and Intervention groups.

SOURCE	DF	SS	MS	F	P
Subj Stratum					
Group	2	11396.3	5698.2	14.230	<0.001
Sex	1	113.4	113.4	0.283	NS
Group.Sex	2	1165.8	582.9	1.456	NS
Covariates	3	17814.9	5938.3	14.830	
Residual	44	17618.9	400.4	3.321	
Total	52	48109.3	925.2	7.674	
Subj.Time Stratum					
Time	3	470.7	156.9	1.301	NS
Time.Group	6	1527.1	254.5	2.111	NS
Time.Sex	3	1274.3	424.8	3.523	<0.025
Time.Group.Sex	6	899.1	149.8	1.243	NS
Covariates	3	6929.5	2309.8	19.160	
Residual	138	16636.9	120.6		
Total	159	27737.5	174.4		
Grand Total	211	75846.8			