# AN INVESTIGATION OF THE RELIABILITY AND VALIDITY OF THE GROVER DEVELOPMENTAL CHARTS FOR VERY YOUNG CHILDREN

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by

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# INTRODUCTION

Increasing interest in and acknowledgement of the importance of the early childhood period has resulted in a growing need for assessment techniques during the first few years of life. Various reasons can be put forward to account for this growing awareness of the significance of the early childhood period and the need for early assessment.

The 'nihilistic' concept (Buckle in Segal, 1974) of the constancy of IQ is no longer defensible and research evidence (Stein and Susser, 1971) suggests that IQ change both in individuals and in populations is systematic through time and that exposure of children to certain social environments can have an appreciable effect on their mental development. Consequently there emerged the feasibility of prevention and intervention in the early childhood period.

Available evidence does not support the view that there are critical periods during which children must be exposed to a given learning opportunity or forever suffer some degree of intellectual deficit. Rather a period of maximum susceptibility to learning is now more accurately referred to as 'optimal' (Clarke, 1968) or 'sensitive' (Clarke & Clarke, 1965; Connolly, 1972; Rutter, 1972) periods.

Evidence drawn from animal studies such as those of Hubel and Wiesel (1963) suggests that in the phase of early development, the functional competence of the nervous system depends on function itself, a concept which is important when considering early intervention.

"The lack of attentionto a child's handicapped condition during the early childhood developmental period, can lead to irreversible deterioration of his potential for leading a normal and useful life" (Rothstein).

Furthermore Capute and Biehl (in Haslam, 1973) stress the importance of "early identification of developmental delay and intervention before secondary disabilities develop." (page 25). Such secondary handicaps may be the result of either extrinsic hazards such as those mentioned by Hughes (1971), Grover (1975) and Saint-Anne Dargassies (1972) or intrinsic hazards such as those outlined by Hughes (1971).

Assessment is seen as forming the core of the intervention process and as such plays a profoundly important role.

The Grover Developmental Charts were developed in an attempt to fill the need for a detailed, finely graded and sufficiently objective means of assessing the child's development in certain important areas, and although they may be used for normal children, they were primarily intended for use with handicapped children and in particular the mentally retarded child.

Many of the existing infant and preschool tests while adequate for assessing the normal child, have limitations which make them not entirely suitable or adequate for the atypical child. These limitations are discussed.

The aim of the present study is to investigate the reliability and validity of the Grover Developmental Charts as an objective measure

of the child's current level of functioning in certain significant, measurable and selected areas of development. These areas are (1) body management and mobility (2) interaction with objects, dexterity and fine co-o dination (3) socialization and awareness of self and others and (4) communication both receptive and expressive.

METHOD

The sample on which this study was carried out consisted of a group of 108 white, English speaking children of both sexes between the ages of 10 months and 36 months from both creches and private homes in the Cape Peninsula. An attempt was made to select an equal number of males and females and four children at each month were examined. The parents' social class was rated according to the six classes used in the "Tri-axial classification of mental disorders in childhood" (Rutte , et al., 1969).

All the subjects were tested on the Grover Developmental Charts and then retested between five and seven days later to establish test-retest reliability. At the same time as the children were retested on the Grover Developmental Charts, the Denver Developmental Screening Test was administered as the criterion test against which the Grover Developmental Charts were validated. Tester-observe reliability was established using 21 subjects.

The Grover Developmental Charts were examined for face validity; criterion related validity; concurrent rather than predictive validity; construct validity as reflected in age differentiation;

correlations with another test, factor analysis and internal consistency. The significance of the variables sex; social class and home vs creche was examined.

## RESULTS

Test-retest reliability correlation coefficients of between ,951 and ,999 were obtained and tester-observer reliability coefficients of between ,997 and ,999. When the subscales on the Grover Developmental Charts were correlated with the corresponding subscales on the DDST the correlation coefficients ranged between ,863 and ,969.

In terms of age differentiation, results indicate that the set of scores obtained on an individual will reflect an increase in developmental age and not necessarily chronological age. The factor analysis yielded one factor which explained 94,2% of the variability of the five subscale scores on the Grover Developmental Charts, and which is an estimate of developmental age. On examining internal consistency, the correlations of subscales of the Grover Developmental Charts with the total score ranged between ,951 and ,990.

## DISCUSSION

The results indicate that the Grover Developmental Charts have excellent test-retest and tester observer reliability. Furthermore as is substantiated by the results of an examination of the criterion related validity, age differentiation, internal consistency and factor analysis, the Grover Developmental Charts are a valid instrument

and serve the purpose for which they were designed.

## CONCLUSION

One can thus conclude that the Grover Developmental Charts are applicable for use with the normal child from 10 to just under 36 months. Furthermore, although the Grover Developmental Charts have not yet been applied to any extent to the atypical child, the results so far obtained in this study suggest that they would provide a valuable instrument for use with the handicapped child.

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# 1. INTRODUCTION

Increasing interest in and acknowledgement of the importance of the early childhood period has resulted in increasing demands for assessment techniques during the first few years of life. Several reasons can be put forward to account for this growing awareness of the significance of the early childhood period and the resultant need for early assessment. Some contributing factors will be discussed here.

The research involving normal development and the early childhood period will first be dealt with.

## 1.1 MUTABILITY OF INTELLIGENCE AND THE IMPORTANCE OF THE EARLY CHILDHOOD PERIOD

The "nihilistic" concept (Buckle in Segal, 1974) of the constancy of the IQ has, despite contrary evidence, been perpetuated for far too long. As early as the beginning of the twentieth century Binet is quoted as saying: "Some recent philosophers appear to have given their moral support to the deplorable verdict that the intelligence of an individual is a fixed quantity, a quantity which cannot be augmented. We must protest and act against this brutal pessimism... the intelligence of children may be increased. One increases that which constitutes the intelligence of a school child; namely the capacity to learn, to improve with instruction." (In Clarke and Clarke, 1958, p.70.)

Today, however, the concept of the IQ as constant is no longer defensible. Stein and Susser (1971) in their review of present individual and population data about IQ change at the lower end of the scale conclude that in general the evidence tends to show that

IQ change both in individuals and in populations is systematic through time. Changes in IQ with age and with particular experiences suggest that exposure of children to certain social environments can have an appreciable effect on their mental development.

In the course of the past fifteen years, a very extensive literature has grown up on the effects of early experience on later behaviour (Newton and Levine, 1968). We now know that genetically based characteristics may be extensively modified by early experience and we know also that early experiences are oneof the principal sources of individual differences in behaviour. We know, too, that early experiences have multiple effects and that the age at which they are administered is crucial." (Connolly, 1972, p.706).

Research evidence proved fallacious the assumption of intelligence being an immutable, inborn phenomenon insensitive to changes in environment. More tenable was the concept of development being influenced by and sensitive to variation in environment. Consequently there emerged the feasability of prevention and intervention in the early childhood period.

Bloom (1964) in emphasizing the importance of the first few years of life in terms of later development says, "...evidence so far suggests that marked changes in the environment in the early years can produce greater changes in intelligence than will equally marked changes in the environment at later periods of development." (p.89)

## 1.2 CRITICAL PERIOD HYPOTHESIS

Evolving out of and complimentary to the research supporting the mutability of intelligence and the significance of environment during the early childhood period in view of future development, is the research pertaining to the 'critical' period hypothesis.

Caldwell and Denenberg (in Endler, Boulter and Osser, 1968) give two ways in which the critical period hypothesis can be interpreted.
(a) a critical period beyond which a given phenomenon will not appear (i.e. a point in time which marks the onset of total indifference or resistance, to certain patterns of stimulation; and
(b) a critical period during which the organism is especially sensitive to various developmental modifiers, which if introduced at a different time in the cycle, would have little or no effect, i.e. a period of maximum susceptibility. It is the latter interpretation which Clarke (1968) uses when he refers to 'optimal' periods of learning or 'sensitive' periods. This interpretation is also used by Clarke, 1965; Connolly, 1972; Rutter, 1972.

There is no good evidence so far to suggest that there is only one period of intellectual development sensitive to external intervention, "...on present knowledge intervention could be justified throughout the recognized period of mental development and possibly later." (Stein and Susser, 1971, p.395). Available evidence does not support the view that there are'critical periods'during which children must be exposed to a given learning opportunity or forever suffer some degree of intellectual deficit. "Rather, this concept, a carry over from studies that demonstrated imprinting in certain animals, may

hamper the development of a soundly based approach to the learning difficulties of deprived children." (Wolf, 1973, p.58).

However, the better understanding of the dependence of brain structure and function on environmental stimulation has added a different perspective to the concept. The findings from animal studies such as those of Hubel and Wiesel (1963) that the CNS requires stimulation to maintain structural integrity, that this requirement is greater in the young than in the mature organism, has served as circumstantial evidence for the assumption that the human infant has similar requirements. In other words, that stimulus deprivation may cause mental retardation. (Wolff, 1973; Mackay, 1973).

That one should interpret these animal studies with caution is obvious, especially in view of the fact that animals have a relatively short period of immaturity, making the role of learning during the developmental period of a correspondingly short period. Man's prolonged development, as Clarke and Clarke (1960) point out, "implies prolonged flexibility and hence although deprivation effects in children may be considerable there is a greater period for compensatory recovery..." (p. 26).

However the evidence that suggests that in the phase of early development, the functional competence of the nervous system also depends on function itself, is strong enough to be considered as an important concept when considering early intervention.

This leads to the second part of the discussion, namely the research and issues involved with early development in the handicapped child or abnormal early development.

## 1.3 EARLY IDENTIFICATION

Clearly the goal of this current wave of concern with early childhood development is to "develop the optimum potential of all children" (McGraw, 1970, p.754). However, although the need for early identification, assessment and remediation of both mental and physical handicap is an accepted fact, it is not yet an established service. "The lack of attention to a child's handicapped condition during the early childhood developmental period can lead to irreversible deterioration of his potential for leading a normal and useful life." (Rothstein, 1971, p.141).

Capute and Biehl (in Haslam, 1973) add a further important point when in the final analysis they state "that it is of the utmost importance to stress the early identification of developmental delay and intervention before secondary disabilities develop." (p. 25). Such secondary handicaps may be the result of either extrinsic hazards such as those mentioned by Hughes (1971), Grover (1975) and Saint-Anne Dargassier (1972), or intrinsic hazards such as those outlined by Hughes (1971). The extrinsic hazards are those of a deprivational nature which can then impose a secondary handicap on the individual "which can be as severe as those resulting from his original handicapping condition." (Grover, 1975). The intrinsic hazards such as are outlined by Hughes (1971), a physiotherapist, result in abnormal patterns of movements which occur during periods of arrested motor development or 'stuck' periods, and which have far reaching effects. "Therapy begun after the motor development has become arrested or distorted must be remedial, and the chances of achieving normal posture and movement varies universally with the age at which it is started." (Hughes, 1971, p.408).

## 1.4 THE IMPORTANCE OF THE EARLY CHILDHOOD PERIOD AND THE MENTALLY RETARDED CHILD IN SOUTH AFRICA

In most developed countries it has long been recognized that all children have the right to education, and subsequent provision has been made for the education of the mentally retarded child as well as the normal child. However, in South Africa, it is only since the enactment of the Mentally Retarded Children's Training Bill in 1974 that provision has been made for the education of the mentally retarded child. Through this Bill, training in special centres under the authority of the Department of National Education has become compulsory between six and eighteen years of age, for those retarded children considered capable of it.

The significance, therefore, of the preschool period in the light of the retarded child's future, cannot be over-emphasized. For, as Grover (1975) stresses, the child's ability to meet the criterion of capability and hence eligibility for admission into the special training centres at about six years of age "...will depend not so much on what some people think of as inborn intelligence, but on what has happened to the child before he reaches the age of six years." According to Grover (1974), for the retarded child, the pre-school years are even more critical than for the normal child, for two reasons. "Firstly, the retarded child is less able to initiate and sustain meaningful play and exploratory activities through which the normal child spontaneously instigates his own sensori-motor and perceptual and language growth; and secondly, the retarded child's development is usually so uneven that a much more systematic programme, based on careful individual assessment is essential." (p.11).

All the aforementioned research evidence, thus seems to point to the

need for early identification and remediation of both mental and physical handicapping conditions if the individual is indeed to actualise his optimum potential.

It is obvious that assessment, as part of this process of early intervention, is seminal. "Assessment of the child leads to the cultivation of maturity of function in the context of the developing individual" (Mackay, 1973, p.1.)

This leads to a consideration of the general purpose of assessment of the handicapped during the early childhood period.

It should be made clear that assessment is seen as forming the core of the intervention process and as such plays a profoundly important role. Viewed in this way assessment may be described as a process of studying the individual beyond the medical diagnosis to find ways to develop potential abilities in the face of disability ... Potential is unknown at the beginning of the process and emerges as a result of assessment and developmental training. (Mackay, 1973, p.1)

If early assessment leads to early intervention so that those closely involved in the care and training of the child glean directives for fostering development, the appraisal is worthwhile. In other words if findings are utilized to prevent, ameliorate or uncover the difficulties encountered by handicapped children and to plan for optimal development, our assessment activities assume some meaning." (Chase, 1975, p.341). The entire assessment process should always be clearly child centred and intervention based. "When problems are identified early in life, data collected as to their character and extent and treatment plans formulated and executed for prevention of complications and attendant social handicaps, I believe the psychologist is engaging in the 'highest order' evaluation, preventive assessment." (Chase,

1975, p.342)

## 1.5 THE NEED FOR AND JUSTIFICATION OF THE INTRODUCTION OF A NEW ASSESSMENT INSTRUMENT

### 1.5 (i) Specific purpose for which the Grover Development Charts were designed

Although the Grover Developmental Charts were standardized on a normal population and can indeed be used for the assessment of the normal child, it was specifically for the purpose of assessing the handicapped and more especially the mentally handicapped child that these Charts were devised.

For it was while working with and attemtping to assess young mentally retarded children, and after a detailed and thorough review of the available infant and preschool assessment charts, scales and tests that it was in fact deemed necessary to devise this new assessment instrument.

It must be emphasized from the outset and most categorically stated that the Grover Developmental Charts make no claim to measure some hypothetical, innate, static and global entity often referred to as intelligence. These Charts aim at providing an assessment procedure which will objectify the child's current level of functioning in certain significant, measureable and selected areas of development. This level will depend in part on the integrity and maturity of the organism and in part on the environment, experiences and opportunities to which the growing individual has been exposed up to this point.

Furthermore the Grover Developmental Charts were intended to provide a

good diagnostic tool rather than a mere screening instrument. Whereas a screening instrument would merely state whether the individual's performance in a test was found to be within normal limits of development or not, a diagnostic test would provide a detailed assessment, in finely graded stages, of the abilities and disabilities of the very young child in the four main areas of development: gross motor co-ordination, fine motor co-ordination, socialization and communication.

The benefits of such a qualitative assessment are many. Importantly such a diagnostic instrument would enable one to identify the often uneven development or developmental lag of the atypical child at an early age, so that a programme of intervention and remediation based on this assessment could be designed to meet the needs of each individual child concerned. "The earlier such data is gathered and all concerned, both parents and professionals, are recruited to assist the developmental process, the greater the likelihood of success." (Chase, 1975, p.341). Assessment thus is seen as playing a seminal role in the intervention process.

A diagnostic test meeting the above requirements would invalidate the criticisms of people such as Mittler (1973) who speak of "the routine use of assessment procedures unrelated to the needs of the handicapped person" (p.x) He expresses the dissatisfaction of many psychologists who have pleaded not only for a more selective and discriminatory use of tests "but for the forging of a closer link between assessment and the design of appropriate treatment programmes". (Mittler, 1973, p.v)

1.5 (ii) General limitations of existing infant assessment procedures in view of the purpose for which the Grover Developmental Charts were designed.

While existing assessment procedures are often adequate for the screening and broad assessment of normal children or children whose general development follows the normal pattern of developmental growth, they were found not to be wholly adequate or appropriate for use with the very young atypical child and more especially the mentally handicapped child. The general inadequacies of the major existing tests reviewed will be mentioned here:-

(a) The test may not be sufficiently finely graded and may not provide a sufficiently detailed profile to give the qualitative assessment necessary for the purpose of assessing the mentally handicapped young child. The subtest items may not represent each month but may leave gaps of two, three or more months. For example in the Cattell Infant Intelligence Scale (Cattell, 1947) the levels are at one-month intervals from 2 to 12 months of age, 2-month intervals from 12 to 24 months and 3-month intervals from 24 to 30 months. Similarly, the Gesell Developmental schedules (Gesell and Amatruda, 1947) has several different forms including one for each 4-week period up to 56 weeks of age and one for each 3-month period for age 15-24 months. For a similar reason, the Bayley Scales of Infant Development (Bayley, 1969) were also not considered completely adequate, as they do not provide a detailed enough or finely graded enough profile for the purpose of assessing the young atypical child's development.

The progress of the atypical child needs constant reassessment in order to establish the efficiency of the particular programme

implemented as this will require modification with the development of the individual. A finely graded and detailed test would provide a good medium for reassessment, especially where improvement is very slow or slight, as is so often the case with the mentally retarded child. A disadvantage of most tests giving a less detailed picture with large gaps in development, when used for reassessment purposes is that they may fail to indicate the growth and would consequently tendto show a discouraging and imperceptible lack of change.

Through being able to follow closely the development of the individual in this way, the possiblity exists of a further advantage of such an instrument, namely that it may provide insight into the seemingly idiosyncratic nature of the development of the handicapped child.

Furthermore William (in Mittler, 1973) in his review of many of the existing scales for the assessment of social behaviour and ability of individuals concludes that the disadvantage of most of the scales is that they cover many different areas of social ability and behaviour and the information obtained in any one area is not sufficient in itself for the design of adequate training programmes, nor is the scale sufficiently detailed in each area to provide an adequate assessment of progress in that specific area." (p.167)

(b) The test may not have a low enough floor or a high enough ceiling. That is they may not cover the age group 10 months to 36 months chosen to be covered by the Grover Developmental Charts. This particular age group was chosen for various reasons. Before the age of ten months it was felt that assessment of the infant could probably best be undertaken by a paediatrician. "Assessment of normal or handicapped children in the early months of life usually has a greater medical

component because physical disability or ailment is more threatening at this age." (Mackay, 1973, p.5).This view is upheld by others such as Knobloch and Pasamanick (1963).

Furthermore developmental theorists such as Piaget have indicated that up to about the age of ten months, growth is characterised by a form of development that reflects largely the maturation of the organism's nervous sytem. But a new and very important stage of emergent development begins at about the age of ten months.

After the age of thirty-six months, various tests such as the Merrill-Palmer Scale of Mental Tests (1948) and the Stanford-Binet Intelligence Scale (1960) for example, are available and fairly suitable for the assessment of both the normal and handicapped child.

The existing assessment procedures therefore are not entirely adequate for our purposes as they do not cover the selected age range. Some examples may be mentioned here. The Agpar Test (Agpar, 1966) assesses the baby at birth; Buhler Baby Tests (Buhler et al., 1930) from two months to two years; Griffiths Abilities of Babies Scale and Griffiths Mental Development Scale (Griffiths, 1954) from birth to two years of age.

(c) For some tests no norms are available at all at present. Other tests were standardized many years ago,on perhaps very small samples, and their norms may no longer be valid as children have since changed their patterns of development. This applies to such tests as the Gesell Developmental Schedules (Gesell, 1947). For many tests such as the Gesell Developmental Schedules (Gesell, 1947), the Piaget Series (Decarie, 1965) and the Merrill-Palmer Scale of Mental Tests

(Stutsman, 1948) there is either no reliability and validity data available at present, or such reliability and validity figures as are available may be inadequate.

(d) The test may not cover all the significant areas of development. A test such as the Merrill-Palmer Scale of Mental Tests (Stutsman, 1948), for example, does not cover the area of socialization at all. In an assessment of the handicapped child it is especially important that all areas of development be covered, as certain areas are more vulnerable to impairment than others. Thus for the purpose of the Grover Developmental Charts in which it is hoped both strengths and weaknesses, abilities and disabilities will be highlighted, it is of great importance that no significant area of development be omitted.

(e) There are no infant scales covering the ten to thirty-six month period, standardized on any of our South African population groups. This again becomes very important when considering the enactment of the Mentally Retarded Children's Training Bill in 1974, whereby as mentioned in a previous section, training in special centres under the authority of the Department of National Education, will become compulsory between the ages of six and eighteen years for those retarded children considered capable of it. This means that retarded children may have to be assessed on tests that are neither designed for their needs, nor standardized on the South African population.

(f) Perhaps one of the most important and certainly most original features of the Grover Developmental Charts is found in the Communication Chart, where receptive and expressive language skills are separately assessed. None of the existing infant scales covering

general development has a language scale which distinguishes between receptive and expressive skills. This inadequacy becomes of great importance when assessing the mentally handicapped child. For mentally handicapped children as well as some other kinds of handicapped children, usually have a specific deficit in spoken or expressive language, but language comprehension or receptive language may be considerably better. In such a case a single communication score, which is all that is most often revealed, would tend to reflect an inaccurate and misleading assessment of that child's communicative ability.

## 1.6 A BRIEF HISTORY OF INTELLIGENCE TESTS LEADING TO THE DEVELOPMENT OF INFANT ASSESSMENT

Although psychologists such as Sir Francis Galton and James M. Cattell had been interested in testing individual differences considerably prior to 1900, "their efforts in assessing 'pure' sensorimotor functions, such as reaction times and muscle strength, provided little of practical use in understanding significant human behaviour." (Wissler, 1901 in Robinson and Robinson, 1965, p.411).

Using a different approach the French psychologist Alfred Binet, began to publish studies concerned with the nature of intellect in the 1890's. By 1904 however the Paris school authorities, concerned about the problems created by ineducable children in regular classrooms, prevailed upon Binet to devise an objective, practical test which would measure the potential ability of slow learning children to profit from ordinary classroom experience, and which would be employed to determine which children to assign to special new classes for the retarded. Together with the psychiatrist Theodore Simon, he published a thirty item scale based on his previous work, which

measured functioning on tasks which were more or less related to the intellectual abilities required for success in school. The test was first published in 1905; its first revision, in which the tests were grouped according to age levels on the basis of empirically derived evidence, appeared in 1908. The scale was scored according to mental age. A second revision was published in 1911. The 1908 and 1911 scales were translated into many languages, including English, and were taken to the United States by several people including among others Terman (Terman, 1916; Terman and Childs, 1912). Terman's 1916 revision of the 1911 Binet-Simon test was so popular that it eventually became the standard test of general mental ability in English speaking countries. (Robinson & Robinson, 1965, p.411). The 1916 test was replaced in 1937 by another by Terman and Merrill, which appeared in two equivalent forms, Form L and Form M. This was again revised in 1960 combining the best items of Form L and Form M and is thus known as Form L-M.

"The chief rival of the Stanford-Binet is the Wechsler Intelligence Scale for Children, the WISC, published in 1949 by David Wechsler" (Robinson & Robinson, 1965, p.417). The WISC is a downward extension of the the Wechsler Adult Intelligence Scale (WAIS) which was published in 1955 and its predecessors, the Wechsler-Bellevue Intelligence Scale, Forms I and II (Wechsler, 1939; 1944 in Robinson and Robinson, 1965). The Wechsler Preschool and Primary Scale of Intelligence (WPPSI) published in 1968, designed for ages 4 to 6½ years is a downward extension of the WISC, and the "baby" of the series.

Infant Assessment

One of the pioneers in the testing of infants was Arnold Gesell. Following a series of longitudinal studies, performed over more than twenty years, of the normal course of behaviour development in the

infant and preschool child, Gesell and his associates at Yale prepared the Gesell Developmental Schedules (Gesell and Amatruda, 1947). These schedules cover four major areas of behaviour: motor, adaptive, language, and personal-social. They provide a standardized procedure for observing and evaluating the course of behaviour development in the child's daily life. "Although a few may be properly described as tests, most of the items in these schedules are purely observational. Data are obtained through the direct observation of the child's responses to standard toys and other stimulus objects and are supplemented by information provided by the mother. In evaluating the child's responses, the examiner is aided by very detailed verbal descriptions of the behaviour typical of different age levels, together with drawings" (Anastasi, 1976, p.267) While extending from the age of four weeks to 6 years, the Gesell schedules typify the approach followed in infant testing. Items from these schedules have been incorporated in several other developmental scales designed for the infant level.

Although both observational and scoring procedures are less highly standardized in the Gesell schedules than in the usual psychological test, evidence shows that examiner reliability coefficients of over ,95 can be attained with adequate training. (Knoblock & Pasamanick, 1960, in Anastasi, 1976). "In general these schedules may be regarded as a refinement and elaboration of the qualitative observations routinely made by paediatricians and other specialists concerned with infant development. They appear to be most useful as a supplement to medical examinations for the identification of neurological defect and organically caused behavioural abnormalities in early life." (Donofrio, 1965; Knoblock & Pasamanick, 1960, in Anastasi, 1976, p.267.)

Another type of developmental scale is more restricted in the types of behaviour observed but covers a much wider age range. The prototypes of such scales are the Oseretsky Test of Motor Proficiency and the Vineland Social Maturity Scale. According to Anastasi (1976) although they extend well beyond the preschool period, they are relevant to the present discussion because of certain similarities to the Gesell Scales in both content and general approach and furthermore are more suitable for use at the lower age and intellectual levels than at the higher levels.

The Oseretsky Tests of Motor Proficiency were originally published in Russia in 1923 and were thereafter translated into many languages and used in several European countries. In 1946 Doll (1946) then director of Research for the Vineland Training School, both sponsored and edited an English translation of the Portuguese adaptation of these tests. In 1955, the Lincoln-Oseretsky Motor Development Scale (Sloan, 1955) was issued "as a revision and restandardization of the Oseretsky tests with simplified instructions and improved scoring procedures. Covering only ages six to 14, this revision includes 36 of the original 85 items." (Anastasi, 1976, p.269.)

The Vineland Social Maturity Scale (Doll, 1953, 1965) is a developmental schedule, covering a range from birth to over 25 years, concerned with the individual's ability to look after his practical needs and to take responsibility. It consists of 117 items grouped into appropriate year levels. The information needed for each item is obtained by means of an interview with an informant or with the examiner himself.

According to Anastasi (1976) a newer and more comprehensive instrument is the Adaptive Behaviour Scale prepared by a committee of the American Association on Mental Deficiency. It was designed primarily for mental retardates, but may also be used with emotionally maladjusted and other handicapped people. Adaptive behaviour is defined as the "effectiveness of an individual in coping with the natural and social demands of his or her environment" (American Association on Mental Deficiency, 1974, in Anastasi 1976, p.270). In its 1974 revision, this scale provides a single form applicable from the age of three years on." Like the Vineland, it is based on observations of everyday behaviour and may be completed by parents, teachers, ward personnel or others who have been in close contact with the examinee. The information may also be obtained through questioning or interviewing of one or more observers." (Anastasi, 1976, p.270).

During the 1960's and 1970's there was an upsurge of interest in tests for infants and preschool children. Anastasi (1976) contends that one contributing factor to this interest was the rapid expansion of educational programmes and facilities for mentally retarded children. Another was the widespread awareness of the need for and development of preschool programmes of compensatory education for culturally disadvantaged children. As a consequence in order to meet these needs, new tests were devised and a great deal of research was carried out on innovative approaches to assessment. A comprehensive review of available tests at both the infant and preschool levels can be found in such studies as that of Stott and Ball (1965).

The Bayley Scales of Infant Development provide a good example of the kind of test devised to fill this important need for infant

tests. Anastasi (1976) describes it as an "especially well constructed test for the earliest age levels. Incorporating some items from the Gesell schedules and other infant and preschool tests, these scales represent the end product of many years of research by Bayley and her co-workers, including the longitudinal investigations of the Berkeley Growth study". (p. 272). The Bayley Scales provide an assessment of the current developmental status of children between the ages of two months and 2½ years. "In the technical quality of their test construction procedures the Bayley scales are clearly outstanding among tests for the infant level." (Anastasi, 1976, page 273)

The McCarthy Scales of Children's Abilities may briefly be cited as an example of the kind of test devised for use at the preschool and early school level and are suitable for use with children between the ages of 2½ and 8½ years.

Piagetian Scales

"Although applicable well beyond the preschool level, the scales modelled on the developmental theories of Jean Piaget have thus far found their major applications in early childhood." (Anastasi, 1976, p.276) Piaget conceives of intellectual development in terms of an "evolution through qualitatively different stages of thought" (Ginsburg & Opper, 1969, page 6).

Piaget believes that cognitive processes emerge through a process of development which consists of a reorganisation of psychological structures resulting from organism-environment interaction..."

"Cognitive development is to be found neither in the structure and maturation of the organism nor in the teaching structures of the environment but in the structure of the interaction between organism and environment." (Kohlberg, 1968, p.1015).

All the scales which are based on Piaget's theory of intellectual development are as yet in an experimental form and few are commercially available for distribution. Most have been devised for use in the author's own research work and programmes although there are some scales which are available to other research workers. "At this stage, the major contribution of Piagetian scales to the psychological testing of children consists in their providing a theoretical framework that focusses on developmental sequences and a procedural approach characterized by flexibility and qualitative interpretation. Piagetian Scales are ordinal in that they presuppose a uniform sequence of development through successive stages. They are also content referenced in so far as they provide qualitative descriptions of what the child is actually able to do. Piagetian tasks focus on the long term development of specific concepts of cognitive schemata, rather than on broad traits." (Anastasi, 1976, p.276) As far as administering these scales is concerned, the major object of Piagetian scales is to elicit the child's explanation for an observed event and the reasons that underlie his explanation. The examiner thus concentrates more on the process of problem solving than on the product thereof.

Being a highly individualized procedure Piagetian testing is very well suited for clinical work, and has attracted the attention of educators too, because it permits the integration of testing and teaching. It is however still most often used in research on developmental psychology.

Examples of such Piagetian Scales are the Ordinal Scales of Psychological Development designed by Uzgiris and Hunt (1975) covering the age period two weeks to two years. This period covers approximately what Piaget terms the sensorimotor period within which he recognises six stages. These are object permanence; development of means; imitation; operational causality; object relations in space; development of schemata for relating to objects. Althought no norms exist for this test, some psychometric data is available.. Uzgiris and Hunt clearly explain that these are only provisional scales, although they are available to other investigators for research purposes.

As a result of their comprehensive and long-term research project designed to replicate Piaget's work under standardized conditions and in a different cultural milieu, Laurendeau and Pinard of the University of Montreal have constructed scales of mental development that will eventually be available to other researchers. They deal with amongst other things, the child's concept of space and causality. (Laurendeau & Pinard, 1962, 1970 in Anastasi, 1976).

The Concept Assessment kit - Conservation by Goldschmid and Bentler (1968 in Anastasi, 1976) is designed for ages 4 to 7 years in order to provide a measure of the concept of conservation as an indicator of the child's transition from the preoperational to the concrete operational stage of thinking which Piaget places roughly at the age of seven or eight years. This test is readily available with norms and other psychometric data.

It may be mentioned at this point that the Grover Charts for Very Young Children, although not a Piagetian type scale in its structure and function such as those mentioned above, is indebted to the work

of Piaget as a theoretical background. For Piaget's work has indicated by providing a richer and more penetraing understanding and exposition of what development in the early years entails, the importance of the early childhood period. His work has played a very influential role in the selection of items for the Grover Charts, the interpretation of its results and in determining the age range to be covered by the Grover Charts. It may be kept in mind that the Grover Developmental Charts cover the end of the period designated by Piaget as the period of sensorimotor development and the beginning of the preoperational period.

This history is in no way an attempt to provide an exhaustive and all encompassing list of tests available at the infant level. It is merely hoped that it will provide a description of the beginning of infant testing, and its expansion. The various types of infant scales have been mentioned and described. If a comprehensive review and list of available infant and preschool scales is required, one may refer to such studies as that by Stott and Ball (1965) as mentioned previously and Thomas (1970).

## 1.7 PURPOSE OF THE STUDY

### 1.7 (i) General aims

The aim of this study is to perform an exploratory investigation of the Grover Developmental Charts, in an attempt to provide preliminary data on the reliability and validity of this assessment procedure as an objective measure of the current level of functioning in selected areas of development as measured in children aged between ten months and thirty-six months. These areas of development are

(i) body management and mobility (ii) interaction with objects, dexterity and fine co-ordination (iii)socialization and awareness of self and others and (iv) communication both receptive and expressive.

In an attempt to define reliability as used in this study I refer to Anastasi (1968) where she says that "reliability refers to the consistency of scores obtained by the same individuals when re-examined with the same test on different occasions, or with different sets of equivalent items, or under other variable examining conditions. This concept of reliability underlies the computation of the error of measurement of a single score, whereby we can predict the range of fluctuation likely to occur in a single individual's score as a result of irrelevant, chance factors." (P.71) "In its broadest sense, test reliability indicates the extent to which individual differences in test scores are attributable to 'true' differences in the characteristics under consideration and the extent to which they are attributable to chance errors." (Anastasi, 1968, p.71). In other words measures of test reliability make it possible to estimate what proportion of the total variance of test scores is error variance; error variance being essentially, any condition that is irrelevant to the purpose of the test.

"Despite optimum testing conditions, no test is a perfectly reliable instrument. Hence every test should be accompanied by a statement of its reliability." (Anastasi, 1968, p.71).

The validity of a test concerns what the test measures and how well it does so. "Most test names are far too broad and vague to furnish meaningful clues to the behaviour area covered... the trait measured by a given test can be defined only through an examination of the

objective sources of information and empirical operations utilized in establishing its validity."(Anastasi, 1950 in Anastasi, 1968, p.99) Furthermore no test's validity can be abstractly expressed as 'high' or 'low', but must be determined with reference to the particular use for which the test is being considered.

"Fundamentally all procedures for determining test validity are concerned with the relationship between performance on the test and other independently observable facts about the behaviour characteristics under consideration." (Anastasi, 1968, p.99) There are many methods employed for investigating these relationships, which may be include under three principal categories, namely content, criterion related and construct validity.

The particular methods of examining the reliability and validity of the Grover Developmental Charts will be discussed under the Method in more detail.

1.7 (ii) Rationale in selection of time interval

In choosing a time interval over which test-retest reliability would be measured the following considerations were borne in mind. Firstly, too short a period might present the problem of practise effect and memory and secondly too long a period might present the problem of rapid development in infancy. "In checking this type of test reliability, an effort is made to keep the interval short. In testing young children, the period should be even shorter than for older subjects, since at early ages progressive developmental changes are discernible over a period of a month or even less." (Anastasi, 1968, p.79) Bearing these points in mind,and having reviewed the

the time intervals used by other well-established and widely used infant tests, a time interval of between five and seven days was chosen.

Frankenburg, Camp, Van Natta and Demersseman (1971) have found that "there is a paucity of data pertaining to the concurrent validity and the short-term test retest stability of infant and preschool tests". (p.1316) In view of their findings, it would appear that a study such as this one, which would provide data on short term test-retest reliability, might prove to be a source of useful and much need information of this kind.

In their review of literature on reliability of infant scales Werner and Bayley (1966) found that most of the reliability studies on infant tests reported split-half coefficients rather than test-retest stability. They found only one study reporting tester-observer reliability coefficients and only two studies reporting test-retest stability over an interval of less than a month. A current search of the literature adds only the report of Werner and Bayley (1966) to this list.

Furthermore, below the age of 2½ years, reports of test-retest stability are confined to children below the age of 12 months (Conger, 1930; Herring, 1937; Werner & Bayley, 1966 in Frankenburg et al. 1971) and reports of tester-observer reliability are confined to a group of infants eight months of age (Werner & Bayley, 1966) and another group of nine months of age (Knobloch & Pasamanick, 1960 in Frankenburg et al., 1971).

## 1.7 (iii) Rationale for choosing tester-observer reliability as a means of examining scorer reliability

For the purpose of this study the manner of examining scorer reliability used was the method of tester-observer reliability. "Standard text books on psychological testing and research methods (Anastasi, 1960) have emphasized the need for a check on the tester-observer and test-retest reliability of infant scales; since the subtle nature of the test observations and the distractability of the small "subjects" leave considerable leeway for possible disagreement between one observer and another for possible inconsistency from one testing occasion to another. Empirical evidence on tester-observer and test-retest reliability of infant tests is however quite scarce." (Werner & Bayley, 1966, p.41) These authors continue that their clinical experience in training infant-testers has made them acutely aware of the need for demonstrating high interscorer agreement. Often, they have found, the very position of the examiner seems to influence the accuracy of his observations of the infant's behaviour.

"It has been our impression that object-oriented behaviour seems to be observed more accurately at close hand, while the incidental explorations and the social behaviour of the infant can be precisely recorded by an observer who is not involved in the examiner-child interaction. For the development of tests in this area there is a real need to demonstrate which tasks two or more observers can agree are responded to in the same way by the infant." (Werner & Bayley, 1966, p.42.)

Taking all this into account it was decided that it would be the most appropriate and most advantageous to investigate interscorer reliability by means of the tester-observer method in this study.

# 2. METHOD

## 2.1 DESIGN

The design of the study is represented in the following table:

| | | |
|---|---|---|
| Session 1 | Test | |
| Session 2 | Retest | DDST |

A total of 108 subjects were assessed on the Grover Developmental Charts and then were reassessed on the Grover Developmental Charts between five and seven days later. During the same session in which the children were reassessed on the Grover Developmental Charts they were also assessed on the DDST.

## 2.2 SUBJECTS

### 2.2 (i) General sampling procedure

The sample on which both the reliability and validity study of the Grover Developmental Charts was carried out, consisted of a homogeneous group of 108 white, English speaking children of both sexes between the ages of 10 months and 36 months who lived in the Cape Peninsula.

"A desirable and growing practice in test construction is to fractionate the standardization sample into more homogeneous subgroups, with regard to age, sex, socio-economic level, occupation, etc., and to report separate reliability coefficients for each subgroup." (Anastasi, 1968, p.94)

There are 27 age groups, spaced one month apart from 10 to 36 months. Four subjects at each age group were assessed on the Charts; that is, four children were tested at 10 months of age, four at 11 months, and so on up to 36 months, making up the total population of 108 children who were sampled. An attempt was made, when selecting the subjects at the various age groups, to balance the sexes.

All children with high risk of developmental abnormalities or suspected developmental delay were excluded from this study in the process of selection of subjects. That is, children with either gross mental or physical defects were not included, and also children who had prolonged periods of hospitalization and whose development might consequently have been affected were excluded. Furthermore, if two or more siblings were suitable, only one was selected and assessed.

It was hoped that, by selecting a random sample of children from creches and homes distributed throughout the Cape Peninsula, a representative and balanced sample would 'naturally' be selected which would approximate the socio-economic status or social class distribution of the population in this area.

The children's socio-economic status was rated according to the six classes used in the "Tri-axial classification of mental disorders in childhood" (Rutter et al, 1969) a widely used technique of scoring socio-economic class. By this method social class is rated according to the father's profession. If he has retired, social class is rated according to what the father used to do. Social classes 1 to 6 are as follows:

Class I: Traditional aristocracy, millionaires, cabinet ministers, chancellors and principals of universities, managing directors or chairman of boards of nationwide or international companies.

Class II: Professionals, salaried executives, owners of large firms, operators of moderate-sized enterprises, student of universities and colleges, prosperous farmers and landowners.

Class III: Small businessmen , small farmers, clerical workers, white collar workers, semi-professionals.

Class IV: Skilled workers, qualified tradesmen, apprentices.

Class V: Semi-skilled workers.

Class VI: Unskilled workers, permanently unemployed, poor whites.

The majority of children in this study were selected from creches in different areas of the Cape Peninsula. This formed the group of 'creche' children. It was originally hoped that enough children would be available for selection from creches so that all subjects would be creche children. However, it was found that the majority of creches only took children from three years old and upwards so that a relatively small number of children were available in creches who fell within the range of 10 to 36 months. This necessitated a selection of home children to supplement the required number of 108 subjects over the various age groups.

The 'home' children were selected from private homes where the children

did not attend a creche but were cared for at home.

The exact age at which the child was tested within the particular age group was obtained in this manner. Each child was assessed between plus or minus seven days of its chronological age in months or birthday. Thus if the child is to be tested or retested at 27 months, he can be tested any time between 26 months 23 days and 27 months 7 days.

2.2 (ii) Selection of creche subjects

Children from four creches were used in this study and made up the group of creche children. The creches were selected from a list of registered European creches in the magisterial areas of Cape Town, Wynberg and Simonstown, which was issued by the Cape Regional Office of the Department of Social Welfare and Pensions.

The selected creches were situated in different suburbs of the Cape Peninsula and serve a variety of people from different socio-economic groups. A list of children attending the creche and their relevant background information was obtained from the person in charge of the creche whose permission had been obtained to carry out the study. All suitable children between the ages of 10 months and 36 months were then selected as subjects who would be used in this study.

2.2 (iii) Selection of home subjects

Suitable children were selected from private homes. These children were cared for at home, usually by their mother, and did not attend

a creche at the time of testing. However, it was possible that a 'home' child might at some stage previously have attended a creche for a brief period. This then made up the group of 'home' children.

The names of these children were obtained in the following way. Through the courtesty of the Cape Education Department, letters were sent out through primary schools in different suburbs of the Cape Peninsula, to all parents of children attending school from Sub A to Standard 5. This letter described the study very simply and asked whether there were any brothers and sisters who fell within this 10 to 36 month age range, and if so, whether the parents would be willing to allow their children to be involved in this research project.

The names, ages, sex, address and telephone numbers of available children were then returned on a detachable reply slip by the primary school children to their schools and were then sent on to us. Parents who had thus made themselves available, were then contacted and an appointment was made at which the child could be visited at home and at a time when the mothers would be present.

## 2.3 TESTS

### 2.3 (i) The Denver Developmental Screening Test

In selecting a criterion test against which the Grover Charts would be validated, the following factors were considered:

(a) The test should cover the age range covered by the Grover Charts.

That is the selcted test should cover the age range ten to thirty-six months.

(b) The selected test should be an objective measure of development in the same areas as those covered by the Grover Charts. That is they should cover the areas of gross motor development, fine motor development, socialization and language.

(c) The test should have acceptable reliability and validity data available.

(d) The test if possible should be fairly quick to administer as the Grover Charts are fairly comprehensive and take some time to administer.

(e) The test should preferably require a minimum of equipment and be available.

After a thorough review of the available infant scales possible, the test which most adequately fulfilled these requirements and which was consequently chosen as the most suitable criterion test against which the Grover Charts were to be validated was the Denver Developmental Screening test (1967).

"Increasing recognition of the importance of early development on later cognitive and affective functioning, along with needs for early diagnosis of delayed development or retardation in order to plan for effective care and treatment of deviant children, have pushed clinicians to formalize observations in normative sequences. One such effort with apparent promise is the Denver Developmental Screening Test" (Mo ia ty in Buros, 1972, p.733).

The Denver Developmental Screening Test (DDST) was designed and

standardized "to meet the need of having a simple, useful tool to aid in the early discovery of children with developmental problems. The test is designed for use by people who have not had special training in psychological testing and is easy to give and score." (Frankenburg, Dodds & Fandal, 1970, p.i)

The DDST evaluates four areas of a child's functioning: (i) gross motor (ii) fine motor adaptive (iii) language and (iv) personal social development.

By fine motor adaptive is meant "the child's ability to see and use his hands to pick up objects and to draw." Gross motor is "the child's ability to sit, walk and jump". Language is the "child's ability to hear, carry out commands and to speak." Personal social involves those "tasks which indicate the child's ability to get along with people and to take care of himself." (Frankenburg, Dodds & Fandal, 1970, p.3)

In the construction of the DDST, more than 12 existing infant and preschool tests were surveyed to select 240 potentially discriminating items which required no elaborate equipment and were easy to administer and score. Using these items, the authors in a preliminary survey (Frankenburg & Dodds, 1967) of 200 infants and preschool children, experimentally eliminated items felt to be ambiguous or insufficiently discriminating. From this survey, the authors kept 105 items that best satisfied the criteria of not requiring elaborate equipment and of being easy to administer and score. These items were then administered to a standardization population of 1036 children (543 males and 493 females) between the ages of 2 weeks and 6,4 years.

Children who were adopted, premature or known to be handicapped in any way were excluded from the sample, which quite closely approximated the racio-ethnic and occupational group characteristics of the population of the City of Denver according to the 1960 census. Computer calculations were then made of the age at which 25, 50, 75 and 90 per cent of the sample passed each item.

Test materials consist of a skein of red wool, a box of raisins, a rattle, eight one inch square coloured (red, blue, yellow, green) blocks, a small glass bottle, a small bell, a tennis ball and a pencil. On the record form each test item in the four sectors is designated by a bar which indicates the ages at which 25, 50, 75 and 90 percent of the standardization population can perform the particular test item. Across the top and bottom of the test form are age scales which show ages in months from 1 to 24 and in years from 2½ to 6. An age line is drawn down the page in the following way, using the ages shown at the top and bottom of the test form as a guide. A line is drawn through the four sectors of the test form at the child's age. This line needs to be accurate because the test interpretation depends on the age line. The date of the test is written at the top of this age line.

The results in each sector are categorized as normal, abnormal and questionable. A child's performance in any sector is considered normal if he passes at least one item which is intersected by his age line and if he has no delays on any items in that sector. A delay is "any item failed which is completely to the left of the age line. That is the child failed an item which 90% of children normally can pass at a younger age." (Frankenburg, Dodds, & Fandal, 1970, p.9).

A child's performance in a sector is considered abnormal if either two sectors each have two or more delays or one sector has two or more delays and one other sector has one delay and in the same sector the age line does not go through an item that is passed. The child's performance is considered questionable if either there are two or more delays in one sector or one or more sectors have one delay and in the same sector the age line does not go through an item which is passed.

In their initial study Frankenburg and Dodds (1967) test-retest reliabilities and inter examiner reliabilities were based on extremely small samples of children (20 and 21 respectively ) representing a wide age range, from two months to 5½ years.

A later and more extensive study of the reliability and stability of the DDST (Frankenburg, Camp, Van Natta & Demersseman, 1971) evaluated tester-observer agreement and test-retest stability of the DDST with 76 and 186 subjects respectively. The correlation coefficients for mental ages obtained at a one-week interval were calculated for 13 age groups between ,66 and ,93 with no age trend displayed. On individual test items tester-observer agreement was, generally, greater than test-retest stability. There was a higher percentage of passable by report items i.e. items scored by interview with informant in the group of items with high test-retest stability. The test-retest stability of the DDST is as high or higher than similar reliabilities for such diagnostic tests as Bayley's Revised Scale of Mental and Motor Development.

The preliminary validity study (Frankenburg & Dodds, 1967) was

restricted to 18 children, ranging in age from 4 to 68 months who were given both the DDST and the Revised Yale Developmental Schedule (RYDS). Fifteen of the 18 children scored below 90 IQ on the YDS. "A correlation of ,97 appears spuriously inflated because the sample is small, skewed in the direction of abnormality and encompasses a wide age range." (Werner in Buros, 1972, p.735)

However, in a more extensive validity study (Frankenburg, Camp and Van Natta, 1971) 236 children were evaluated with the DDST and the following criterion tests: Stanford Binet (N91; mean age 52,5 months); RYDS (N64; mean age 33 months); Cattell Infant Intelligence Scale (N50; mean age 12,8 months) and Bayley Scales of Infant Development (N31; mean age 6,2 months). Correlations of mental ages obtained with the DDST and the criterion tests varied between ,86 and ,97. Scoring the DDST as normal, questionable and abnormal agreed very highly with IQ's or DQ's obtained on the criterion tests.

The article of Frankenburg, Goldstein, and Camp (1971) describes three studies done on the revised DDST. These studies reveal that the use of a revised method of interpretation for the DDST has yielded a much greater degree of agreement between the DDST results and those obtained by more definitive tests such as the Revised Bayley Infant Mental and Motor Scales and the Stanford Binet form L-M.

Since the validity of test findings also depends upon the test-retest reliability it is important to examine the stability of the DDST test scores. Use of the revised DDST method of interpretation yielded 97 percent agreement in test findingsafter a one week interval, which is within acceptable limits. Furthermore in order to assure a high level of screening accuracy, it is important to make regular checks of screening results.

In the cross validation study the co-positivity (or the ability of the test to detect abnormal findings ) and conegativity (or the ability of the test to give a negative finding when the individual is not abnormal) were almost identical for the Revised Bayley Infant Scale and the Stanford-Binet test.

"The results of the three studies... indicate that the revised interpretation (as in the 1970 manual, Frankenburg, Dodds & Fandal) of the DDST increases its validity and test-retest stability." (Frankenburg, Goldstein and Camp, 1971, p.995).

Further studies done on the DDST may be mentioned briefly. The DDST has been standardized on 688 Cardiff children in their first year of life (Bryant, Davies & Newcombe, 1974). Furthermore during this standardization the effect of sex, social class and position in family on the age of achievement of the test item was studied (Bryant & Davies, 1974). No conclusive differences were seen. Nugent (1976) considered the psychometric efficiency of the DDST using an estimate of the base rate of mental retardation in the screening population and found that the Revised DDST is relatively inefficient in the detection of preschool children with IQ's below 70.

In conclusion it can be said that with certain reservations and cautions (some mentioned by the authors themselves) and in the context of the purposes for which the DDST was designed, the DDST is a practical, efficient and dependable device which is inexpensive, quick and easy to administer and evaluate with relatively little training or experience in testing. "The manual is direct and clear. and scoring guides are explicit. The test seems to meet standards of reliability and validity for the pu poses for which it was designed." (Moriarty in Buros, 1972, p.734)

The DDST was designed as a quick and efficient screening technique and was not designed to render a detailed diagnostic assessment. It could thus be said that it was not entirely appropriate to select such a screening technique as a test with which to compare a diagnostic instrument such as the Grover Developmental Charts.

However, on the basis of this data available on the DDST and also in view of the shortcomings of the other infant scales reviewed, it was decided to select the DDST as the most suitable criterion test against which the Grover Developmental Charts were to be validated.

2.3 (ii) The Grover Developmental Charts for Very Young Children

It has been previously mentioned that the Grover Developmental Charts were developed in an attempt to fill the need which existed for a detailed, finely graded and sufficiently objective means of assessment of the child's development in certain important areas. The Grover Developmental Charts "may be used for normal children between the ages of ten months and just under thirty-six months of age. They are, however, primarily intended for use with handicapped children and particularly the mentally retarded child up to six years of age, or if more severely retarded, up to eight or nine years of age." (Grover, 1977, p.1)

It has also been discussed in a previous section that many of the existing infant and preschool tests while adequate for assessing the normal child, have limitations which make then not entirely suitable or adequate for handicapped children. The Grover Developmental Charts were thus designed in an attempt to overcome these

limitations.

The Grover Developmental Charts are intended for use by qualified psychometrists, who must, however, undergo training in the administration and interpretation of the Charts.

The Grover Developmental Charts are indebted for item types, materials, and suggestions to existing infant scales, but they also include original items, based on observation of very young children, especially in the Communication Chart which will be discussed below. Some of the major existing and widely used infant scales which were reviewed in the process of compiling, selecting, modifying and devising items to be used in the Grover Developmental Charts are: The Catell Infant Intelligence Scale (1947); Gesell Developmental Schedules (1947); Haeussermann structured interview (1958); Griffiths Abilities of Babies Scale (1954); Gunzburg's Progress Assessment Charts (1963); Bayley Scales of Infant Development (1969): Vineland Social Maturity Scale (1947): Stanford-Binet Intelligence Scale form L-M(1960); Merrill-Palmer Scale of Mental Tests (1948).

The Grover Developmental Charts consist of four major charts, the fourth being divided into two subscales, namely Receptive Language and Expressive Language. Thus five separate scores are derived and these separate scores form the basis for the child's profile of functioning, be this typical or atypical. The first three charts consist of 72 items each and the fourth and fifth scales each has a maximum score of 50 points.

The Grover Developmental Charts will take an experienced examiner

approximately one hour to administer. This may appear uneconomic to those who look for an instrument which will give a quickly obtained, purely numerical single result purporting to reflect a child's intelligence. The shortcomings and dangers inherent in these 'instant', crude procedures, especially when the result is used to make a once and for all statement about the child's potential or decisions about his long term placement are only too well known..

What can be obtained by the proper application of the Grover Developmental Charts is a detailed and accurate description, both quantitative and qualitative, of the child's functioning in a number of separate areas on the basis of which practical guidance can be offered and clear cut remedial measures initiated where needed. As Anastasi (1968) has said,".. the longer the test, the more reliable it will be" (p.83). An hour devoted at a critical period of the child's life, to securing such a degree of reliability cannot be considered extravagant.

Chart 1 : Progressive stages in Body management and Mobility

This is comprised of 72 items designed or chosen to tap gross motor development. The items reflect the gradual, finely graded progression in the development of the most important body management and mobility skills. For example, stages in the development of walking are traced - from the child's ability to pull itself to its feet at a rail or its cot, to stand at its cot rail, to walk two hands held, to walk one hand held, to side step holding onto rail of cot, to stand briefly unsupported, to walk a few steps alone unsupported, to get into standing position from floor, to trot about well over wide area, to walk holding doll or toy in one hand, to stoop from standing

and pick up object and stand again, to run stiffly, to walk without gross arm movements or legs widely spaced - to run well stopping and starting easily.

In a similar way the items in this Chart 1 trace the gradual progressive stage in the development of other body management and mobility skills, such as sitting; kneeling; pushing; pulling; stair and ladder climbing; jumping; forward and backward walking; kicking; throwing and catching a ball; balancing; stretching and bending; and the more advanced skills such as riding a tricycle.

The items on this chart follow the general principles of development in the area of body management and mobility, namely,
(a) Neuromuscular development follows the pattern of cephalocaudal and proximodistal maturity
(b) Development in general proceeds along the continuum from gross to fine movement, co-ordination and control.

The child's performance on this Chart renders a score of his present level of functioning or developmental age in the area of body management and mobility.

Chart 2 : Progressive stages in interaction with objects; dexterity and fine co-ordination

This subscale consists of 72 items chosen to tap fine motor development. The items reflect the gradual, finely graded progressional development of manual and manipulative skills. They are arranged so as to reveal the child's growing ability to interact more meaningfully with a variety of common objects and simple playthings, indicating

his increasing awareness of their characteristics, use and interrelations. In the same way as in Chart 1, the selected skills which are tapped by the items on Chart 2, are traced from their early emergent stage to the stage where they are well established.

Some of the skills whose gradual, progressive development is traced by these items in this area of interaction with objects; dexterity and fine co-ordination are bringing two objects in contact; throwing; rolling; pushing; opening and closing; screwing and unscrewing; object constancy; pouring; turning pages; scribbling; eye hand co-ordination and visual discrimination in such things as simple two and three shape formboards, pegboards, hook and ringboards; imitation and copying skills of horizontal, vertical and circular shapes; winding; building blocks horizontally and vertically; and the development of palmar to digital grasp.

The items on this Chart follow the general developmental principles in the area of interaction with objects; dexterity and fine co-ordination. These are,

(a) From lack of visuo-motor co-ordination to planned and controlled visuo-motor perception and co-ordination

(b) From bidexterous to unidexterous grasp

(c) From palmar to fine pincer and digital grasp

(d) From unidexterous ability to ability to co-ordinate separate but combined bidexterous movements.

The child's observed performance on the items in this chart renders a score of his present level of functioning or developmental age in the area of interaction with objects; dexterity and fine co-ordination.

Chart 3 : Progressive stages in Socialization and awareness of Self and Others

This scale is comprised of 72 items selected to tap personal-social development. In the same manner as the other charts, the chosen skills which are tapped by the items on the chart are traced from the stage of early development of these skills to the stage where these skills are well established. Some of these skills whose gradual, progressive, finely graded development is traced from dependence to gradual independence by the items on this Chart 3 are: progressive response to mirror image leading to final identification of self in mirror; eating and chewing including ability to feed self and manipulation of implements with which to eat such as fork and spoon; drinking; dressing and undressing; interaction with adults and children in play; domestic mimicry; imaginative play; bowel and bladder control; washing and drying hands; avoidance of simple hazards; helps with household tasks; some idea of sharing; brushing hair.

The items on this chart follow the general principles of development in this area of socialization and awareness of self and others. They are:
(a) From total helplessness and dependence towards autonomy, self help and independence
(b) From unawareness of self as a separate being, to knowledge of the child's own body and its actions, self attributes and limitations
(c) From immediate and direct satisfaction of needs to increasing ability to delay gratification of needs and control of behaviour according to the subsequent approval or disapproval
(d) From self-centred egocentric activities to co-operative interaction with adults and peers.

Chart 4(5) : Progressive stages in communication

This is divided into two sections (a) receptive and (b) expressive language. The communication chart is a unique feature of the Grover Developmental Charts and consists largely of new items. The separate assessment of receptive and expressive language skills is especially valuable in contributing to differential diagnosis.

A single communication score, derived from the indiscriminate lumping together of receptive and expressive items, an unfortunate procedure employed by some of the older scales for infants, may give an inaccurate and misleading picture.

It could not, for instance, help to differentiate the child with a specific expressive deficit (as in some forms of aphasia) nor could it reveal the wide discrepancy between these two aspects of language in many mentally retarded children. Such a lack of appreciation of the more mildly retarded child's understanding (reception) of language as opposed to his extremely limited use of words (expression) often inclines parents and others to refrain from verbal communication with the child, much to his detriment.

The communication chart consists of 25 basic items, as yet undifferentiated, constituting the Common Section, followed by 25 receptive and 25 expressive items. The method of scoring gives a maximum possible score of 50 for Receptive language and a maximum possible score of 50 for Expressive language.

As in the other Charts, the items are finely graded to follow the gradual development of both receptive and expressive language skills.

Thus, expressive language items tap such skills as two, three, four and more than four syllable utterances; an expressive vocabulary of one, two to more than thirty words; combinations of words; length of sentences; use of plurals; naming I and you; naming body parts; naming familiar objects; naming items in picture cards and naming items from a detailed black and white drawing. Some of the receptive skills tapped by the items are listening to speech; knowing name; listening to story; obeying simple and complex commands; identifying by pointing body parts; identifying familiar objects; identifying by their usage common objects; identifying items in picture cards; identifying items from a detailed black and white drawing.

The items on this chart follow the general developmental principles in this area of communication, both receptive and expressive. They are:
(a) From random vocalization to babbling, to use of single words to the use of a growing vocabulary and complex sentence structure
(b) From language used as an accompaniment to action to language used as a substitute for action
(c) From general response to the human voice to the ability to interpret and carry out actions in accordance with increasingly complex verbal stimuli
(d) From recognition of real objects to recognition of symbols for objects.

The child's performance on the communication chart reflects his present level of functioning in the area of receptive and expressive language development. Two scores or developmental ages are obtained for this Chart. The first is a receptive language developmental age and the second is an expressive language developmental age.

The administration and scoring procedure of the Grover Developmental will be described further on.

## 2.4 PROCEDURE OF ASSESSMENT

### 2.4 (i) Procedure of administering the Grover Developmental Charts

#### 2.4 (i) (a) Procedure of administering the Grover Developmental Charts to creche subjects

Having obtained a list of creche children & having selected from this a list of children who met the necessary criteria, the examiner would observe this child in his group and allow some time in which to familiarize herself with the child and for the child to familiarize itself with the tester.

It was found that in each creche the children were subdivided into different age groups. For example all children from 10 - 17 months would be together in one room with one or two caretakers, all children from 18 - 25 months in another room with other caretakers. The various groups would spend either all day or most of the day together in their separate rooms, but might for instance join other groups for meals or go outside to play in which case more than one group might be together.

During this time of familiarization, various items on the four charts might be observed and scored on the answer sheets by the examiner. Then, after this initial period of familiarization, which at each creche might take several days, the child would be asked to accompany the examiner to a separate room if available, or to a section of the

room which was not being used by the rest of the goup , a less satisfactory arrangement.

Before administering the Charts to the subjects used in this study, the examiner had undergone a period of training in the administration of these charts, and had gained profficiency in their administration.

The child would sit at a small table on a small chair next to the examiner who would either kneel or sit next to the child. The examiner would then administer the rest of the items one at a time on Chart 2, Progressive stages in interaction with objects; dexterity and fine co-ordination. Following this the examiner would then administer the rest of the items of Charts 4 (5) - Progressive stages in Communication, receptive and expressive. The examiner would then administer the remaining items from Chart I - Progressive stages in body management and mobility. If an informant, namely the mother or other daily caretaken of the child is available, most of the items on Chart 3 - Progressive stages in Socialization and awareness of self and others, can be scored in an interview with them.

However, if an informant is either not available or appears to be highly unreliable in the quality of the information given about the child by grossly overestimating or underestimating the child's ability or by guessing at unknown answers as to the child's capabilities, the remaining items of the Socialization chart will have to be either administered or observed by the examiner.

In the unpublished manual, Grover (1977) emphasizes the need to understand what an informant is and how they should be correctly used

as a source of reliable information about the child. In obtaining data from the informant, great care must be taken not to put answers into his or her mouth. Particularly the examiner must be careful never to suggest that the child ought to be doing certain things.

Each of the following areas must be covered systematically (a) dressing/undressing (b) feeding (c) toileting (d) imitative play (e) relationship with adults (f) relationship with children (g) a few other items. In each area the examiner should ask an inital question of this type, "Tell me about John's dressing" (feeding, toileting, etc.) The informant should then be given an opportunity to speak spontaneously during which time the examiner unobtrusively scores as many items as possible. If certain specific items do not emerge, the examiner will direct the informant's attention to them e.g. "What about his shoes (buttons) etc?" Where precision is lacking, the examiner must seek greater clarity regarding any particular item.

It was found with both the creche and home subjects, that this sequence of giving the items and Charts best facilitated the establishment of rapport between the examiner and the child. However, if a child was very restless and easily distracted and had a short concentration span, Chart 1 - Progressive stage in Body management and mobility, could either be put first or between Chart 2 and the Communication Charts or the items could be interspersed between the other charts.

As this study is examining the Grover Developmental Charts and not so much examining the child for clinical purposes all items on all charts were given to as many children as was possible. Obviously if a child was 10 months old there would be no point in putting him on a tricycle to see whether he could pedal. Thus within reasonable

limits as many items as could be administered were given to each child. In clinical usage it would not be necessary to start each child at item one. Rather, one would start at a point on the scale which would be a rough estimate of the child's age and proceed until the child could pass no further item. For the purposes of this study, however, the examiner started each child at item 1 and went as far as possible on each chart. This was done to ensure that there would be as much data as possible available which could be computed.

The time of assessing the children at the various creches was between 9 a.m. and 11.30 a.m. and between 2 p.m. and 4.00 p.m. Before 9.00a.m. the children were usually given breakfast and toileted. Between about 11.30 a.m. and 2.00 p.m. the children were given lunch and rested. After 4.00 p.m. the children started going home. In order to ensure that no systematic bias could creep in as far as the times at which the children were assessed, children of one age group were examined at different times during the day.

To administer the entire Grover Developmental Charts to one child took an experienced examiner about one hour.

2.4 (i) (b) Procedure of administering the Grover Developmental Charts to home subjects

Having established the suitability of the child to be examined at home, by making initial contact through the mother, an appointment was made at which the examiner would go to the child's house and assess him or her. A time suitable to the mother was made so that she would be able to attend the examination session or at least be available to answer questions. The date of appointment depended

on whether or not on that day the child's age fell within plus or minus seven days of the month at which he or she was to be assessed as was explained earlier.

Having arrived at the child's house, the examiner would familiarize herself with the child by showing a ball or doll or perhaps playing with the child with one of his own toys. Sometimes if the child was very withdrawn or negativistic in the beginning, the examiner would converse with the mother and perhaps use this time to gather information from the mother for the Chart 3 - Socialization and awareness of self and others. This initial phase in which rapport with the child was established lasted approximately ten to fifteen minutes. The examiner would then administer the charts to the child in the same order and manner as she administered the Charts to children in the creche situation. Again if the child was found to be distractable, restless and with a short concentration span, Chart 1 could either be administered first or between Chart 2 and the communication charts or the items could be interspersed between the other charts.

During this session, the mother could remain present, and usually did so, as it was generally what the child wanted, but she was asked not to comment on the child's performance or to help by prompting or interjecting with positive or negative comments. If there were other brothers or sisters present in the house, they were asked to leave the room during this period so as to provide the child being examined with as little distraction as possible.

## 2.4 (ii) Procedure of administering the Grover Developmental Charts at Retest to both creche and home subjects

The Grover Developmental Charts were readministered to the original subjects within a period of five to seven days following the day of initial administration.

The procedure of administration did not differ at retesting from the procedure followed at the first testing as outlined in the previous sections. The period of familiarization between the examiner and child was in almost every case greatly reduced as the child generally felt at ease with the examiner and the assessment situation and was keen to get involved with the items on the Charts.

## 2.4 (iii) Procedure of Administering the Denver Developmental Screening Test (DDST)

The DDST was administered once to each subject. This was done during the session at which the subject was retested on the Grover Developmental Charts. In order to obviate the possiblity of a systematic bias, alternate children were given first the Grover Developmental Charts Retest and then the DDST. So, for example, the first child would first be administered the Grover Developmental Charts retest and then the DDST and the next child would be administered first the DDST and then the Grover Developmental Charts retest and so on.

The DDST was administered to the child in the following way. First the items on the Personal-Social sector were given. Here was with

the Grover Charts, in the Socialization Chart,most of the information is gathered from an informant, usually the mother or daily caretaker. The items on the DDST which the informant may be asked are those marked items called "passed by report". These are items which would be hard to observe but which may be passed on the basis of the mother's reporting the required information. After the Personal Social Sector items are administered the Fine Motor adaptive items are given, followed by the language sector and finally the Gross Motor items. This is the order of testing advocated by the authors in the revised manual (Frankenburg, Dodds & Fandal, 1970.)

To administer the DDST took the examiner approximately 15 minutes with each child. The number of items to be given varied with the age of the child being tested. All items through which the age line passed were given. In addition each sector should have at least three items which are passed and three items which are failed. The examiner made certain that the child had several passes to the left of any failure. The test was begun with items below the age of the child and was continued up to the child's age, the examiner continuing to test upward, that is to the right, until the child had three failures in the sector being tested.

2.4 (iv) Procedure of establishing tester-observer reliability on the Grover Developmental Charts.

The study of tester-observer agreement was carried out using 21 subjects out of the total of 108 subjects. Both the examiners who carried out this study with these 21 children were female, trained and experienced in administering the Grover Developmental Charts.

The subjects were randomly picked from both creches and homes within the various age groups.

All 21 children used in this study were examined after the new language charts were established and were thus only assessed on the Grover Developmental Charts which included the new language charts. This addition of the new language charts will be described later.

Both examiners would go either to the house or to the creche at which the particular child selected was present. The children had not had contact with either of the examiners before. As the child's results were used for both the tester-observer study as well as for the larger study to make up one of the 108 subjects, the data obtained provided the results for the first administration of the Grover Developmental Charts and not for the retest data.

It was decided before arrival at the creche or home who was to be the tester and who the observer for that particular child. Each examiner was alternatively tester with one child and observer with the next, so that one examiner was tester for ten children and observer for the other 11 children, while the other examiner was tester for 11 children and observer for the other 10 children.

If the examiner were the tester, she would follow the procedure of administering the Grover Developmental Charts as employed for the rest of the study, beginning with a period of familiarization followed by administering the items of the various charts. This procedure has been outlined in a previous section. She would score the child's performance on her separate form.

If the examiner were the observer, she would greet the child and then sit in a convenient place at a slight distance from the child and the examiner, such that she had a clear and unhampered view of the child's performance during the administration of the Grover Charts by the examiner who was the tester. She would then score the child's performance on her own form in as unobtrusive a manner as possible.

2.4 (v) Procedure of administering new Communication Charts of the Grover Developmental Charts

A short way through this study the Chart - progressive stages in Communication - was found to be not altogether satisfactory and a revised communication chart was designed. The reason for the inadequacy of the language chart was that it did not provide a detailed enough assessment of both receptive and expressive communicative skills.

Whereas the old communication chart had consisted of 18 undifferentiated common items, 18 receptive items and 18 expressive items, the revised communication chart consists of 20 undifferentiated common items, 30 separate items tapping expressive language skills and 30 separate items tapping receptive language skills.

Those children who had already been tested and retested on the old language charts were therefore tested on the revised language charts, in a separate session, as soon as possible. With a small number of children a period of time had elapsed between test and retest using the full Grover Developmental Charts including the old communication chart and the administration of the new revised language chart only.

In most cases, however, no such significant lapse of time had occurred.

The data obtained in these various ways on the communication charts was used thus. All data obtained on children examined first on the Grover Developmental Charts including the old communication charts and who were then reexamined either at the same age (N=41) or at a later age (N=10) on the new revised communication charts (Total N = 51) was kept separate. All data obtained on children examined after the new revised communication charts had been incorporated (N=57) was kept separate.

Sometimes the data of the group N = 51 and the data of group N = 57 were combined N = 108 as far as the Charts 1, 2 and 3 were concerned, but the two separately obtained communication chart scores were always kept and examined separately.

## 2.5 SCORING PROCEDURES

### 2.5 (i) Scoring procedure of the Grover Developmental Charts

On observing the child's performance on the various items on the Grover Developmental Charts, the examiner marks on the test form a + if the child passes the item correctly and a - if the child fails an item.

Various other symbols are used. R or refusal is scored if a child does not wish to co-operate and perform an item after persuasion. O or omission is scored if for some reason an item is not given to the child being examined.

The total raw score for each of Chart 1, 2 and 3 is obtained by

simple additon of items marked +. In the communication Charts (4,5) two scores are obained, one for Receptive Language and one for Expressive Language, the results on the Common section being incorporated into each of them.

The norms were established in the previously mentioned standardization study, which ran concurrently with this study, on a population of approximately 600 white, English speaking children of both sexes in the Cape Peninsula.

The norms had already been established at the time of the present study and the tables were thus used for translating raw scores to developmental ages in months. Thus the Grover Developmental Charts yield five subscale scores which, when converted by means of the table of norms, emerge as five developmental age levels. These are namely developmental age for the body management chart; a developmental age for the interaction with objects chart; a developmental age for the Socialization chart; a developmental age for receptive language and a developmental age for expressive language.

2.5 (ii) Scoring procedure of the DDST as used in this study

The DDST was designed to yield a qualitative assessment of a child's present level of functioning or development.

A child's performance is rated as normal, abnormal or questionable. These terms and the way they are designated have been described earlier under the description of the DDST.

However, for the purposes of the present study, this proved not to be a sufficiently rigorous technique for deriving the child's developmental age and was not able to yield other such suitable data required for this study. In order to enable the examiner to extract a developmental age on each of the four subscales of the DDST which would then be available for a comparison with the corresponding subscales of the Grover Developmental Charts; the DDST being used as a criterion test against which the Grover Charts were validated, the qualitative scoring system had to be converted to a quantitative one.

Scoring the items as + or - a total raw score for each subscale was obtained in a similar way to that of the Grover Developmental Charts. The total raw score was then converted to a standard score by means of a table of norms. This normative data was established in the following way.

Each item was ranged in ascending order of age at which 50% of children passed that item. A best fitting exponential curve was computed in order to predict this 50th percentile age from the item number. To a first approximation, given that the child passes, e.g. 15 items, the predicted 50th percentile age for item 15 was taken as the estimated developmental age of the child. This is a somewhat roundabout procedure necessitated by the fact that the scoring method employed on the DDST could not yield a single reliable estimate for the child's age which was needed in studying the correlation between the child's developmental age as yielded by the DDST and the child's developmental age as yielded by the Grover Charts.

## 2.6 THE METHOD BY WHICH THE RELIABILITY OF THE GROVER DEVELOPMENTAL CHARTS WAS EXAMINED

### 2.6 (i) Test - retest reliability

The test-retest method of investigating the reliability of test scores involves repeating the same test on a second occasion. In this event, the reliability coefficient is simply the correlation between the score obtained by the same person on the two administrations of the test.

"Retest reliability shows the extent to which scores on a test can be generalized over different occasions; the higher the reliability the less susceptible the scores are to the random daily changes in the condition of the subject or of the testing environment... The interval over which retest reliability was measured should always be specified." (Anastasi, 1968, p.78).

The way in which the degree of test-retest reliability of the Grover Developmental Charts was calculated, was the following. The five scores obtained for each child at the first administration of the Grover Charts was correlated with the corresponding five scores obtained for each child at the second adminstration or retest of the Grover Charts. These five scores were the raw scores obtained for the Charts (1) Progressive stages in body management and mobility (2) Progressive stages in interaction with objects: dexterity and fine co-ordination (3) Progressive stages in socialization and awareness of self and others (4) Progressive stages in communication - receptive (5) Progressive stages in communication - expressive.

This was done for each of the 108 children used in the study irrespective of whether the child was tested in a home or a creche situation. The correlations were computed by means of the Bivariate plotting method, BMDP 6D. In this study the interval between the test and retest of the Grover Developmental Charts was a period of between five and seven days.

2.6 (ii) Tester observer reliability

Tester observer reliability was calculated by performing an analysis of variance, programme BMDP 2V, between the scores obtained by two different examiners with repeated measures or five raw scores. That is body management; interaction with objects; socialization; communication receptive and communication expressive on the same child to establish to what degree the two scores thus separately obtained differed.

The two examiners were the examiner who had been the tester and the examiner who had been the observer for each child. This was performed using scores obtained on 21 children all of whom had been examined on the Grover Developmental Charts including the new language charts.

## 2.7 THE METHOD WHEREBY THE VALIDITY OF THE GROVER DEVELOPMENTAL CHARTS WAS EXAMINED

### 2.7 (i) Content Validity

"Content validity involves essentially the systematic examination of the test content to determine whether it covers a representative

sample of the behaviour domain to be measured.... Content validity is built into a test from the outset through the choice of appropriate items" (Anastasi, 1968, p.100). Such an examination of the content validity of the Grover Developmental Charts does not fall within the scope of this study but is rather the domain of the larger study run concurrently with this study, namely the standardization of the Grover Developmental Charts wherein the selection of test items was preceeded by a thorough and systematic examination of relevant and existing scales.

Face validity

"Content validity should not be confused with face validity. The latter is not validity in the technical sense; it refers, not to what the test actually measures but to what it appears superficially to measure. Face validity pertains to whether the test "looks valid" to the subjects who take it, the administrative personnel who decide on its use and other technically untrained observers." (Anastasi, 1968, p.104). Face validity is considered a desirable feature of a test, in order to obtain good co-operation from the users and subjects, but it should not be regarded as a substitute for objectively determined validity.

As the Grover Developmental Charts very obviously have face validity a study to investigate its face validity was deemed unnecessary. Such a study could be conducted by, for example, making a list of clinical psychologists, paediatricians, child psychiatrists and others who would be likely to either use or come into contact with the Grover Developmental Charts in practice. A copy of the Grover

Developmental Charts could be given to these people and their comments as to face validity could be recorded. However, the face validity of the Grover Developmental Charts could quite easily be established without such a study.

2.7 (ii) Criterion-related validity

"Criterion-related validity indicates the effectiveness of a test in predicting an individual's behaviour in specified situations. For this purpose, performance on the test is checked against a criterion, i.e. a direct and independent measure of that which the test is designed to predict....The criterion measure against which test scores are validated may be obtained at approximately the same time as the test scores or after a stated interval." (Anastasi, 1968, p.105)

The criterion measure in the case of this study against which the Grover Developmental Charts was validated, was the Denver Developmental Screening Test which was administered during the same session as the retest or second administration of the Grover Charts.

Other than selecting a previously available test in order to provide criterion related validity no other criterion was available. There existed for example no other criteria such as school performance, teacher rating or academic achievement for such an infant population.

Long-term prediction versus diagnosis

For certain uses of psychological tests, concurrent validity is the most appropriate type to be used and can be justified in its own

right. "The logical distinction between predictive and concurrent validity is based not on time but on the objectives of testing. Concurrent validity is relevant to tests employed for diagnosis of existing status, rather than prediction of future outcomes." (Anastasi, 1968, p.105). Thus in the case of this study, the Grover Developmental Charts having been designed for use as a diagnostic instrument, it was appropriate to examine concurrent validity and not predictive validity.

As predictive validity will be mentioned in the discussion of this study a brief mention of its current status in infant testing is relevant.

"Much confusion still exists in the literature and in practice concerning the use of infant evaluations in the prediction of later intellectual functioning." (Knobloch & Pasamanick, 1963, p.43). Over the last 50 years there have been numerous attempts to relate developmental test scores, obtained during infancy, to standardized intelligence tests, given later in adolescence and adulthood. Reviews of this literature (Bayley, 1970; Rutter, 1970; Stott & Bell, 1965; Thomas, 1970) tend to concur with Bayley's summary.

"The findings of these early studies of mental growth of infants have been repeated sufficiently often so that it is now well established that test scores earned in the first year or two have relatively little predictive validity (in contrast to tests at school age or later) although they may have high validity as measures of the children's cognitive ability at the time." (Bayley, 1970, p.1174 in McCall et al., 1972, p.728.)

In finding the validity of test scores an essential precaution is to make certain that the test scores do not themselves influence any individual's criterion status. "Such influences would obviously raise the correlation between test scores and criterion in a manner that is entirely spurious or artificial." (Anastasi, 1968, p.106).

This possible source of error in test validation is known as criterion contamination as the criterion scores become so called 'contaminated' by the scorer's preknowledge of the test scores. To prevent the possibility of such a source of error it is absolutely essential that no person who participates in the assignment of criteria ratings have any knowledge of the examinee's test scores." (Anastasi, 1976, p.142)

In this study, in order to prevent this possible source of error, all items on both the Grover Developmental Charts and the DDST were scored, that is marked plus or minus, but none of the final or total scores were added up or converted to norm scores until all 108 children had been tested and retested on the Grover Developmental Charts and tested on the DDST. Thus total scores of individual children were known only at the end of the study after all administration of tests used had been completed.

2.7 (iii) Construct validity

"The construct validity of a test is the extent to which the test may be said to measure a theoretical construct or trait, " (Anastasi, 1968, p.114) such as intelligence, anxiety and so on. In the case of the Grover Developmental Charts the construct hopefully being

measured is developmental level or developmental age in several clearly defined and separately assessed areas.

Age differentiation

According to Anastasi (1968) a major criterion used in the validation of many intelligence tests is age. Since abilities are expected to increase as the child develops and becomes older, test scores should likewise reflect such growth and increase, if the test is valid.

The criterion of age differentiation is applicable in the case of the Grover Developmental Charts as it supposedly measures a trait, namely development, which exhibits clear cut and consistent age changes.

The criterion of age differentiation was examined by using the following procedure:

(i) Each individual's score for each item on all the subscales i.e. body management; interaction with objects;socialization, communication receptive; communication expressive, was correlated with each individual's chronological age. The individual's scores for the items on the subscales, as dependent variables, and the individual's chronological age as independent variable, were plotted on a graph.

(ii) The particular programme used i.e. BMDP 6D also gives the correlation coefficients between the dependent and independent variables

(iii) On examining the graphs thus obtained, it was found that the relationship between age and the non-language dependent variables were non-linear.

(iv) In order to make the relationship linear, an attempt was made to fit various transformations such as logit, asymptotic and arcsin, on the dependent variables

(v) The transformation which best rendered the relationship between age and the non-language scores linear, was the logit transformation, which was then used

(vi) Using this function, a multiple linear regression analysis was done on these transformed body management etc. scores. From a multiple linear regression analysis an estimated age was obtained for each individual from his body management, etc. scores.

(vii) A principle component analysis was done on the scores on the five subscales. This principle component analysis yielded only one component of importance. This component explained 94,2% of the variability in the five subscale scores. The component score for each individual was correlated with the actual or chronological age of the individual as well as the expected age obtained by means of the regression function. It was found that the principle component analysis takes out a component which is an estimate of developmental age of the individual.

Correlations with other tests

"Correlations between a new test and similar earlier tests are sometimes cited as evidence that the new test measures approximately the same general area of behaviour as the other tests designated by the same name," (Anastasi, 1968, p.115) such as developmental scales. Unlike the correlation found in criterion-related validity these correlations should according to Anastasi (1968) be moderately high but not too high. For "if the new test correlates too highly

with an already available test, without such added advantages as brevity or ease of administration, the new test represents needless duplication." (Anastasi, 1968, p.115).

In the case of this study the scores on the Grover Developmental Charts were correlated with the scores on the DDST by means of bivariate plotting BMDP 6D. Both tests are purported to measure development or developmental age, the Grover Developmental Charts are however more detailed and render a qualitatively different profile from the DDST.

Each individual's body management score on the Grover Developmental Charts was correlated with his gross motor score on the DDST. The interaction with objects scores on the Grover Developmental Charts were correlated with the fine motor adaptive scores on the DDST. The socialization scores on the Grover Developmental Charts were correlated with the personal-social scores on the DDST. The total score for the Grover Developmental Charts old communication chart ($N = 51$) which consisted of expressive score (i.e. common plus expressive items) plus receptive score (i.e. common plus receptive items) was correlated with the language score on the DDST. The total score for the Grover Developmental Charts new communication chart ($N = 57$) which consisted of expressive score (i.e. common plus expressive items) plus receptive score (i.e. common plus receptive items) was correlated with the language score on the DDST.

Factor analysis

This is a statistical procedure for the identification of psychological traits. "Essentially factor analysis is a refined technique for

analyzing the interrelationships of behaviour data....In the process of factor analysis, the number of variables or categories in terms of which each individual's performance can be described is reduced from the number of original tests to a relatively small number of factor or common traits." (Anastasi, 1968, p.116).

Once the factors have been identified, they can in turn be used to describe the factorial composition of a test. In this way a test can be characterized in terms of the major factors determining its scores, together with the weight or loading of each factor.

In this study a factor analysis was done using the programme BMDP 4M on the variables which had been transformed by the logit transformation i.e. the body management, interaction with objects, socialization, communication both receptive and expressive. With the latter only those subjects scores who had been examined originally on the new communication chart and not on the new communication chart at a later date after the old communication chart had been administered, were used, and body management, etc., as the variables for each individual. The factor analysis or in this case principle component analysis was preceded by an intercorrelation of the five subscales of the Grover Developmental Charts. The method employed by which the intercorrelation between the five subscales was calculated was bivariate plotting BMDP 6D.

The factor analysis or principle component analysis formed part of the procedure of examining the criterion of age differentiation.

Internal consistency

"The essential characteristic of this method is that the criterion is none other than the total score on the test itself....It is apparent that internal consistency correlations, whether based on items or subtests, are essentially measures of homogeneity. Because it helps to characterize the behaviour domain or trait sampled by the test, the degree of homogeneity of a test has some relevance to its construct validity. Nevertheless, the contribution of internal consistency data to test validation is very limited." (Anastasi, 1968, p.117).

One manner in which the criterion of internal consistency can be applied involves the correlation of subtest scores with the total score. The correlation of the subtests with the total score should be high in order for the test to have internal consistency.

Internal consistency of the Grover Developmental Charts was examined through bivariate plotting BMDP 6D in the following way: Each individual's subtest score on the Grover Developmental Charts i.e. body management, etc., was correlated with the individual's total developmental age or overall score, that is the total score of all the subtest scores.

This was done separately, that is twice. Once for those 51 individuals originally examined on the Grover Developmental Charts including the old communication chart and once for those 57 individuals examined originally on the Grover Developmental Charts including the new communication chart.

## 2.8 THE METHOD BY WHICH THE SIGNIFICANCE OF THE VARIABLES SEX; SOCIAL CLASS; HOME VS CRECHE WAS EXAMINED

In order to examine the significance of the variables sex; social class, home vs creche as related to the five subscales of the Grover Developmental Charts a one-way analysis of variance and covariance BMDP IV correcting for age and age$^2$. That is the age of the individual was extracted from the score so that the significance of the score should not be a reflection of age but be the significance of the variable being examined i.e. sex, social class, and home vs creche.

The computer used in examining all the data in the present study was IBM 370/158 of Multidata Co. at the Medical Research Council, Institute for Biostatistics, Tygerberg.

# 3. RESULTS

SUBJECTS

Out of the total number of 108 children used in the study, a total of 70 children formed the group of creche children. Of these 70 children ranging in age from 10 to 36 months, 34 were male and 36 were female. A total of 38 children formed the group of home children. Of these 38 children ranging in age from 10 to 36 months, 14 were male and 24 were female. Thus of the 108 children in total, 48 were males and 60 were females.

COMMUNICATION CHARTS

10 children were retested on the new language charts separately, at some period not exceeding five months after their initial test and retest on the Grover Developmental Charts including the old communication charts. There were 6 females and 4 males.

41 children were retested on the new language charts separately, immediately i.e. at the same age in months as their initial test and retest on the Grover Developmental Charts including the old communication charts. There were 20 females and 21 males.

This group of 10 plus 41 children make up the group N = 51. This data was examined separately.

57 children were tested and retested on the Grover Developmental Charts including the new revised communication charts. There were 34 females and 23 males and they made up the group of N = 57 whose data was examined separately from the group N = 51.

## 3.1 RELIABILITY

### 3.1 (i) Test - retest reliability BMDP 6D Bivariate plotting

Table I: Test vs retest reliability coefficients on the Grover Developmental Charts

| | N | cor. |
|---|---|---|
| Body management test vs retest | 108 | ,999 |
| Interaction with objects test vs retest | 108 | ,992 |
| Socialization test vs retest | 108 | ,999 |
| Receptive old comm test vs retest | 51 | ,992 |
| Expressive old comm test vs retest | 51 | ,998 |
| Receptive new comm test vs retest | 57 | ,990 |
| Expressive new comm test vs retest | 57 | ,994 |
| Receptive new sep comm vs rec old comm | 51 | ,971 |
| Expressive new separate comm vs express old comm. | 51 | ,951 |

### 3.1 (ii) Tester - Observer reliability BMDP 6D Bivariate plotting

Table 2: Tester vs Observer reliability coefficients on the Grover Developmental Charts

| | N | cor. |
|---|---|---|
| Body management tester vs observer | 21 | ,998 |
| Interaction with objects tester vs obs | 21 | ,999 |
| Socialization tester vs observer | 21 | ,997 |
| Receptive comm tester vs observer | 21 | ,999 |
| Express comm tester vs observer | 21 | ,997 |

## 3.2 VALIDITY

### 3.2 (i) Criterion related validity and construct validity i.e. correlations with other tests BMDP 6D Bivariate plotting

Table 3: Grover Developmental Charts vs Denver Developmental Screening Test Correlation

| | N | cor. |
|---|---|---|
| Socialization (Grover vs Personal-Social (DDST) | 108 | ,940 |
| Interaction with objects (Grover) vs Fine motor adaptive (DDST) | 108 | ,863 |
| Body management (Grover) vs Gross motor (DDST) | 108 | ,936 |
| Old communication total (Grover) vs Language (DDST) | 51 | ,969 |
| New communication total (Grover) vs Language (DDST) | 57 | ,955 |

### 3.2 (ii) Construct validity - internal consistency

BMDP 6D Bivariate plotting

Table 4: Subscores on the Grover Developmental Charts vs Total scores on the Grover Charts Correlation

| | Total 1 | Total 2 |
|---|---|---|
| Body management | ,971 | ,972 |
| Interaction with objects | ,983 | ,986 |
| Socialization | ,985 | ,990 |
| Receptive communication | ,970 | ,982 |
| Expressive communication | ,951 | ,982 |

Table 4: Total 1: N = 51: Data obtained on Grover Developmental Charts including old communication charts

Total 2: N = 57: Data obtained on Grover Developmental Charts including new communication charts

3.2 (iii) Construct validity - age differentiation

A. BMDP 6D Bivariate plotting

Table 5: Correlation of subscales on Grover Developmental Charts vs Age at administration of the subscale

| | N | cor |
|---|---|---|
| Body management test vs age at test | 108 | ,926 |
| Interaction with objects vs age at test | 108 | ,941 |
| Socialization test vs age at test | 108 | ,942 |
| Body management retest vs age at retest | 108 | ,925 |
| Interaction with objects vs age at retest | 108 | ,932 |
| Socialization retest vs age at retest | 108 | ,939 |
| Receptive old comm test vs age at test | 51 | ,942 |
| Expressive old comm test vs age at test | 51 | ,950 |
| Receptive old comm vs age at retest | 51 | ,932 |
| Expressive old comm vs age at retest | 51 | ,949 |
| Receptive new comm test vs age at test | 57 | ,904 |
| Expressive new comm test vs age at test | 57 | ,912 |
| Receptive new comm vs age at retest | 57 | ,897 |
| Expressive new comm vs age at retest | 57 | ,915 |
| Personal social DDST vs ag at retest | 108 | ,921 |
| Fine Motor adaptive DDST vs age at retest | 108 | ,906 |
| Language DDST vs age at retest | 108 | ,923 |
| Gross Motor DDST vs age at retest | 108 | ,952 |
| Receptive new sep comm vs age at admin | 51 | ,961 |

| | N | cor. |
|---|---|---|
| Expressive new sep comm vs age at admin | 51 | ,968 |
| Receptive new sep or new retest comm vs age at admin | 108 | ,919 |
| Expressive new sep or new retest comm vs age at admin | 108 | ,931 |

B. Multiple Linear Regression BMDP IR

1. N = 108: Stepwise regression to predict age from Body management ($X_{43}$); Interaction with objects ($X_{44}$); Socialization ($X_{45}$).

Prediction equation: Age = $-0,326 - 6,758X_{43} - 8,955X_{44} - 7,625X_{45}$

$$X_{43} = \text{Log}_e \left\{\frac{72 - \text{BMI}}{72 \times \text{BMI}}\right\}$$

$$X_{44} = \text{Log}_e \left\{\frac{72 - \text{IWOI}}{72 \times \text{IWOI}}\right\}$$

$$X_{45} = \text{Log}_e \left\{\frac{72 - \text{SOCI}}{72 \times \text{SOCI}}\right\}$$

2. N = 57: Stepwise regression to predict age from Body management($X_{43}$); Interaction with objects ($X_{44}$); Socialization ($X_{45}$): Receptive new communication ($X_{46}$); Expressive new communication ($X_{47}$).

Prediction equation: Age = $0,864 - 8.827X_{43} - 9,145X_{44} - 5,661X_{45} - 0,092X_{46} + 0,092X_{47}$

$$X_{43} = \text{Log}_e \left\{\frac{72 - \text{BMI}}{72 \times \text{BMI}}\right\}$$

$$X_{44} = \text{Log}_e \left\{\frac{72 - \text{IWOI}}{72 \times \text{IWOI}}\right\}$$

$$X_{45} = \text{Log}_e \left\{ \frac{72 - \text{SOCI}}{72 \times \text{SOCI}} \right\}$$

$$X_{46} = \text{Log}_e \left\{ \frac{72 - \text{Rec.New I}}{72 \times \text{ec.New I}} \right\}$$

$$X_{47} = \text{Log}_e \left\{ \frac{72 - \text{Express.New I}}{72 \times \text{Express.New I}} \right\}$$

C. Factor Analysis-Double Precision Version BMDP 4M

Unrotated factor loadings (pattern) for principal components

| | Factor 1 |
|---|---|
| Body management | 0,961 |
| Interaction with objects | 0,970 |
| Socialization | 0,973 |
| Receptive new communication | -0,974 |
| Expressive new communication | -0.977 |

Factor 1 explains 94,2% of the variability of these five subscale scores.

3.2 (iv) Construct validity - Factor analysis

A. Bivariate Plotting BMDP 6D

Table 6: Intercorrelation between 5 subscales on Grover Developmental Charts

| | | |
|---|---|---|
| Interaction with objects vs body management | 108 | ,956 |
| Socialization vs Body management | 108 | ,951 |
| Receptive old comm vs Body management | 51 | ,902 |
| Socialization vs Interaction with objects | 108 | ,959 |

| | N | cor |
|---|---|---|
| Expressive old comm vs Body management | 51 | ,886 |
| Receptive old comm vs Inter. with objects | 51 | ,935 |
| Expressive old comm vs Inter. with objects | 51 | ,906 |
| Receptive old comm vs Socialization | 51 | ,962 |
| Expressive old comm vs Socialization | 51 | ,936 |
| Expressive old comm vs Recept old comm | 51 | ,965 |
| Receptive new comm vs Body management | 57 | ,924 |
| Expressive new comm vs Body management | 57 | ,921 |
| Receptive new comm vs Inter. with objects | 57 | ,961 |
| Expressive new comm vs Inter. with objects | 57 | ,957 |
| Receptive new comm vs Socialization | 57 | ,962 |
| Expressive new comm vs Socialization | 57 | ,966 |
| Expressive new comm vs Receptive new comm | 57 | ,991 |

B. Factor Analysis - Double Precision Version BMDP 4M

(As in 3C under age differentiation)

Factor 1 explains 94,2% of the variability of the five subscale scores on the Grover Developmental Charts.

C. Bivariate Plotting BMDP 6D

Table 7: Factor scores correlated with predicted and Chronological age

| | N | co |
|---|---|---|
| Factor scores vs Predicted age | 54 | ,989 |
| Factor scores vs Chronological age | 54 | -,960 |
| Predicted age vs Chronological age | 54 | ,971 |

## 3.3 SIGNIFICANCE OF VARIABLES SEX; SOCIAL CLASS AND HOME VS CRECHE

One way analysis of variance and co-variance BMDP IV correcting for age and age$^2$

### 3.3 (i) Body management and mobility N = 108

No significant difference was found between the sexes, within the various social classes or between children examined at home or in a creche situation.

### 3.3 (ii) Interaction with objects N = 108

A significant difference was found between the sexes $p = 0,0017$, females greater than males.

Social class 4 was significantly less than social class 2 $p = 0,0219$.

Social class 4 was also significantly less than social class 3 $p = 0,0300$.

No significant difference was found between children examined at home or in a creche situation.

### 3.3 (iii) Socialization N = 108

A significant difference was found between the sexes $p = 0,0076$, females greater than males.

No significant difference was found within the various social classes or between children examined at home or in a creche situation.

3.3 (iv) Receptive new communication N = 57

A significant difference was found between the sexes p = 0,0056, females greater than males.

Social class 4 was significantly higher than social class 4 p = 0,0051.

Social class 2 was significanly higher than social class 4 p = 0,0399.

No significant difference was found between children examined at home or in a creche situation.

3.3 (v) Expressive new communication N = 57

A significant difference was found between the sexes p = 0,0053, females greater than males.

Social class 3 was significantly higher than social class 4 p = 0,0148.

Social class 2 was also significantly higher than social class 4 p = 0,0371

No significant difference was found between children examined at home or in a creche situation.

## 3.4 HISTOGRAMS

Univariate Plotting BMDP 5D

Table 8: Histogram of N = 108

| | Mean | std dev |
|---|---|---|
| Body management (test) Grover Charts | 48,231 | 20,038 |
| Interaction with objects (test) Grover Charts | 46,796 | 20,732 |
| Socialization (test) Grover Charts | 46,868 | 21,413 |
| Body management (retest) Grover Charts | 48,648 | 20,160 |
| Interaction with objects (retest) GroverCharts | 48,194 | 21,072 |
| Socialization (retest) Grover Charts | 46,916 | 21,384 |
| Personal Social DDST | 21,222 | 8,084 |
| Fine Motor Adaptive DDST | 20,120 | 7,554 |
| Language DDST | 20,342 | 9,359 |
| Gross Motor DDST | 22,472 | 8,856 |
| Age at test | 22,947 | 7,857 |
| Age at retest | 23,149 | 7,869 |

Table 9: Histogram of N = 51

| | Mean | Std dev |
|---|---|---|
| Body management (test) Grover Charts | 43,725 | 20,760 |
| Interaction with objects (test) Grover Charts | 42,823 | 20,755 |
| Socialization (test) Grover Charts | 41,000 | 21,929 |
| Body management (retest) Grover Charts | 44,117 | 20,879 |
| Interaction with objects (retest) Grover Charts | 44,039 | 21,400 |
| Socialization (retest) Grover Charts | 41,059 | 21,805 |
| Personal Social DDST | 18,686 | 7,092 |
| Fine Motor Adaptive DDST | 18,078 | 6,603 |
| Language DDST | 16,992 | 8.634 |
| Gross Motor DDST | 20,333 | 8,170 |
| Age at test Grover Charts | 21,197 | 7,648 |
| Age at retest of Grover Charts & DDST | 21,416 | 7,684 |
| Age at new separate comm Grover Charts | 22,452 | 8.732 |
| Age in months test | 20,549 | 7,682 |
| Age in days test | 19,451 | 9.981 |
| Receptive comm old (test) Grover Charts | 19,451 | 10,550 |
| Expressive comm old (test) Grover Charts | 17,823 | 10,013 |
| Age in months retest | 21,157 | 7,788 |
| Age in days retest | 7,765 | 10,349 |
| Receptive comm old (retest) Grover Charts | 19,706 | 10,618 |
| Expressive comm old (retest) Grover Charts | 17,922 | 10,050 |
| Age in months new sep. comm Grover Charts | 22,431 | 8.748 |
| Age in days new sep comm Grover Charts | 0,608 | 3,482 |
| Receptive comm new sep Grover Charts | 25,980 | 15,932 |
| Expressive comm new sep Grover Charts | 25,588 | 16,060 |

Table 10: Histogram of N = 57

| | Mean | Std dev |
|---|---|---|
| Body management (test) Grover Charts | 52,281 | 18,614 |
| Interaction with objects (test) Grover Charts | 50,298 | 20,311 |
| Socialization (test) Grover Charts | 51,859 | 19,842 |
| Body management (retest) Grover Charts | 52,702 | 18,758 |
| Interaction with objects (retest) Grove Charts | 51,912 | 20,241 |
| Socialization (retest) Grover Charts | 52,158 | 19,748 |
| Personal Social DDST | 23,491 | 8,298 |
| Fine Motor Adaptive DDST | 21,947 | 7,932 |
| Language DDST | 23,403 | 8.978 |
| Gross Motor DDST | 24,386 | 9,075 |
| Age at test Grover Charts | 24,512 | 7,775 |
| Age at retest Grover Charts and DDST | 24,700 | 7,773 |
| Age in months (test) | 24,228 | 7,885 |
| Age in days (test) | 8,526 | 10,825 |
| Receptive new comm (test) Grover Charts | 34,947 | 15,028 |
| Expressive new comm (test) Grover Charts | 34,737 | 15,240 |
| Age in months (retest) | 24,438 | 7,785 |
| Age in days (retest) | 7,842 | 7,010 |
| Receptive new comm (retest) Grover Charts | 35,982 | 14,940 |
| Expressive new comm (retest) Grover Charts | 35,263 | 14,972 |

Table 11: Histogram of N = 21

| | Mean | Std dev |
|---|---|---|
| Age in months (test) | 21,905 | 7,476 |
| Age in days (test) | 12,476 | 10,524 |
| Body management (test) Grover Charts | 46,428 | 20,302 |
| Interaction with objects (test) Grover Charts | 43,333 | 20,674 |
| Socialization (test) Grover Charts | 47,238 | 20,428 |
| Receptive new communication Grover Charts | 30,857 | 15,717 |
| Expressive new communication Grover Charts | 30,429 | 15,961 |
| Age at which tester observer administered | 22,321 | 7,331 |

# 4. DISCUSSION

## 4.1 EVALUATION OF RESULTS

The aim of this study was to establish preliminary data on the reliability and validity of the Grover Developmental Charts as an objective measure of the current level of functioning in selected areas of development as measured in a population of white, English speaking children between the ages of 10 and 36 months.

### 4.1 (i) Reliability

#### Test - retest reliability

The time interval over which test - retest reliability was measured in this study was between 5 and 7 days. The test-retest correlation coefficients obtained on the five subscales ranged between ,951 and ,999 (see Table 1 in results). Accorrding to Anastasi (1968, p.78), "the higher the reliability the less susceptible the scores are to random daily changes in the condition of the subject or of the testing environment. Thus the results indicate that the Grove Developmental Charts have excellent test-retest reliability.

#### Tester - observer reliability

The tester-observer correlation coefficients obtained on the Grover Developmental Charts ranged between ,997 and ,999 (see Table 2 in results). These results indicate that the Grover Developmental Charts have excellent tester-ovserver reliability.

4.1 (ii) Validity

Criterion related validity and construct validity i.e. correlations with other tests

The criterion test against which the Grover Developmental Charts were validated was the Denver Developmental Screening Test, as a direct and independent measure of that which the Grover Developmental Charts are designed to be a measure ; namely, developmental status or developmental age in certain selected areas. When the subscales on the Grover Developmental Charts were correlated with the corresponding subscales on the DDST, the correlation coefficients ranged between ,863 and ,969 (see Table 3 in results). These results substantiate that the Grover Developmental Charts are a valid measure of developmental age.

Construct validity

Age differentiation: The results indicate that the set of scores obtained i.e. body management; interaction with objects; socialization; receptive communication and expressive communication, on an individual will reflect an increase in developmental age and not necessarily chronological age. It can therefore be concluded that the Grover Developmental Charts are valid in terms of age differentiation.

Factor analysis: The factor analysis or as in this case, the principle component analysis attempts to find underlying factors, so that the scores obtained on the Grover Developmental Charts can be thought of in terms of combinations of these factors. A factor

analysis will also indicate which scores are related to which factors.

The principle component analysis yielded only one component of importance. This component explained 94,2% of the variability of the five subscale scores on the Grover Developmental Charts. Consequently all the scores reflect this one component which is an estimate of the developmental age of the individual.

When the factor scores were plotted against the expected age of the individual, the correlation coefficient rendered was ,989 which is larger than the correlation coefficient of ,960 which was obtained when the factor scores were plotted against chronological age (see Table 7 in results). This then explains why this component is identified as an estimate of developmental age rather than chronological age.

Internal consistency: The correlations of the subscales of the Grover Developmental Charts with the total score ranged between ,951 and ,990 (See Table 4 in results). According to Anastasi (1968) such correlations should be high, as is revealed by these results, in order for the test to have internal consistency. Therefore one can say that the Grover Developmental Charts are valid in terms of their internal consistency.

4.1 (iii) Significance of variables sex; social class; home vs creche

In this study with a sample of 108 subjects, significant differences were found:-

(a) between the sexes, females greater than males on all the G ove Developmental Charts, except the chart on body management and mobility (see results),
(b) between the social classes on the chart, interaction with objects, and on both the receptive and expressive communication charts (see results).

However, although these significant differences were found in this study, in an independent and far larger statistical analysis (n = 550) of Gilbert (1977) when these same variables were examined for their significance, no significant differences were found. Therefore one can conclude that the significant differences which were found in this study were probably due to random sampling variations.

## 4.2 METHODOLOGICAL CONSIDERATIONS

Although an attempt was made in the present study to overcome the methodological problems inherent in a stuy of this kind, two problems encountered may now be mentioned.

Firstly, due to the unfortunate difficulty encountered a short way through this study, when the old communication charts were found to be inadequate and the new revised communication charts were instituted, a retest of some of the subjects on the new revised communication charts was necessitated. As a result the data thus available for examination in this study, was reduced to N = 51 and N = 57 respectively for the old and new communication charts as compared with the data available for examination N = 108, on the first three charts i.e.body management; interaction with objects and socialization.

Secondly, in this study only one criterion was used against which the Grover Developmental Charts was validated, namely the DDST. Obviously if one or two more criteria had been used, the criterion related validity might have been established with a greater degree of secuirity. However, as has previously been mentioned in the Method, with a population of this age group, no other objective criteria are available such as school performance for example. One must therefore rely on other previously validated tests, which examine the same area as the Grover Developmental Charts. For practical reasons of time and man power available, however, for the purposes of this study it was only feasible to validate the Grover Developmental Charts against one criterion related test.

## 4.3 IMPLICATION OF THE PRESENT STUDY FOR FURTHER STUDY

As has previously been mentioned, the Grover Developmental Charts were designed primarily for use with handicapped children and particularly the mentally retarded child. Although it was necessary to do a study such as this on a normal population and to have established norms on a normal population it would be of value to extend a study of this kind to a mentally retarded population and other kinds of handicapped population groups. Such a study might uncover certain trends in the seemingly uneven development of the atypical child.

Such a study should also be carried out on the black population group in South Africa as no test exists with norms established for this large group of people, either normal or atypical. Such a shortcoming makes work with this population very difficult.

The Grover Developmental Charts were designed for use as an instrument for the diagnosis of the current level of functioning in certain selected areas, and not as a means of predicting future outcomes. Furthe more it has previously been mentioned in the Method, that "test scores earned in the first year or two have relatively little predictive validity (in contrast to tests at school age or later) although they may have high validity as measures of the children's cognitive ability at the time." (Bayley, 1970 in McCall et al., 1972, p.728.)

However, recent research studies such as those of Du Bose (1976), Van der Veer and Schweid (1974), Hatcher (1976) and Illingworth (1971) indicate that the predictive validity of infant tests on the mentally retarded population is good.

Thus in terms of the mentally handicapped child for whom the Grover Developmental Charts were specifically designed, they may well have predictive validity for this population. This points to a need for further research to be done in this direction.

At the end of the present study and as a result of another statistical analysis (Gilbert, 1977) which examined among other things item analysis and established the normative data for the Grover Developmental Charts, they were modified. The extent of the modifications is very limited (97% of the items remaining unchanged), and does not affect the fundamental results or the applicability of this study.

# 5. CONCLUSION

An analysis of the results obtained in this study leads to the conclusion that the Grover Developmental Charts have excellent test-retest and tester-observer reliability. Furthe more as is substantiated by the results of an examination of the criterion related validity, age differentiation, internal consistency, and factor analysis, the Grover Developmental Charts are a valid instrument and serve the purpose for which they were designed.

One can thus conclude that the Grover Developmental Charts are applicable for use with the normal child from 10 months to just under 36 months. Furthe more, although the Grover Developmental Charts have not yet been applied to any extent to the atypical child, the results so far obtained in this study suggest that they would provide a valuable instrument for use with the handicapped child.

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# APPENDIX

## Reliability

### 1. Test-retest reliability

a) Body management retest score (Y) vs Body management test score (X)

N = 108 cor = ,999

| | mean | std dev |
|---|---|---|
| X | 48,240 | 20,029 |
| Y | 48,648 | 20,160 |

b) Interaction with objects retest score (Y) vs Interaction with objects test score (X)

N = 108 cor = ,992

| | mean | std dev |
|---|---|---|
| X | 46,768 | 20,767 |
| Y | 48,194 | 21,072 |

c) Socialization retest score (Y) vs Socialization test score (X)

N = 108 cor = ,999

| | mean | std dev |
|---|---|---|
| X | 46,731 | 21,458 |
| Y | 46,916 | 21,384 |

d) Receptive retest score (Y) vs Receptive test score (X) (old communication)

N = 51 cor = ,992

| | mean | std dev |
|---|---|---|
| X | 19,451 | 10,550 |
| Y | 19,706 | 10,618 |

e) Expressive retest score (Y) vs Expressive test score (X) (old communication)

N = 51 cor = ,998

| | mean | std dev |
|---|---|---|
| X | 17,823 | 10,013 |
| Y | 17,922 | 10,050 |

f) Receptive retest score (Y) vs Receptive test score (X) (new communication)

N = 57 cor = ,990

| | mean | std dev |
|---|---|---|
| X | 34,947 | 15,028 |
| Y | 35,982 | 14,940 |

g) Expressive retest score (Y) vs Expressive test score (X) (new communication)

N = 57 cor = ,994

| | mean | std dev |
|---|---|---|
| X | 34,737 | 15,240 |
| Y | 35,263 | 14,972 |

h) Receptive new separate comm. score (Y) with Receptive old comm. score (X)

N = 51 cor = ,971

| | mean | std dev |
|---|---|---|
| X | 19,451 | 10,550 |
| Y | 25,980 | 15,932 |

i) Expressive new separate comm. score (Y) with Expressive old comm. score (X)

N = 51 cor = ,951

| | mean | std dev |
|---|---|---|
| X | 17,823 | 10,013 |
| Y | 25,588 | 16,060 |

2. Tester - Observer Reliability

a) Body management (observer) score (Y) vs Body management (tester) score (X)

N = 21 cor = ,998

| | mean | std dev |
|---|---|---|
| X | 46,619 | 20,304 |
| Y | 46,428 | 20,302 |

b) Interaction with objects (observer) score (Y) vs Interaction with objects (tester) score (X)

N = 21 cor = ,999

| | mean | std dev |
|---|---|---|
| X | 43,333 | 20,328 |
| Y | 43,333 | 20,674 |

c) Socialization (observer) score (Y) vs Socialization (tester) score (X)

N = 21 cor = ,997

| | mean | std dev |
|---|---|---|
| X | 46,905 | 20,741 |
| Y | 47,238 | 20,428 |

d) Receptive (observer) score (Y) vs Receptive (tester) score (X)

N = 21 cor = ,999

| | mean | std dev |
|---|---|---|
| X | 30,809 | 15,526 |
| Y | 30,857 | 15,717 |

e) Expressive(observer) score (Y) vs Expressive (tester) score (X)

N = 21 cor = ,997

| | mean | std dev |
|---|---|---|
| X | 30,857 | 16,107 |
| Y | 30,429 | 15,961 |

Validity

1. Criterion related validity and construct validity i.e. correlations with other tests. Grover Dev. Charts vs Denver Dev. Screening Test

a) Socialization (Grover Dev. Charts) $^{Y}$ retest score vs Personal Social (DDST) $^{X}$ score

N = 108 cor = ,940

| | mean | std dev |
|---|---|---|
| X | 21,222 | 8,0841 |
| Y | 46,916 | 21,384 |

b) Interaction with objects (Grover Dev. Charts) $^{Y}$ retest score vs. Fine Motor Adaptive $^{X}$ (DDST) score

N = 108 cor = ,863

| | mean | std dev |
|---|---|---|
| X | 20,120 | 7,5539 |
| Y | 48,194 | 21,072 |

c) Body management (Grover Dev. Charts) $^{Y}$ retest score vs Gross Motor $^{X}$ (DDST) score

N = 108 cor = ,936

| | mean | std dev |
|---|---|---|
| X | 22,472 | 8,8556 |
| Y | 48,648 | 20,160 |

d) Total score old communication (Grover Dev. Chart) $^{Y}$ retest score vs Language $^{X}$ (DDST) score

N = 51 cor = ,969

| | mean | std dev |
|---|---|---|
| X | 16,922 | 8,6345 |
| Y | 24,019 | 16,259 |

e) Total score new communication (Grover Dev. Charts) retest score vs. Language (DDST) score

N = 57 cor = ,955

| | mean | std dev |
|---|---|---|
| X | 23,402 | 8,779 |
| Y | 49,123 | 25,183 |

2. Construct validity - internal consistency: Subscores on GroverDev. Charts vs Total scores on Grover Charts

A. a) Total score of Grover Dev. Charts vs Body management Score (test)

N = 51 cor = ,971

| | mean | std dev |
|---|---|---|
| X | 43,725 | 20,760 |
| Y | 164,82 | 81,922 |

b) Total score of Grover Dev. Charts vs Interaction with objects score (test)

N = 51 cor = ,983

| | mean | std dev |
|---|---|---|
| X | 42,823 | 20,755 |
| Y | 164,82 | 81,922 |

c) Total score of Grover Dev. Charts vs Socialization score (test)

N = 51 cor = ,985

| | mean | std dev |
|---|---|---|
| X | 41,000 | 21,929 |
| Y | 164,82 | 81,922 |

d) Total score of Grover Dev. Charts vs old rec. comm. score (test)

N = 51 cor = ,985

| | mean | std dev |
|---|---|---|
| X | 41,000 | 21.929 |
| Y | 164,82 | 81,922 |

e) Total score of Grover Dev. Charts (Y) vs Old Expressive communication score (test) (X)

N = 51 cor = ,951

| | mean | std dev |
|---|---|---|
| X | 17,823 | 10,013 |
| Y | 164,82 | 81,922 |

B. a) Total score of Grover Dev. Charts (Y) vs Body management score (test) (X)

N = 57 cor = ,972

| | mean | std dev |
|---|---|---|
| X | 52,281 | 18,614 |
| Y | 224,12 | 87,475 |

b) Total score of Grover Dev. Charts (Y) vs Interaction with Objects score (test) (X)

N = 57 cor = ,986

| | mean | std dev |
|---|---|---|
| X | 50,298 | 20,311 |
| Y | 224,12 | 87,475 |

c) Total score of Grover Dev. Charts (Y) vs Socialization score (test) (X)

N = 57 cor = ,990

| | mean | std dev |
|---|---|---|
| X | 51,859 | 19,842 |
| Y | 224,12 | 87,475 |

d) Total score of Grover Dev. Charts (Y) vs New Receptive Communication score (test) (X)

N = 57 cor = ,982

| | mean | std dev |
|---|---|---|
| X | 34,947 | 15,028 |
| Y | 224,12 | 87,475 |

e) Total score of Grover Dev. Charts (Y) vs New Expressive Communication score (test) (X)

N = 57 cor = ,982

| | mean | std dev |
|---|---|---|
| X | 34,737 | 15,240 |
| Y | 224,12 | 87,475 |

3. Age differentiation - construct validity

Bivariate Plotting BMDP 6D

A. a) Body management score (test) (Y) vs age at test (X)

N = 108 cor = ,926

| | mean | std dev |
|---|---|---|
| X | 22,947 | 7,8570 |
| Y | 48,240 | 20,029 |

b) Interaction with objects score (test) (Y) vs age at test (X)

N = 108 cor = ,941

| | mean | std dev |
|---|---|---|
| X | 22,947 | 7,8570 |
| Y | 46,768 | 20,767 |

c) Socialization score (test) (Y) vs age at test (X)

N = 108 cor = ,942

| | mean | std dev |
|---|---|---|
| X | 22,947 | 7,8570 |
| Y | 46,731 | 21,458 |

d) Body management score (retest) (Y) vs age at retest (X)

N = 108 cor = ,925

| | mean | std dev |
|---|---|---|
| X | 23,149 | 7,8693 |
| Y | 46,648 | 20,160 |

e) Interaction with objects score (retest) vs age at retest (Y vs X)

N = 108 cor = ,932

| | mean | std dev |
|---|---|---|
| X | 23,149 | 7,8693 |
| Y | 48,194 | 21,072 |

f) Socialization score (retest) vs age at retest (Y vs X)

N = 108 cor = ,939

| | mean | std dev |
|---|---|---|
| X | 23,149 | 7,8693 |
| Y | 46,916 | 21,384 |

B. a) Receptive old communication score (test) vs age at test (Y vs X)

N = 51 cor = ,942

| | mean | std dev |
|---|---|---|
| X | 21,197 | 7,6481 |
| Y | 19,451 | 10,550 |

b) Expressive old communication score (retest) vs age at retest (Y vs X)

N = 51 cor = ,950

| | mean | std dev |
|---|---|---|
| X | 21,197 | 7,6481 |
| Y | 17,823 | 10,013 |

c) Receptive old communication score (retest) vs age at retest (Y vs X)

N = 51 cor = ,932

| | mean | std dev |
|---|---|---|
| X | 21,416 | 7,6843 |
| Y | 19,706 | 10,618 |

d) Expressive old communication score (retest) vs age at retest (Y vs X)

N = 51 cor = ,949

| | mean | std dev |
|---|---|---|
| X | 21,416 | 7,6843 |
| Y | 17,922 | 10,05o |

C. a) Y X
Receptive new communication score (test) vs age at test

N = 57 cor = ,904

| | mean | std dev |
|---|---|---|
| X | 24,512 | 7,7746 |
| Y | 34,947 | 15,028 |

b) Y X
Expressive new communication score (test) vs age at test

N = 57 cor = ,912

| | mean | std dev |
|---|---|---|
| X | 24,512 | 7,7746 |
| Y | 34,737 | 15,240 |

c) Y X
Receptive new communication score (retest) vs age at retest

N = 57 cor = ,897

| | mean | std dev |
|---|---|---|
| X | 24,700 | 7,7726 |
| Y | 35,982 | 14,940 |

d) Y X
Expressive new communication score (retest) vs age at retest

N = 57 cor = ,915

| | mean | std dev |
|---|---|---|
| X | 24,700 | 7,7726 |
| Y | 35,263 | 14,972 |

D. a) Y X
Personal Social score (DDST) vs age at retest

N = 108 cor = ,921

| | mean | std dev |
|---|---|---|
| X | 23,149 | 7,8693 |
| Y | 21,222 | 8,0841 |

b) Fine Motor Adaptive (DDST) vs age at retest (Y vs X)

N = 108 cor = ,906

| | mean | std dev |
|---|---|---|
| X | 23,149 | 7,8693 |
| Y | 20,120 | 7,5539 |

c) Language score (DDST) vs age at retest (Y vs X)

N = 108 cor = ,923

| | mean | std dev |
|---|---|---|
| X | 23,149 | 7,8693 |
| Y | 20,342 | 9,3591 |

d) Gross Motor score (DDST) vs age at retest (Y vs X)

N = 108 cor = ,952

| | mean | std dev |
|---|---|---|
| X | 23,149 | 7,8693 |
| Y | 22,472 | 8,8556 |

E. a) Receptive communication score (new separate) vs age at administration (Y vs X)

N = 51 cor = ,961

| | mean | std dev |
|---|---|---|
| X | 22,451 | 8,7324 |
| Y | 25,980 | 15,932 |

b) Expressive communication score (new separate) vs age at administration (Y vs X)

N = 51 cor = ,968

| | mean | std dev |
|---|---|---|
| X | 22,451 | 8,7324 |
| Y | 25,588 | 16,060 |

F. a) Receptive communication score (new separate or new retest) (Y) vs age at administration (X)

N = 108 cor = ,919

| | mean | std dev |
|---|---|---|
| X | 23,638 | 8,2779 |
| Y | 31,176 | 16,052 |

b) Expressive communication score (new separate or new retest) (Y) vs age at administration (X)

N = 108 cor = ,931

| | mean | std dev |
|---|---|---|
| X | 23,638 | 8,2779 |
| Y | 30,694 | 16,168 |

Multiple Linear Regression BMDPIR

A. N = 108

1. Body management (test) - $X_{43}$
2. Interaction with objects (test) - $X_{44}$
3. Socialization (test) - $X_{45}$

(stepwise regression on age i.e. age predicted from 1, 2 and 3)

Multiple R 0,9716 std error of estimate = 1,8491

Multiple R-square 0,9440 i.e. 94,40% of variance is accounted for

Prediction equation: $Age = -0,326 - 6,758X_{43} - 8,955X_{44} - 7,625X_{45}$

$$X_{43} = \text{Log}_e \left\{\frac{72 - \text{B.M.I}}{72 \times \text{B.M.I}}\right\}$$

$$X_{44} = \text{Log}_e \left\{\frac{72 - \text{I.W.O.}}{72 \times \text{I.W.O.}}\right\}$$

$$X_{45} = \text{Log}_e \left\{\frac{72 - \text{SOCI}}{72 \times \text{SOCI}}\right\}$$

B. N = 57

1. Body management (test) - $X_{43}$
2. Interaction with objects (test) - $X_{44}$

3. Socialization (test) - $X_{45}$

4. Receptive new communication (test) - $X_{46}$

5. Expressive new communication (test) - $X_{47}$

(stepwise regression on age i.e. age predicted from 1,2,3,4,5)

Multiple R 0,9705 std error of estimate = 1,9205

Multiple R-squared 0,9419 i.e. 94,19% of variance is accounted for

Prediction equation:

$$Age = -0,864 - 8.827X_{43} - 9,145X_{44} - 5,661X_{45} - 0,092X_{46} + 0,092X_{47}$$

$$X_{43} = \text{Log}_e \left\{\frac{72 - BMI}{72 \times BMI}\right\}$$

$$X_{44} = \text{Log}_e \left\{\frac{72 - IWOI}{72 \times IWOI}\right\}$$

$$X_{45} = \text{Log}_e \left\{\frac{72 - SOCI}{72 \times SOCI}\right\}$$

$$X_{46} = \text{Log}_e \left\{\frac{72 - Rec.New.1}{72 \times Rec.New.1}\right\}$$

$$X_{47} = \text{Log}_e \left\{\frac{72 - Express.\ New\ 1}{72 \times Express.\ New\ 1}\right\}$$

Factor Analysis - Double Precision version BMDP4M

Factor 1 explains 94,2% of the variability.

4. Factor Analysis - construct validity

Bivariate Plotting BMDP 6D

A. a) Interaction with objects score (test) (Y) vs Body management score (test) (X)

N = 108 cor = ,956

| | mean | std dev |
|---|---|---|
| X | 48,240 | 20,029 |
| Y | 46,768 | 20,767 |

b) Socialization score (test) (Y) vs Body management score (test) (X)

N = 108 cor = ,951

| | mean | std dev |
|---|---|---|
| X | 48,240 | 20,029 |
| Y | 46,731 | 21,458 |

c) Socialization score (test) vs Interaction with objects score (test) (Y vs X)

N = 108 cor = ,959

| | mean | std dev |
|---|---|---|
| X | 46,768 | 20,767 |
| Y | 46,731 | 21,458 |

B. a) Receptive old communication score (test) vs Body management score (test) (Y vs X)

N = 51 cor = ,902

| | mean | std dev |
|---|---|---|
| X | 43,725 | 20,760 |
| Y | 19,451 | 10,550 |

b) Expressive old communication score (test) vs Body management score (test) (Y vs X)

N = 51 cor = ,886

| | mean | std dev |
|---|---|---|
| X | 43,725 | 20,760 |
| Y | 17,823 | 10,013 |

c) Receptive old communication score (test) vs Interaction with objects score (test) (Y vs X)

N = 51 cor = ,935

| | mean | std dev |
|---|---|---|
| X | 42.823 | 20,755 |
| Y | 19,451 | 10,550 |

d) Expressive old communication score (test) (Y) vs Interaction with objects (test) score (X)

N = 51 cor = ,906

| | mean | std dev |
|---|---|---|
| X | 42,823 | 20,755 |
| Y | 17,823 | 10,013 |

e) Receptive old communication score (test) (Y) vs Socialization score (test) (X)

N = 51 cor = ,962

| | mean | std dev |
|---|---|---|
| X | 41,000 | 21,929 |
| Y | 19,451 | 10,550 |

f) Expressive old communication score (test) (Y) vs Socialization score (test) (X)

N = 51 cor = ,936

| | mean | std dev |
|---|---|---|
| X | 41,000 | 21,929 |
| Y | 17,823 | 10,013 |

g) Expressive old communication score (test) (Y) vs Receptive old communication score (test) (X)

N = 51 cor = ,965

| | mean | std dev |
|---|---|---|
| X | 19,451 | 10,550 |
| Y | 17,823 | 10,013 |

C. a) Receptive new communication score (test) (Y) vs Body management score (test) (X)

N = 57 cor = ,924

| | mean | std dev |
|---|---|---|
| X | 52,281 | 18,614 |
| Y | 34,947 | 15,028 |

b) Y X
Expressive new communication score (test) vs Body management score (test)

N = 57 cor = ,921

| | mean | std dev |
|---|---|---|
| X | 52,281 | 18,614 |
| Y | 34,737 | 15,240 |

c) Y X
Receptive new communication score (test) vs Interaction with objects score (test)

N = 57 cor = ,961

| | mean | std dev |
|---|---|---|
| X | 50,298 | 20,311 |
| Y | 34,947 | 15,028 |

d) Y X
Expressive new communication score (test) vs Interaction with objects score (test)

N = 57 cor = ,957

| | mean | std dev |
|---|---|---|
| X | 50,298 | 20,311 |
| Y | 34,737 | 15,240 |

e) Y X
Receptive new communication score (test) vs Socialization score (test)

N = 57 cor = ,962

| | mean | std dev |
|---|---|---|
| X | 51,859 | 19,842 |
| Y | 34,947 | 15,028 |

f) Expressive new communication (test) score vs Socialization score (test)

N = 57 cor = ,966

| | mean | std dev |
|---|---|---|
| X | 51,859 | 19,842 |
| Y | 34,737 | 15,240 |

g) Expressive new communication score (test) vs Receptive new communication score (test)

N = 57 cor = ,991

| | mean | std dev |
|---|---|---|
| X | 34,947 | 15,028 |
| Y | 34,737 | 15,240 |

Factor Analysis - Double Precision Version BMDP 4M

Unrotated factor loadings (pattern) for principal components.

| | Factor 1 |
|---|---|
| Body management | 0,961 |
| Interaction with objects | 0,970 |
| Socialization | 0,973 |
| Receptive new communication | -0,974 |
| Expressive new communication | -0,977 |

Factor 1 explains 94,2% of the variability of these 5 subscale scores.

Bivariate Plotting - BMDP 6D

a) Factor scores vs Predicted age

N = 54 cor = -,989

| | mean | std dev |
|---|---|---|
| X | 23,947 | 7,3600 |
| Y | -213E - 7 | 1,0000 |

b) Factor scores vs Chronological age (Y, X)

N = 54 cor = -,960

| | mean | std dev |
|---|---|---|
| X | 23,933 | 7,6098 |
| Y | -213E - 7 | 1,0000 |

c) Predicted age vs Chronological age (Y, X)

N = 54 cor = ,971

| | mean | std dev |
|---|---|---|
| X | 23,933 | 7,6098 |
| Y | 23,947 | 7,3600 |

Histograms

Univariate plotting - BMDP 5D

A. N = 108 : Data obtained on group of children tested and retested on Grover Development Charts, some with new revised Communication charts and others with old Communication charts. The children were also tested on the DDST.

a) Histogram of variable Body management (test)

count 108

mean 48,231

st.dev 20,038

b) Histogram of variable Interaction with Objects (test)

count 108

mean 46,796

st.dev 20,732

c) Histogram of variable Socialization (test)

count 108

mean 46,768

st.dev 21,413

d) Histogram of variable Body management (retest)

count 108

mean 48,648

st.dev 20,160

e) Histogram of variable Interaction with objects (retest)

count 108

mean 48,194

st.dev 21,072

f) Histogram of variable Socialization (retest)

count 108

mean 46,916

st.dev 21,384

g) Histogram of variable Personal social (DDST)

count 108

mean 21,222

st.dev 8,084

h) Histogram of variable Fine motor adaptive (DDST)

count 108

mean 20,120

st.dev 7,554

i) Histogram of variable Language (DDST)

count 108

mean 20,342

st.dev 9,359

j) Histogram of variable Gross Motor (DDST)

count 108

mean 22,472

st.dev 8.856

e) Histogram of variable Socialization (test)

count 51

mean 41,000

st.dev 21,929

f) Histogram of variable Receptive Communication (test)

count 51

mean 19,451

st.dev 10,550

g) Histogram of variable Expressive Communication (test)

count 51

mean 17,823

st.dev 10,013

h) Histogram of variable age in months (retest)

count 51

mean 21,157

st.dev 7,788

i) Histogram of variable age in days (retest)

count 51

mean 7,765

st.dev 10,349

j) Histogram of variable Body management (retest)

count 51

mean 44,117

st.dev 20,879

k) Histogram of variable Interaction with objects (retest)

count 51

mean 44,039

st.dev 21,400

l) Histogram of variable Socialization (retest)

count 51

mean 41,059

st.dev 21,805

m) Histogram of variable Receptive communication (retest)

count 51

mean 19,706

st.dev 10,618

n) Histogram of variable Expressive communication (retest)

count 51

mean 17,922

st.dev 10,050

o) Histogram of variable age in months at (new revised separate communication chart)

count 51

mean 22,431

st.dev 8.748

p) Histogram of variable age in days at (new revised separate communication chart)

count 51

mean 0,608

st.dev 3,482

q) Histogram of variable Receptive communication (new separate)

count 51

mean 25,980

st.dev 15,932

r) Histogram of variable Expressive communication (new separate)

count 51

mean 25,588

st.dev 16,060

s) Histogram of variable Personal social (DDST)

count 51

mean 18.686

st.dev 7,092

t) Histogram of variable Fine motor adaptive (DDST)

count 51

mean 18,078

st.dev 6,603

u) Histogram of variable Language (DDST)

count 51

mean 16,922

st.dev 8.634

v) Histogram of variable Gross Motor (DDST)

count 51

mean 20,333

st.dev 8.170

w) Histogram of variable age at test

count 51

mean 21,197

st.dev 7,648

x) Histogram of variable age at retest

count 51

mean 21,416

st.dev 7,684

y) Histogram of variable age at test on new separate communication chart

count 51

mean 22,452

st.dev 8.732

C. N = 57 : Data obtained on group of children tested and retested on Grover Developmental Charts including the new revised communication charts.

a) Histogram of variable age in months (test)

count 57

mean 24,228

st.dev 7,885

b) Histogram of variable age in days (test)

count 57

mean 8,526

st.dev 10,825

c) Histogram of variable Body management (test)

count 57

mean 52,281

st.dev 18,614

d) Histogram of variable Interaction with objects (test)

count 57

mean 50,298

st.dev 20,311

e) Histogram of variable Socialization (test)

count 57

mean 51,859

st.dev 19,842

f) Histogram of variable Receptive communication (test)

count 57

mean 34,947

st.dev 15,028

g) Histogram of variable Expressive communication (test)

count 57

mean 34,737

st.dev 15,240

h) Histogram of variable age in months (retest)

count 57

mean 24,438

st.dev 7,785

i) Histogram of variable age in days (retest)

count 57

mean 7,842

st.dev 7,010

j) Histogram of variable Body management (retest)

count 57

mean 52,702

st.dev 18,758

k) Histogram of variable Interaction with objects (retest)

count 57

mean 51,912

st.dev 20,241

l) Histogram of variable Socialization (retest)

count 57

mean 52,158

st.dev 19,748

m) Histogram of variable Receptive communication (retest)

count 57

mean 35,982

st.dev 14,940

n) Histogram of variable expressive language (retest)

count 57

mean 35,263

st.dev 14,972

o) Histogram of variable Personal Social (DDST)

count 57

mean 23,491

st.dev 8.298

p) Histogram of variable Fine motor adpative (DDST)

count 57

mean 21,947

st.dev 7,932

q) Histogram of variable Language (DDST)

count 57

mean 23,403

st.dev 8.978

r) Histogram of variable Gross Motor (DDST)

count 57

mean 24,386

st.dev 9,075

s) Histogram of variable age at test

count 57

mean 24,512

st.dev 7,775

t) Histogram of variable age at retest

count 57

mean 24,700

st.dev 7,773

D. N = 21 : Data obtained on group of children used in the study of tester-observer reliability examined and re-examined on the Grover Developmental Charts including the new revised communication chart

a) Histogram of variable age in months

count 21

mean 21,905

st.dev 7,476

b) Histogram of variable age in days

count 21

mean 12,476

st.dev 10,524

c) Histogram of variable Body management

count 21

mean 46,428

st.dev 20,302

d) Histogram of variable Interaction with objects

count 21

mean 43,333

st.dev 20,674

e) Histogram of variable socialization

count 21

mean 47,238

st.dev 20,428

f) Histogram of variable receptive communication

count 21

mean 30,857

st.dev 15,717

g) Histogram of variable expressive communication

count 21

mean 30,429

st.dev 15,961

h) Histogram of variable age at which tester-observer done

| | |
|---|---|
| count | 21 |
| mean | 22,321 |
| st.dev | 7,337 |

Frequency Count Routine BMDP 2D

1. Date of birth : day

| | |
|---|---|
| number of values counted | 108 |
| mean | 15,435 |
| median | 15,000 |
| mode | not unique |
| maximum | 31,000 |
| minimum | 1,000 |
| range | 30,000 |
| variance | 66,509 |
| st. dev | 8.155 |

2. Date of birth : month

| | |
|---|---|
| number of values counted | 108 |
| mean | 6,2 2 |
| median | 6,000 |
| mode | not unique |
| maximum | 12,000 |
| minimum | 1,000 |
| range | 11,000 |
| variance | 10,954 |
| st. dev | 3,309 |

3. Date of birth : year

| | |
|---|---|
| number of values counted | 108 |
| mean | 74,148 |

| | |
|---|---|
| median | 74,000 |
| mode | 74,000 |
| maximum | 76,000 |
| minimum | 72,000 |
| range | 4,000 |
| variance | 0,613 |
| st. dev | 0,783 |

4. Laterality

| | |
|---|---|
| number of values counted | 108 |
| mean | 1,601 |
| median | 1,000 |
| mode | 1,000 |
| maximum | 3,000 |
| minimum | 1,000 |
| range | 2,000 |
| variance | 0,821 |
| st. dev | 0,906 |

| | cell percent | |
|---|---|---|
| 1: N = 74 | 68,5 | not established |
| 2: N = 3 | 2,8 | left handed |
| 3: N = 31 | 28,7 | right handed |

5. Sex

| | |
|---|---|
| number of values counted | 108 |
| mean | 1,555 |
| median | 2,000 |
| mode | 2,000 |
| maximum | 2,000 |

| | |
|---|---|
| maximum | 2,000 |
| minimum | 1,000 |
| range | 1,000 |
| variance | 0,249 |
| st. dev | 0,499 |

1: N = 48 cell percent = 44,4 male

2: N = 60 cell percent = 55,6 female

6. Birth order

| | |
|---|---|
| number of values counted | 108 |
| mean | 1,712 |
| median | 1,000 |
| mode | 1,000 |
| maximum | 6,000 |
| minimum | 1,000 |
| range | 5,000 |
| st. dev | 0,957 |
| variance | 0,916 |

| N | cell percent |
|---|---|
| 1: 59 | 54,6 |
| 2: 28 | 25,9 |
| 3: 16 | 14,8 |
| 4: 4 | 3,7 |
| 6: 1 | 0,9 |

7. Length of stay in creche in months

| | |
|---|---|
| number of values counted | 108 |
| mean | 5,879 |
| median | 3,000 |
| mode | 0,000 |

| | |
|---|---|
| maximum | 30,000 |
| minimum | 0,0 |
| range | 30,000 |
| variance | 56,331 |
| st. dev | 7,505 |

| Months | N | cell percent |
|---|---|---|
| 0 | 37 | 34,3 |
| 1 | 10 | 9,3 |
| 2 | 5 | 4,6 |
| 3 | 5 | 4,6 |
| 4 | 6 | 5,6 |
| 5 | 4 | 3,7 |
| 6 | 6 | 5,6 |
| 7 | 3 | 2,8 |
| 8 | 5 | 4,6 |
| 9 | 2 | 1,9 |
| 10 | 2 | 1,9 |
| 11 | 1 | 0,9 |
| 12 | 3 | 2,8 |
| 13 | 2 | 1,9 |
| 14 | 1 | 0,9 |
| 15 | 2 | 1,9 |
| 16 | 1 | 0,9 |
| 17 | 3 | 2,8 |
| 18 | 1 | 0,9 |
| 19 | 1 | 0,9 |
| 20 | 1 | 0,9 |
| 21 | 1 | 0,9 |
| 22 | 1 | 0,9 |

| Months | N | cell percent |
|---|---|---|
| 24 | 1 | 0,9 |
| 27 | 2 | 1,9 |
| 29 | 1 | 0,9 |
| 30 | 1 | 0,9 |

8. Length of stay in previous creche in months

| | |
|---|---|
| number of values counted | 108 |
| mean | 0,611 |
| median | 0,0 |
| mode | 0,0 |
| maximum | 17,000 |
| minimum | 0,0 |
| range | 17,000 |
| variance | 6,426 |
| st. dev | 2,535 |

| Months | Count | cell percent |
|---|---|---|
| 0 | 100 | 92,6 |
| 2 | 1 | 0,9 |
| 3 | 1 | 0,9 |
| 5 | 1 | 0,9 |
| 7 | 1 | 0,9 |
| 8 | 1 | 0,9 |
| 12 | 2 | 1,9 |
| 17 | 1 | 0,9 |

9. Average hours of attendance of creche per day

| | |
|---|---|
| number of values counted | 108 |
| mean | 5,777 |

| | |
|---|---|
| median | 8,000 |
| mode | 9,000 |
| maximum | 10,000 |
| minimum | 0,000 |
| range | 10,000 |
| variance | 17,146 |
| st. dev | 4,140 |

| Hours | Count | cell percent |
|---|---|---|
| 0 | 36 | 33,3 |
| 6 | 1 | 0,9 |
| 7 | 1 | 0,9 |
| 8 | 23 | 21,3 |
| 9 | 43 | 39,8 |
| 10 | 4 | 3,7 |

10. Total number of children in creche

| | |
|---|---|
| number of values counted | 108 |
| mean | 70,740 |
| median | 100,000 |
| mode | 120,000 |
| maximum | 120,000 |
| minimum | 0,0 |
| range | 120,000 |
| variance | 2748,977 |
| st. dev | 52,430 |

| children | count | cell percent | |
|---|---|---|---|
| 0 | 37 | 33,3 | home group |
| 75 | 16 | 14,8 | creche 1 |
| 100 | 13 | 12,0 | creche 2 |

| children | count | cell percent | |
|---|---|---|---|
| 110 | 2 | 1,9 | creche 3 |
| 120 | 41 | 38,0 | creche 4 |

11. Total number of black and white staff at creche

| | |
|---|---|
| number of values counted | 108 |
| mean | 11,194 |
| median | 15,000 |
| mode | 20,000 |
| maximum | 20,000 |
| minimum | 0,0 |
| range | 20,000 |
| variance | 74,475 |
| st. dev | 8,629 |

| staff | count | cell percent | |
|---|---|---|---|
| 0 | 36 | 33,0 | home group |
| 10 | 16 | 14,8 | creche 1 |
| 15 | 13 | 12,0 | creche 2 |
| 17 | 2 | 1,9 | creche 3 |
| 20 | 41 | 38,0 | creche 4 |

12. Number of siblings in family

| | |
|---|---|
| number of values counted | 108 |
| mean | 0,805 |
| median | 1,000 |
| mode | 0,0 |
| maximum | 3,000 |
| minimum | 0,0 |
| range | 3,000 |
| variance | 0,774 |
| st. dev | 0,880 |

| no.sibs | count | cell percent |
|---|---|---|
| 0 | 48 | 44,2 |
| 1 | 36 | 33,3 |
| 2 | 18 | 16,7 |
| 3 | 5 | 4,6 |
| 5 | 1 | 1,2 |

13. Number of weeks spent by subject in hospital

| | |
|---|---|
| number of values counted | 108 |
| mean | 0,287 |
| median | 0,0 |
| mode | 0,0 |
| maximum | 12,000 |
| minimum | 0,0 |
| range | 12,000 |
| variance | 1,701 |
| st. dev | 1,304 |

| weeks | count | cell percent |
|---|---|---|
| 0 | 96 | 88,9 |
| 1 | 6 | 5,6 |
| 2 | 4 | 3,7 |
| 5 | 1 | 0,9 |
| 12 | 1 | 0,9 |

14. Parents' socio-economic status or social class

| | |
|---|---|
| number of values counted | 108 |
| mean | 3,074 |
| median | 3,000 |
| mode | 3,000 |

| | |
|---|---|
| maximum | 5,000 |
| minimum | 2,000 |
| range | 3,000 |
| variance | 0,704 |
| st. dev | 0,839 |

| social class | count | cell percent |
|---|---|---|
| 2 | 29 | 26,9 |
| 3 | 47 | 43,5 |
| 4 | 27 | 25,0 |
| 5 | 5 | 4,6 |

15. Parents together or separated

| | |
|---|---|
| number of values counted | 108 |
| mean | 1,916 |
| median | 2,000 |
| mode | 2,000 |
| maximum | 2,000 |
| minimum | 1,000 |
| range | 1,000 |
| variance | 0,077 |
| st. dev | 0,277 |

| | count | cell percent |
|---|---|---|
| 1:separate | 9 | 8,3 |
| 2:together | 99 | 91,7 |

16. Which parent had custody of child

| | |
|---|---|
| number of values counted | 108 |
| mean | 2,907 |

| | |
|---|---|
| median | 3,000 |
| mode | 3,000 |
| maximum | 3,000 |
| minimum | 1,000 |
| range | 2,000 |
| variance | 0,103 |
| st. dev | 0,321 |

| | count | cell percent |
|---|---|---|
| 1:father | 1 | 0,9 |
| 2:mother | 8 | 7,4 |
| 3:both | 99 | 91,7 |

17. Subject born premature or full term

| | |
|---|---|
| number of values counted | 108 |
| mean | 1,962 |
| median | 2,000 |
| mode | 2,000 |
| maximum | 2,000 |
| minimum | 1,000 |
| range | 1,000 |
| variance | 0,035 |
| st. dev | 0,189 |

| | count | cell percent |
|---|---|---|
| 1:premature | 4 | 3,7 |
| 2:full term | 104 | 96,3 |

18. Age of first sibling in months

| | |
|---|---|
| number of values counted | 59 |
| mean | 59,847 |
| median | 59,000 |

| | |
|---|---|
| mode | not unique |
| maximum | 180,000 |
| minimum | 2,000 |
| range | 178,000 |
| variance | 1708,404 |
| st. dev | 41,332 |

| age in months | count | cell percent |
|---|---|---|
| 2 | 1 | 1,7 |
| 3 | 1 | 1,7 |
| 4 | 1 | 1,7 |
| 6 | 4 | 6,8 |
| 7 | 1 | 1,7 |
| 10 | 1 | 1,7 |
| 11 | 1 | 1,7 |
| 12 | 1 | 1,7 |
| 36 | 1 | 1,7 |
| 39 | 1 | 1,7 |
| 40 | 2 | 3,4 |
| 41 | 2 | 3,4 |
| 42 | 6 | 10,2 |
| 48 | 1 | 1,7 |
| 49 | 1 | 1,7 |
| 51 | 3 | 5,1 |
| 58 | 1 | 1,7 |
| 59 | 1 | 1,7 |
| 60 | 1 | 1,7 |
| 61 | 1 | 1,7 |
| 62 | 1 | 1,7 |
| 66 | 1 | 1,7 |
| 67 | 1 | 1,7 |

| age in months | count | cell percent |
|---|---|---|
| 69 | 1 | 1,7 |
| 72 | 1 | 1,7 |
| 73 | 1 | 1,7 |
| 79 | 1 | 1,7 |
| 82 | 1 | 1,7 |
| 84 | 2 | 3,4 |
| 102 | 1 | 1,7 |
| 106 | 1 | 1,7 |
| 108 | 1 | 1,7 |
| 114 | 1 | 1,7 |
| 115 | 1 | 1,7 |
| 120 | 1 | 1,7 |
| 122 | 1 | 1,7 |
| 168 | 1 | 1,7 |
| 180 | 2 | 3,4 |

19. Sex of first sibling

| | |
|---|---|
| number of values counted | 60 |
| mean | 1,383 |
| median | 1,000 |
| mode | 1,000 |
| maximum | 2,000 |
| minimum | 1,000 |
| range | 1,000 |
| variance | 0,240 |
| st. dev | 0,490 |

| | count | cell percent |
|---|---|---|
| male | 37 | 61,7 |
| female | 23 | 38,3 |

20. Age of second sibling in months

| | |
|---|---|
| number of values counted | 23 |
| mean | 65,739 |
| median | 48,000 |
| mode | 48,000 |
| maximum | 132,000 |
| minimum | 3,000 |
| range | 129,000 |
| variance | 1490,744 |
| st.dev | 38,610 |

| age in months | count | cell percent |
|---|---|---|
| 3 | 1 | 4,3 |
| 6 | 1 | 4,3 |
| 24 | 1 | 4,3 |
| 37 | 1 | 4,3 |
| 39 | 1 | 4,3 |
| 42 | 2 | 8,7 |
| 45 | 1 | 4,3 |
| 46 | 1 | 4,3 |
| 48 | 3 | 13,0 |
| 54 | 1 | 4,3 |
| 55 | 1 | 4,3 |
| 80 | 1 | 4,3 |
| 92 | 1 | 4,3 |
| 95 | 1 | 4,3 |

| age in months | count | cell percent |
|---|---|---|
| 100 | 1 | 4,3 |
| 108 | 1 | 4,3 |
| 120 | 2 | 8,7 |
| 128 | 1 | 4,3 |
| 132 | 1 | 4,3 |

21. Sex of second sibling

| | |
|---|---|
| number of values counted | 24 |
| mean | 1,541 |
| median | 2,000 |
| mode | 2,000 |
| maximum | 2,000 |
| minimum | 1,000 |
| range | 1,000 |
| variance | 0,259 |
| st. dev | 0,508 |

| | count | cell percent |
|---|---|---|
| male | 11 | 45,8 |
| female | 13 | 54,2 |

22. Age in months of third sibling

| | |
|---|---|
| number of values counted | 5 |
| mean | 64,799 |
| median | 79,000 |
| mode | not unique |
| maximum | 96,000 |
| minimum | 5,000 |
| range | 91,000 |

| | |
|---|---|
| variance | 1285,697 |
| st. dev | 35,856 |

| age in months | count | cell percent |
|---|---|---|
| 5 | 1 | 20,0 |
| 60 | 1 | 2020,0 |
| 79 | 1 | 20,0 |
| 84 | 1 | 2 20,0 |
| 96 | 1 | 20,0 |

23. Sex of third sibling

| | |
|---|---|
| number of values counted | 6 |
| mean | 1,5000 |
| median | 1,5000 |
| mode | not unique |
| maximum | 2,000 |
| minimum | 1,000 |
| range | 1,000 |
| variance | 0,3000 |
| st. dev | 0,5477 |

| | count | cell percent |
|---|---|---|
| male | 3 | 50,0 |
| female | 3 | 50,0 |

24. Age in months of fourth sibling

| | |
|---|---|
| number of values counted | 1 |
| mean | 72,000 |
| mode | 72,000 |
| median | 72,000 |
| maximum | 72,000 |
| minimum | 72,000 |
| range | 0,000 |
| variance | 0,000 |
| st. dev | 0,000 |

| age in months | count | cell percent |
|---|---|---|
| 72 | 1 | 100,000 |

25. Sex of fourth sibling

| | |
|---|---|
| number of values counted | 1 |
| mean | 2,000 |
| median | 2,000 |
| mode | 2,000 |
| maximum | 2,000 |
| minimum | 2,000 |
| range | 0,000 |
| variance | 0,000 |
| st. dev | 0,000 |

28. Home or creche

| | |
|---|---|
| number of values counted | 108 |
| mean | 2,805 |
| median | 2,000 |
| mode | 1,000 |
| maximum | 5,000 |
| minimum | 1,000 |
| range | 4,000 |
| variance | 3,036 |
| st. dev | 1,742 |

| creche or home | count | cell percent |
|---|---|---|
| creche 1 | 46 | 38,0 |
| creche 2 | 16 | 13,9 |
| creche 3 | 13 | 12,0 |
| creche 4 | 2 | 1,9 |
| home | 36 | 34,3 |