

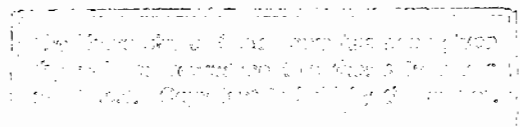
Exertion Therapy for the Mentally  
Subnormal Child

Hein Helgo Schomer, B.A. (Hons.) in Psychology

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of Cape Town, in fulfilment of the requirements for the  
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Supervisor: Prof. Peter du Preez

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"A child of five would understand  
this. Send somebody for a child  
of five."

Groucho Marx

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## ABSTRACT

The use of physical exercise as a therapeutic technique was explored with special reference to the mentally subnormal child. Advances in intellectual capability and social maturity were discussed in direct relation to progress in motor skill and physical fitness. The prerequisites for a successful physical exercise programme for increasing intellectual and social functioning were outlined.

An investigation was carried out to examine the effects of dynamic physical exertion therapy on the intellectual and social functioning of mentally subnormal children. A static physical exertion therapy condition served as control intervention. Thirty-two institutionalised children, matched on age, sex and diagnostic classification, participated in the 30-week programme. Heart rate at rest, heart rate at submaximal workload and maximal oxygen consumption rate estimates served as measures of physical fitness. Changes in intellectual and social functioning were assessed by means of the Vineland Social Maturity Scale, Old South African Individual Scale, and Goodenough Draw-A-Man Test. Highly significant improvements were recorded for the dynamic physical exertion therapy condition. Changes due to the static physical exertion therapy were less significant. The results supported the hypotheses that intensive, regular cardiovascular endurance exercises bring about marked increases in physical fitness associated with increases in intellectual and social functioning.

Implications of the present study were examined and future research needs put forward.

ABOUT THIS STUDY

Primitive man had no choice, he had to adapt to the demands of his environment, his survival depended upon activity - running, jumping, crawling, lugging.

Modern man has a choice - the choice of inactivity seems to be a popular one if one pays any attention to statistics about who does and who does not lead a vigorous life. Opportunities for dynamic physical activity diminish with the progress of urbanization and technology.

Inactivity is the norm, vigorous activity is reserved for the few energetic enough to endure it. Homo sapiens is now homo sitter. According to a steadily growing body of researchers homo sitter in the Western world is becoming prone to cardiac disease and obesity as well as depression, stress and anxiety. The choice is ours.

It is one of the objectives of this study to present this choice to those that would definitely benefit: the institutionalized mentally abnormal child leading a life deprived of intense physical experiences.

The lack of appropriately controlled investigations in the area of physical education tends to contribute to the lack of prominence and concern paid to intense physical experiences in the design of daily routines for children and adults alike. This controlled study is set out to shed more light on the application of physical exertion and its effects on physiological and psychological contingencies.

of the twentieth century when the theory of mind-body duality receded into the background and the mind and body interaction was seen by psychologists and philosophers to be a functional unity. Physical educators welcomed this new view and propagated the idea that physical activity contributes to a healthy personality. The second stage may be identified after 1920 when McDougall, Freud and Adler suggested that sport and physical activity allowed man to vent his instincts and urges and thus release emotional tension. The third stage began around 1930 and went through to the 1950's. It is in this period that empirical research was first undertaken. The fourth and present stage makes use of the experimental method in which hypotheses are proposed and then carefully tested under strictly controlled conditions.

Thus, today, the idea of a separate somatic and psychic life in the human being has hardly any useful application and most neurologists agree on the principle of organismic unity. Yet even nowadays many people outside the realm of sport and physical activity persevere with the assumption that physical education can be separated from the educational sphere and that the process of educating the mind is quite independent from any involvement with physical activity.

That man is made of many parts, acting together in an integrated fashion, was summarized as follows by Breckenridge and Vincent in 1955:

His intellect is related to his physical well-being; his physical health is sharply affected by his emotions, his emotions are

influenced by success or failure, by his physical health and by his intellectual adequacy.

(cited in Ismail, 1972, p.4.)

### Exercise as therapeutic technique

The field of exercise therapy is so large that it is not possible to list all the conditions that have already been successfully treated through physical activity. Only a few areas of application shall be mentioned in this introduction.

Stress emotions such as fear, anxiety, tensions, anger and depression have been effectively treated through the use of vigorous exercise training programmes. Folkins and Amsterdam (1977) studied 42 normal junior college students in a semester long running course and found significant differences between the pre-test and post-test scores on anxiety, depression, self-confidence, adjustment and sleep behaviour measures.

Brown, Ramirez and Taub (1978) found that subjects that chose the most rigorous exercise experienced the greatest reduction in depression.

Greist, Klein, Eischens and Faris (1978) have shown that the results of running therapy compare favourable with those of psychotherapy in the treatment of depression.

Evidence that exercise is a useful tool in the management of anxiety comes from the work of Orwin (1972) who treated the agoraphobic syndrome through use of a running

programme. Orwin's method was utilized by Muller and Armstrong (1975) with an individual suffering from elevator phobia.

Schomer (1981) was able to significantly reduce the anxiety levels of highly anxious first-year students with the use of exertion therapy in combination with positive and negative imagery.

Considerable evidence supports the view that exercise programmes lead to psychological and physical improvement in patients after myocardial infarction ("Change of Pace, Change of Heart", 1979; Folkins and Amsterdam, 1977; Prosser, Carson, Coelson, Tucker, Neophyton, Phillips and Simpson, 1978).

Physical fitness and personality, social, and intellectual measures.

Because of the inherent complication of the long-term study of a specific population, most researchers have opted for the comparison of two or more groups of similar subjects. Assuming that at the beginning of the experiment or study all groups were similar in composition, any change that might occur during a physical exercise programme would lead to the conclusion that the deciding factor influencing the psychological or behavioural measures was due to the extent of, or the type of participation in the sporting activity (Stevenson, 1975).

Some of the numerous studies that have been undertaken in this field of participation and non-participation in

sport shall be reviewed briefly. The evidence does not as yet point to a unanimous characterization of the physically fit person.

In a study of 91 athletes and 90 non-athletes chosen from a junior high school for boys, Ridini (1968) found that the athletic group was significantly better than the non-athletic group on all psychological functions and sport skills measured.

Cowell and Ismail (1962) studied relationships between selected social and physical factors. Boys in the 10-12 year range who received a high score on physical measures were more likely to be socially well-adjusted.

Personality differences between physically fit and unfit groups were found by Young and Ismail (1976). Regardless of age, the physically fit group was more intellectually inclined, emotionally stable, composed, self-confident, easy-going, relaxed, less ambitious, and unconventional when compared to the physically unfit group. When the same researchers executed a four month exercise programme on adult men, however, they found their results did not clearly point to any personality change. Yet the subjects studied did show some changes in that they were more socially precise, persistent, and controlled at the post-test than at the pre-test.

In a later study, Young and Ismail (1978) tested the effectiveness of using personality variables to discriminate between high and low physical fitness levels. The highly-fit individuals were consistently more unconventional,

adventurous and trustful.

Tillman (1965), also studying the effect of human physical fitness on personality traits, was able to significantly raise the fitness level of the experimental group over a period of nine months but found no significant change in personality traits, except in one test item.

Using nursery school children, Smart and Smart (1963) found that personality variables correlated positively with scores on the Kraus-Weber Physical Fitness test.

Werner and Gottheil (1966) collected their research data over a period of four years and found that the intensive physical exercise programme on the cadets as subjects had no significant effect on their personality structure.

Brunner (1969) administered tests and questionnaires to 60 adult men who had been classified into two groups: participants and non-participants of vigorous physical activity. The results revealed that the participants possessed characteristics of the extroverted personality, whereas the non-participants possessed the more introverted personality traits.

Modern theories of personality suggest that man's personality is relatively stable once he has reached adulthood rather than seeing it as ever-changing with the altering influences around him. Brunner sees a possibility of influencing man's personality only during childhood and adolescence and hopes that "with knowledge of the consequences that some of the traits of extroversion and

introversion imply, an attempt can be made to enhance the child's development" (p.469).

It has been postulated that body image is a major contributor to the development of personality:

The role of an individual's body configuration in social interactions and the effects of these interactions on self-concept is an important part of the total process of personality development.

(Staffieri, 1967, p.101)

Zion (1965) has indicated that the confidence a person has in his physical abilities is related to the confidence with which he faces his self and the world. Thus physical appearance and physical performance are likely to shape a person's self-concept.

Kay, Felker and Varoz (1972) concluded that achievement in sport was positively related to self-concept in junior high school boys.

The literature covering the relationship between participation in physical activity and academic achievement points to a positive correlation between these two variables.

After examining 827 college women, Arnett (1968) concluded that greater physical fitness helped in attaining one's academic potential.

Hart and Shay (1964) who also studied the inter-relationship between physical fitness and academic success found that fitness could not be used as a general predictor, but that it was an important contributor

towards the improvement of the academic index of the college student.

Ismail, Kane and Kirkendall (1969) studied the relationship between intellectual and non-intellectual variables. Their results revealed a positive correlation between specific motor items and scores of intelligence and scholastic achievement.

It is interesting to find that the studies in this field do not support the stereotype of the intellectually gifted child as being a physical weakling and suffering from ill-health. Research by Rarick and McKee (1949) and Clarke and Jarman (1961) found that children with high scholastic ability were also found to have proficient motor performance.

Most of the above findings were based on techniques utilizing correlation, and it is not possible to deduce a cause and effect relationship from these. The following studies detail attempts to investigate the effectiveness of well-organized and intensive physical training programmes on IQ and intellectual achievement measures.

Fretz, Johnson and Johnson (1969) compared pre- and post-test performances of the children participating in an 8-week physical development clinic and found that significant improvements in performance IQ as well as improved scores for perceptual-motor skills.

After attending a one-year physical education programme organized by Ismail (1967) children between the age of 10 and 12 years were tested. No improvement in IQ was noted, but the programme showed a significant effect

on academic achievement scores. Ismail was surprised to see this statistically significant increase after only one year of training and proposed that a long-term programme would show even better results. The question of the mechanism involved affecting the child's academic performance due to the participation of the physical activity is left open in this study.

Some researchers have hypothesised that in order to be mentally alert a person also needs to be physically fit and alert. Gutin (1966) suspected that physical and mental exhaustion have much in common. In his study he found a significant relationship between the amount of improvement in physical fitness after 12 weeks of exercise and the changes in mental performance by the participating individuals after the exertion sessions.

That exercise might influence the performance of a simple mental task was tentatively indicated by McAdam and Wang (1967).

Denfrew and Bolton (1979) detected that the physically active group had a higher score on efficient physiological functioning, e.g. quicker reaction time. This finding lends support to the view that physical activity may counteract mental fatigue.

#### Classification of the mentally subnormal child

The classification "mentally subnormal" is applied to a group of mentally subnormal people which cannot be regarded as a homogeneous group having one characteristic

behaviour, mode of mental functioning, physical ability or social development level.

The process of classifying the group of mentally subnormal persons was started in France in the beginning of the 19th Century, the earliest attempts being based on physical measurements of the skull. Alfred Binet, commissioned by the French Minister of Public Instruction laid the foundation for the present classification system based on the intelligence quotient. The 1905 Binet-Simon scale was followed by many standardized tests which measure levels of intellectual and social maturity.

Throughout various phases in history, mentally subnormal persons were labelled incurable and the recent definitions used limited scores of either intelligence or social functioning as their guideline for classification. These often misleading guidelines were finally removed in 1959 when the American Association on Mental Deficiency adopted the definition of mental retardation as follows:

Mental retardation refers to subaverage general intellectual functioning which originates during the developmental period and is associated with impairment in adaptive behaviour... Furthermore an individual may meet the criteria of mental retardation at one time and not at another. A person may change status as a result of changes in social standards or conditions or as a result of changes in efficiency of intellectual functioning, with level of efficiency always being determined in relation to the behavioural standards and norms for the

individuals chronological age group.  
(cited in Drowatzky, 1971, p.6)

It was thus recognised that changes in the condition of the mentally subnormal person were possible. The definition adopted by the American Association of Mental Deficiency was adapted in 1973:

Mental retardation refers to significantly subaverage general intellectual functioning existing concurrently with deficits in adaptive behaviour, and manifested during the developmental period.

(cited in Speakman, 1977, p.171)

Three parts of the above definition may be clarified further. Firstly, significantly subaverage general intellectual functioning is determined by use of either the Stanford-Binet, or Wechsler scales: an individual's IQ score must be more than 2 standard deviations below a mean of 100. Secondly, the developmental period stops at the age of 18 years. Thirdly, adaptive behaviour may be defined as the ability of a person to cope independently and to meet the demands made upon him by society. Only once all three parts of the definition are met is a person classified as mentally subnormal (Speakman, 1977).

Due to the fact that the problem of mental retardation involved the work of many professions, several different systems of classifying this large non-homogeneous group of individuals have evolved.

In the field of medicine specialists have been

concerned with the cause of mental retardation. Much confusion existed in trying to identify a case of mental subnormality, be its origin hereditary, physiological or psychological. An etiological system has been suggested which denotes eight major groups, each with several sub-groupings. A brief summary is given:

TABLE 1

OUTLINE OF MEDICAL CLASSIFICATION OF  
MENTAL DEFICIENCY

- 
- I *Diseases and conditions due to infection.* This category includes maternal diseases such as syphilis, encephalitis and German measles during pregnancy, and postnatal infections accompanying measles, whooping cough, scarlet fever, encephalitis, meningitis, and other childhood diseases known to cause brain damage.
- II *Diseases and conditions due to intoxication.* Prenatal conditions such as toxæmia of pregnancy and blood incompatibility (Rh factor) and postnatal intoxicating substances, poisons, and various drugs that cause nervous tissue injury are among the agents included in this topic.
- III *Diseases and conditions due to trauma or physical agent.* Included as causal agents are injuries that occur during the prenatal stage as a result of irradiation

or of oxygen deprivation due to maternal asphyxia, maternal anaemia or hypotension and birth injuries that are caused by complications during delivery and lack of oxygen during the birth process; older children may suffer physical injury to the nervous system by near-suffocation, automobile accidents and the like.

IV *Diseases and conditions due to disorder of metabolism, growth or nutrition.* This category includes inborn metabolic disorders such as phenylketonuria (PKU) as well as pre- and postnatal nutritional deprivation that inhibits nervous system development.

V *Diseases and conditions due to new growth.* Various hereditary tumors and growths of the central nervous system having variable expression may cause mental retardation. These conditions may or may not be progressive.

VI *Diseases and conditions due to (unknown) prenatal influence.* Among the types of mental retardation commonly included in this classification are various cerebral defects such as absence of the brain, primary cranial anomalies (i.e. hydrocephaly, or microcephaly) and Down's syndrome or mongolism.<sup>+</sup>

VII *Diseases and conditions due to unknown or uncertain cause with structural reactions manifest.* Mental retardation resulting from excessive growth of connective tissue in the central nervous system, degeneration of the cerebellum and conditions resulting from prematurity are included in this grouping.

VIII. *Due to uncertain (or presumed psychologic) cause with functional reactions alone manifest.* This category includes mental retardation with no apparent organic defect, believed to be caused by cultural-familial, environmental deprivation, emotional, psychotic or other factors.

+ Although mongolism is listed under unknown pre-natal influences in this system, the cause of the condition was located in 1959. The mongoloid child is known to possess 47 chromosomes instead of the usual 46. The condition occurs most frequently when the mother is over 35 years of age.

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(Heber, cited in Drowatzky, 1971, p.12)

In education three groups known as "educable", "trainable" and "totally dependent" are often used. The educable mentally subnormal child has an IQ between 50 and 70 and is capable of living an independent adult life. A potential for academic achievement exists and may be realised if special programmes are carried out for these children.

The trainable mentally subnormal child has an IQ between 25 - 49 with much practice, has the ability to acquire basic social skills. Reading and writing present great difficulty and most individuals in this group will need partial care and attention in adulthood.

The totally dependent mentally subnormal child has an IQ below 24 and needs complete care and help in his

personal as well as social life. It is not possible to train this child to cope in its environment.

A classification based on adaptive behaviour allows comprehension of the individual's social, emotional and perceptual-motor abilities or disabilities. An outline of the different levels of adaptive behaviour is given below:

TABLE 2

LEVELS OF ADAPTIVE BEHAVIOUR

Degrees of Retardation	Pre-School Age (0-5 years) Maturation and Development	School Age (6-21 years) Training and Education	Adult (over 21 years) Social and Vocational Adequacy
Mild	Can develop social and communication skills; minimal retardation in sensorimotor areas; rarely distinguished from normal until later age.	Can learn academic skills to approximately 6th grade level by late teens. Cannot learn general high school subjects. Needs special education particularly at secondary school age levels. ("Educable")	Capable of social and vocational adequacy with proper education and training. Frequently needs supervision and guidance under serious social or economic stress.
Moderate	Can talk or learn to communicate; peer social awareness; fair motor development; may profit from self-help; can be managed with moderate supervision.	Can learn functional academic skills to approximately 4th grade level by late teens if given special education. ("Educable")	Capable of self-maintenance in unskilled or semi-skilled occupations; needs supervision and guidance when under mild social or economic stress.

TABLE 2. LEVELS OF ADAPTIVE BEHAVIOUR. (Cont.)

Degrees of Retardation	Pre-school Age (0-5 years) Maturation and Development	School Age (6-21 years) Training and Education	Adult (over 21 years) Social and Vocational Adequacy
Severe	Poor motor development; speech is minimal; generally unable to profit from training in self-help; little or no communication skills.	Can talk or learn to communicate; can be trained in elemental health habits; cannot learn functional academic skills; profits from systematic habit training. ("Trainable")	Can contribute partially to self-support under complete supervision; can develop self-protection skills to a minimal useful level in controlled environment.
Profound	Gross retardation; minimal capacity for functioning in sensorimotor areas; needs nursing care.	Some motor development present; cannot profit from training in self-help; needs total care. ("Dependent")	Some motor and speech development; totally incapable of self-maintenance; needs complete care and supervision.

(cited in Drowatzky, 1971, p.10)

Huberty, Koller and Brink (1980) have called for a greater use of adaptive behaviour criteria in combination with IQ scores for the correct identification of mentally retarded individuals.

#### Physical performance of the mentally subnormal child

Several researchers have studied the relationship of physical performance of mentally subnormal children to a wide range of variables such as physical development, age,

sex, intelligence, academic achievement, motor achievement, body image and social development. To mention all their often contradictory results is beyond the scope of this introduction. Thus an attempt will be made to give outlines of only those studies that relate physical performance and fitness levels to intellectual and social functioning.

Studies that have been undertaken to determine the physical performance of mentally subnormal as compared to normals will be reviewed first.

Sengstock (1966) worked with a group of educable mentally retarded children and compared their physical fitness scores to a group of normal children of the same chronological age. His results showed that the average performance of the mentally subnormal group was nearly halfway between the average performance of the two normal groups.

Auxter (1966) reported lower performance levels among educable mentally retarded children when tested on the vertical jump, grip strength and ankle flexibility measures.

Brown (1967) recorded a high failure rate with trainable mentally retarded children when tested for muscular fitness.

There seems to be a general agreement that the physical fitness levels (strength, muscular endurance, cardiovascular endurance) of mentally subnormal children lag behind those of intellectually normal children. It is thus not surprising that their scores on general

physical performance skills (e.g. balance, agility, coordination) also tend to be low. Without having the necessary strength or endurance they may not perform successfully in a motor skill test.

Studies by Howe (1959), Sloan (1951), and Distefano, Ellis and Sloan (1958) have shown that educable and trainable mentally subnormal children do not compare favourably with normal intelligence children with respect to the development of gross motor skills.

That the motor performance of mentally retarded children is two to four years behind that of normal children of the same age was reported by Francis and Rarick (1959). As the rate of development in the mentally retarded child is slow or even stagnant, the difference in performance becomes far more obvious with increasing age (Rarick, Widdop and Broadhead, 1970).

Although Dobbins and Rarick (1975) supported the above findings they revealed that "the basic components which underlie a major portion of the motor domain of intellectually normal and educable retarded boys are tangibly coincident" (p.447).

Wear and Miller (1962) found a greater similarity between groups that were matched with regard to physique than with groups that were matched with respect to developmental level.

There is quite a high incidence of obesity in mentally subnormal children, especially in adolescence and they present a sad picture of muscular debility and decreased vitality. In certain cases, their deficiency

in physical performance is due to the genetic origin of their handicap which gives rise to an imperfect physical development, e.g. children suffering from Down's syndrome. But very often there are other factors involved which lead to these physical limitations of the mentally subnormal child. Several possible reasons have been offered as to why the physical performance level of mentally retarded children is so low:

Unfortunately, many people believe that children will look after their own physical needs if they are given enough time during break and after school. But leaving a child to his own devices will never allow him to reach his optimum physical performance level. Games and play activity usually only involve bursts of energy and thus do not fully exert the whole body. The range of activities during play is limited and many muscles are never given sufficient training.

Walker (1950) has indicated that many mentally retarded children never learn to play and that for a long time this was accepted as being quite normal. However, this is not true as mentally subnormal children will play in the same way as normal children if they are shown how to play and given much encouragement (Salvin, 1958).

Hollis (1965) observed that play in the life of a profoundly subnormal child barely existed and noticed how these children were left alone in surroundings without much stimulation and how the arousal level for these children remained very low.

Another factor that appears to have considerable influence

in lowering the physical performance score of the mentally subnormal child is the level of difficulty of the exercise. Often it is too complex for the retarded child to comprehend in only a few trials. Many motor skills have an intellectual component which first has to be learnt and understood before the physical activity may be executed correctly and efficiently.

Denny (cited in Keogh and Oliver, 1965) has suggested that "the retarded are poor performers because they are much poorer incidental learners than normals" (p.306). They therefore need far more direct instruction as even basic movements are not performed naturally or "instinctively".

Another reason brought forward to explain the often poor physical performance of mentally subnormal children is their low striving for success. Having behind them a long history of continual failure in both the physical and academic sphere they will set their goal lower after each new failure and will eventually apply very little effort in a mental or physical task in order to avoid a further failure. As they hardly ever experience a climate of success and as the statement "that 'nothing succeeds like success' is a platitude the truth of which is evident in wide and varied situations with all types and all ages" (Oliver, 1958, p.1), it is not surprising that the mentally subnormal child will lower his aspirations with each mishap or disappointment. Postman and Brown (1952) have shown that the will to succeed was lowered after failure but raised after success.

The child soon realises that if it withdraws from a group it will avoid the humiliation or embarrassment that comes with failure. But because of this withdrawal it will also lose the opportunity of practising certain skills and may only deteriorate further.

A further cause of the inferior physical performance of the mentally subnormal child is probably related to the fact that on the whole they have far less opportunities to participate in sporting or physical activities. Mentally subnormal children are often ostracized from their peer group. During play they may exhibit bullying or fighting which Johnson (1950) describes as compensatory behaviour for their lack of playing ability, but this only leads to rejection from the group. Thus although they have the same need for creative physical activity (Oliver, 1957) they can never hope to achieve any amount of prestige or obtain peer respect as they do not have the physical resources to compete with the normal children. In this way a valuable opportunity for physical activity is lost.

In a study by Broadhead and Rarick (1978) children of larger than average family sizes tended to show superior gross motor performance than mentally retarded children from other homes. This finding supports the view that play and physical interaction is of vital importance to the physical development of the child. Another result of Broadhead and Rarick indicated that children who come from low status homes had a better performance level than children from middle and high status homes. A possible

Performance of other fitness test items had also shown remarkable improvement and equalled the performance of the normal group at the post-testing.

Keogh and Oliver (1968) provided six individual instruction lessons to 10 physically severely awkward educationally subnormal boys and hoped to teach them six physical skills. Although the period of instruction was very short, some success was noted. The researchers therefore believed that a potential for improvement existed.

With the aid of special physical education activities which included ball handling, trampolining, rope climbing, etc., Geddes (1968) was able to contribute to the physical development of the primary school educable mentally retarded children. Mobility patterns, e.g. creeping, crawling, walking which were then practised in game situations did not lead to as much success, based on the differences in leg power as measured by the hurdle jump and the standing broad jump.

Chasey (1977) found that overlearning is an important factor in the remembering and relearning of a gross-motor skill. In order for the child to acquire and retain a motor skill, much care and attention needs to be given in the initial stages of learning so that a high level of proficiency is met from the start.

One hour physical education lessons were held for adult retardates in a sheltered workshop setting by Hussey, Maurer and Schofield (1976). The participants were found to significantly increase their performance in the workshop.

Physical performance and intellectual skills

Several theories have been advanced which advocate that the emphasis in education should be placed on sensory motor training. Piaget has very likely put forward the best known of these. His theory states that every child passes through definite stages of intellectual maturity. The first stage is the sensory motor phase lasting about two years. The child learns to manipulate objects but does not understand their function. During the pre-operational period, the child learns to abstract people, objects and events. He is able to co-ordinate his thinking in relation to concrete characteristics of objects. This period gives way to the formal-operational period when the adolescent is capable of stating hypotheses, testing these and finding alternatives. Inhelder has suggested that the "severely and profoundly mentally retarded adult can be viewed as fixated at the level of sensori-motor intelligence; and the retarded adult should be seen as not capable of surpassing the pre-operational period" (cited in Upton, 1979, p.7). It would thus seem relevant to concentrate on physical and creative activities, which are mainly sensory motor in nature, in order to help and improve the academic achievement and learning capacity of the mentally subnormal child.

Physical activity, intellectual and emotional growth are functionally very closely linked, and it is virtually impossible to separate them in practice. In order to understand their interrelationship artificial separations

will be attempted. From studying the literature it may be concluded that a positive relationship exists between intellectual (mental) and non-intellectual (motor) abilities of the mentally subnormal child (Ismail, 1972).

Rabin (1957) researched the relationship between age, intelligence and motor performance in mentally subnormal boys and girls and found that the correlation between their motor performance and their intelligence quotient turned out to be marginally insignificant.

Kugel and Mohr (1963) found a relationship between mental retardation and physical maturity and concluded that the amount of physical disability is related to the severity of the mental retardation. They did not offer a possible cause and effect relationship between mental retardation and physical performance levels.

In the study by Francis and Rarick (1959) the intelligence of 284 mentally retarded children of ages between 7 and 14 years and IQ scores between 50 and 90, were found to be positively correlated with many of the motor performance test scores.

Supporting evidence for this relationship has been given by Blatt (1958), Heath (1942), Howe (1959), Oliver (1958), Guyette, Henry and John (1964).

While observing the motor performance of mentally retarded children Keogh and Oliver (cited in Ismail, 1972) found that the method of scoring physical performance gave deflated measures as these children encounter certain difficulties in trying to execute the exercises of the programme. Problems arise when trying to start or stop

a movement or when different limbs interfere with one another. Some children's movements are unbalanced due to greater control on one side of their body. A change of rhythm as required during hopping or skipping creates difficulties, as does their inability to control the amount of energy required for an exercise. Some children are inhibited to perform to the best of their ability. Not trying hard enough or lacking motivation to perform is a further factor that must be taken into account when evaluating physical performance scores of mentally subnormal children.

Not much research has been undertaken to study and evaluate the effect of physical activity on the intellectual development of the mentally subnormal child. This is surprising as the few studies that have been undertaken have had very positive and encouraging results. It has been shown that physical education has a definite contribution to make towards the total development of the child.

One of the earliest pioneering work in this area was undertaken in the early 19th Century by Jean Marc Itard who set up a training programme for Victor, the wild boy of Aveyron. His publication in 1801 must have been one of the first records of work done on a mentally subnormal child with the aid of sensori-motor training. Itard justified his effort of attempting to "normalize" Victor by saying:

The intimate relation which unites  
physical with intellectual man was

so great that, although their respective provinces appear and are in fact very distinct ... the borderline between the two different sorts of functioning is very confused. Their development is simultaneous and their influence reciprocal. (cited in Upton, 1979, p.6)

As it is often difficult to compare the various achievements of mentally subnormal children Itard's comment is well worth noting:

To be judged fairly this young man must be compared with himself. Put beside another adolescent of the same age, he is an ill-favoured creature, an outcast of nature as he was of society. But if one limits oneself to the two terms of comparison offered by the past and present status of young Victor, one is astonished at the immense space which separates them, and one can question whether Victor is more unlike other individuals of his same age and species.

(cited in Stephens, 1976, p.164)

Edovard Seguin trained under Itard and continued his work by introducing many physical education programmes into institutions for mentally subnormal children. He believed in sensori-motor stimulation and called his method "physiological". He used normal developmental sequences as models for his training schedules which "presumed the existence of a mind which could be taught to attend to,

compare, and make judgements about sensory learnings; [Sequin] reached [the mind] by activating hands, eyes, ears, nose, tongue and body" (Talbot and Sequin, cited in Stephens, 1976, p.164).

During the 19th Century it became commonplace to lock up the mentally retarded in institutions and the emphasis was on isolation, not training. This was partially due to the aversive influence of sociological studies of the Jukes and Kallikaks which connected mentally subnormal individuals with undesirable behaviour and characteristics (Stephens, 1976). Slowly, at the beginning of the 20th Century, studies dealing with the physical performance of the mentally subnormal began to make an appearance. But physical activity programmes were as yet not recognised as part of the overall education system. Physical exercise was merely used as a tool to avoid too much boredom in mentally subnormal individuals. It was only after World War II that attitudes began to change dramatically and that physical education was no longer seen as a means of control but rather as an important and vital component in the total adjustment and orientation of the person.

Leland, Walker and Taboada (1959) organized a 90-hour play therapy programme over a period of one month for mentally subnormal boys in the range 4 - 8 years. No definite IQ increase was claimed, nevertheless the researchers believed that the children were able to realize some intellectual potential after having participated in the experiment.

Supportive evidence was published by Groves (1967) who found that educationally subnormal girls that had joined

the movement lessons became far more creative and were able to improve on their written work.

Using a wide variety of strengthening exercises, such as rope climbing, road work, digging and log activities Oliver (1957) set out to improve the physical condition of mentally retarded boys aged 13 to 15 years with IQs ranging from 57 to 86. The log exercises were by far the most popular and the boys soon made up their own variations. They carried their enthusiasm over into more scholastic activities and it was found that they approached their assignments with greater confidence than usual. Oliver believed this to be due in part to a "transfer of effect" (p.27). Their morale had increased after experiencing success at the physical exercises they had performed previously and this feeling of well-being stayed with them for the day.

The importance of finding the right kind of exercise to excite the children and keep them interested for long enough was seen in the experiment by Oliver. Salvin (1958), too, believed that the exercise and equipment chosen for the children should meet their needs.

Not only is there a "right exercise", but there is also a "right time" in which to introduce new skills. If the mentally retarded child has not reached a certain developmental level and cannot cope with a specific exercise this may, according to Fait and Kupferer (1956), put the mentally retarded child in a stress situation and hinder the learning process. They further said that some activities will always be too difficult as they require some thought

or are made up of many components of which the child needs to remember the sequence.

In a later study, Oliver (1958) found that he could not only increase the motor proficiency levels of educationally subnormal boys but also significantly increase their intelligence scores. The boys were between 13 and 15 years old and attended a revised school programme for 10 weeks, its major component being strenuous physical activity. The programme is summarized in the table below:

TABLE 3

OLIVER'S DAILY PROGRAMME

9.15	-	9.30	Assembly
9.30	-	10.15	Physical education exercises
10.15	-	11.15	English
11.15	-	11.30	Break
11.30	-	11.40	Individual remedial exercises
11.40	-	12.25	Strengthening activities
12.25	-	2.00	Lunch
2.00	-	3.00	Number
3.00	-	3.15	Break
3.15	-	4.25	Recreative activities

(p. 158)

Oliver felt that this exciting result was most probably not directly dependent on the physical activity as such:

The factor responsible for the improvement on the mental side is probably largely emotional. It is likely to be a combination of (1) the effect of achievement and success and improved confidence that is associated with these feelings, (2) improved adjustment and the happier atmosphere that arises from it, (3) improved general fitness and the feeling of well-being that goes with it, (4) the effect of the feeling of importance that the boys must have had at having so much interest and attention centred in them.

(Oliver, 1958, p.163)

Oliver's results were supported by Corder (1966). Twenty-four boys were divided into three groups. The first group participated in an intensive 20-day physical education programme including sprinting, throwing, and relays. The daily session lasted for one hour. A further eight boys were designated as "officials" and had to keep daily records of the performances of the active group. This group was used in order to study the expected Hawthorne effect. The central group remained in the classroom, executing only the tests before and after the programme. The main aim of the experiment had been to find the effect of a planned programme of physical education on the intellectual development of the physically active group. Using the WISC it was found that significant differences existed between the three groups on the Full Scale and the Verbal Scale, but not on the Performance Scale. Significant Full

Scale and Verbal Scale gains were recorded for the physical education group. No significant differences were recorded for the "officials" and the control group on the Full Scale. A significant increase existed for the officials group on the Verbal Scale. This result is similar to that of Oliver (1958), who found the largest improvement in verbal and scholastic achievements in the Terman Merrill Test.

Solomon and Pangle (1966), in a similar experiment held 45-minute daily exercise sessions over a period of eight weeks. Although the motor ability of the educable mentally retarded boys increased significantly, they were unable to show up an improvement in IQ or mental achievement. But it has been pointed out that seeing the timing of the post-testing was ill chosen and the testing conditions for the boys was inadequate, the absence of improved measures is not unexpected (Oliver, 1972).

A study involving an enormous number of educable mentally retarded and minimally brain-damaged children was undertaken by Rarick and Broadhead (cited in Moran and Kalakian, 1977). The researchers divided 481 children into three groups: one received individualized physical exercise instruction, the other received group orientated physical exercise instruction and the last group attended art lessons, which was to control for the Hawthorne effect. The experiment lasted over a period of 20 weeks with daily thirty-five minute meetings. After the termination of the programme all groups were found to have significantly improved intellectual achievement scores.

In order to assess the effects of two different physical

education programmes on physical fitness, IQ and social functioning of trainable mentally retarded children, Goodman (cited in Moran and Kalakian, 1977) drew up a traditional physical education programme and a programme involving movement exploration for his subjects. The two groups participated in half-an-hour of daily activity for 10 weeks. Both groups of subjects manifested improvement in physical fitness, IQ and social maturity.

Thus, two approaches have been utilized to study the relationship of physical performance to intelligence. In the first, correlations were established between physical fitness levels and intelligence quotient. Most results have shown a small positive relationship. In the alternative approach a physical education programme was undertaken and its effect on the level of IQ studied. Some authors found a definite positive improvement, others found none. A critical commentary on these discrepant results is offered in the Discussion.

#### Physical performance and social maturity

Social performance entails a large number of skills. During a child's social development he needs to learn the ability to relate to himself, to his surroundings and to other people. In order to be accepted into society the child is required to learn a myriad of behaviour patterns. Success during this growth process usually leads to the enhancement of a child's self-concept. Continual failure can presumably result in a lowered self-esteem and confidence.

The child may become anxious and frustrated and problems of social adjustment may arise. Mangus (1950) encountered many adjustment problems in mentally retarded children with a poor school record.

Having no realistic self-image, Ringness (1960) believed that the mentally subnormal child will overestimate his abilities and hence experience continual failure. This in turn leads to disappointment and a feeling of defeat.

Studying the personality and behaviour patterns of mentally subnormal patients, Cromwell (1961) found that these had a negative effect on their social and mental performances. He believed this to be due to their constant experience of failure both in the academic and social sphere.

Lapp (1957) who assigned slow learning children part-time to regular classes noticed that because the retarded children had no positive contribution to make towards the normal group they were treated indifferently and hence not given equal peer status.

Johnson (1950) believed that the rejection of mentally subnormal children by members of a normal class was mainly due to their anti-social behaviour. He especially noted bullying and aggressive attitudes on the side of the mentally retarded children. This loss of interaction had a detrimental effect on their social and emotional functioning.

Coleman, Keogh and Mansfield (1963) again pointed out the social difficulties that are encountered by children that do not fit the norm intellectually. They examined the motor performance of boys with a serious learning problem and found that a definite relationship existed between

their motor performance scales and their social adjustment ratings.

Physical education programmes are a means of creating an opportunity for intense social interaction which is such a necessary component in the growth of social maturity. This does not imply that physical education programmes will automatically give rise to emotional development, but rather "hold promise of enabling pupils to meet the unfolding demands and stresses of growth, development, and maturity with confidence and a degree of efficiency and adjustment" (Lawrence, 1966, p.252). Greater physical functioning and an improved capacity for the participation in recreational activities is very likely to lead to a beneficial feeling of security and self-reliance.

An interesting survey was undertaken by Brace (1968) who sent questionnaires to schools having mentally subnormal pupils on their registers. Of the 1589 schools that responded, practically all agreed that a physical education programme can make a positive contribution to the social and emotional development of the mentally retarded child.

A large number of studies have been undertaken to evaluate the effect of physical activity on the social development of the mentally subnormal child. There is substantial agreement that benefits may be derived from the participation in a rigorous exercise programme, but unfortunately several results are based on the subjective judgement of the experimenters.

Harrison, Lecrone, Tremmerlin and Trousdale (1966) utilized music and physical exercises in their programme to

investigate the effect on the self-help skills of non-verbal retardates. A significant improvement in self-help skills was noted.

In a thorough physical exercise programme devised by Oliver (1958) a group of mentally retarded boys made important advances in their social behaviour. Although the results were not measured with the aid of a specific test, the author describes in detail how the boys' confidence grew as they set themselves new challenges and thereby strove to meet higher and higher standards. In order to achieve these, their perseverance was improved as could be seen from the fact that they voluntarily began their exercises on their own accord and practised them painstakingly. Their interaction with other boys intensified. Oliver saw the most pleasing result in the progress the boys made in their adjustment towards staff and peers alike.

Tofte (1950), too, detected an improved spirit in his subjects from a mental home after they had experienced a programme involving a broad range of physical and recreative activities. The number of incidences of anti-social behaviour decreased substantially.

Although both the physical fitness and the intelligence quotient of the mentally subnormal boys increased in the study by Corder (1966), no significant improvement in social status was measured, using the Cowell Personal Distance Scale. Corder explained that social status did not primarily depend on mental ability and that rejection from the group appeared to arise from personality clashes.

Salvin (1958) recounted the social and emotional

adaptations he was able to observe during a scouting experience for severely mentally subnormal children. The many physical activities forced the children to interact with one another extensively with the result that the children started to respect each other, to be more considerate and to accept defeat during competitive games.

Jurcisin (cited in Moran and Kalakina, 1977) tested severely mentally retarded children after a four-week physical education programme and indicated that their self-sufficiency and social adaptability had improved.

Both the movement exploration programme and the traditional physical education programme by Goodwin (cited in Moran and Kalakian, 1977) pointed towards a betterment in social maturity in the trainable mentally subnormal children.

### Physical fitness

In the very early beginnings of man, physical fitness was an absolutely essential component of his daily life. Primitive man had to keep active in order to stay alive. He had to maintain an optimum physical fitness level so that he might cope with unexpected danger or destruction. The phrase "survival of the fittest", popularized by Charles Darwin, rings more true for the past than for our present. Today we live in a technocratic world where we are not forced to make any rigorous use of our body. This, naturally, leads to a fateful biological degeneration.

The law of use is, that which is used grows, develops and becomes strong, and that which is not used softens and deteriorates.

("Recreation and Physical Activity", 1966, p.4)

In order for healthy growth and development to take place, children need to be involved in strenuous exercises, games and recreational activities. It is thus of utmost importance that opportunities are available for children to train and move their bodies so that they may attain physical proficiency. Mentally subnormal children, too, should be physically fit in order to execute everyday duties without strain and effort. The child should be able to endure certain stress, work and emotional pressure without excessive fatigue. Physical fitness contributes to the health and feeling of well-being in the individual.

#### Components of physical fitness

Physical fitness is a complex phenomenon incorporating many single items that are not necessarily linked with each other. Moran and Kalakian (1977) have distinguished between two major components of physical fitness: organic performance, which includes the measures of strength, flexibility, muscular endurance and cardiovascular endurance and motor performance which includes the entities balance, agility, speed, co-ordination and reaction time.

Exercises used to develop strength, e.g. pull-ups, push-ups, cause maximal or submaximal exertion in the muscles

for very short periods. The exercises must bring on immediate fatigue otherwise the effect is not on strength development. When a mentally subnormal child needs to execute an exercise during a fitness test, a low performance score can often be traced to inadequate strength rather than skill.

Flexibility refers to the ability to move through the range of motion about a joint. Flexibility determines how much bending, turning, twisting and stretching is possible in the child's movements. Flexibility contributes to the success or failure of a physical education exercise as it allows the person to perform the exercise without strain on the muscles and ligaments. Flexibility exercises are important especially for the mentally retarded children who have fallen into a very sedentary daily routine. These exercises are performed up to the sensation of pain.

Muscular endurance allows one to produce muscular effort over an extended period of time. Muscular endurance exercises require a sustained effort rather than an all-out vigorous burst of effort. This quality is very important as most activities found in the home or in the sheltered workshop situation make demands on the person's muscular endurance. Common exercises that are performed to develop muscular endurance use weights, barbells, and medicine balls which overload the body through the resistance they offer during movement.

Cardiovascular endurance implies the ability of the heart, lung and the blood circulatory system to adjust to

demands of extensive physical exertion. This parameter of physical fitness is considered by many to be the single most important component of all (Moran and Kalakian, 1977). Activities like running, jumping, climbing, swimming and cycling contribute effectively towards cardiovascular endurance.

The motor performance components of physical fitness pertain to the ability of a person to accomplish movement with co-ordination, perfection and efficiency. Balance involves the ability to maintain a correct relationship between the body's centre of gravity and the points of support e.g., hands, feet, hips, knees, etc. Balance is important if the mentally retarded child hopes to walk and run with greater competence.

Agility is the capacity to change direction quickly and forcefully and is vital if the child needs to react to impending danger. Speed is the skill required to cover short distances in the shortest possible time. Training should therefore also only involve short stretches during which the child tries to attain his maximum speed. Longer stretches would involve the fitness component of cardiovascular endurance.

Co-ordination ensures the synchronized movement of muscles and limbs. Muscles need to contract and relax at the appropriate moment and the correct amount of energy is required for the completion of the exercise. Reaction time cannot be improved much with training. The time taken between the reception of a stimulus by the nervous system and the response of the child is called reaction time.

It plays an important role in the cognitive domain where concentration and a longer attention span are required. If the child cannot exclude distracting stimuli from the task being done, low performance skill will be recorded.

It may thus be noted that organic fitness items can be improved with intensive training programmes whereas the motor fitness items need much practice at the learning stage.

### Physiological effects of exercises

Physical fitness programmes have a biological long term effect on the body which involve structural as well as functional changes in the organ systems of the body.

A muscle is made up of a large number of muscle fibres, each supplied with blood capillaries. The muscle fibre contains an aqueous matrix, the sarcoplasm, which contains the myofibrils (contractile elements), the energy producing enzyme systems and the pigment myoglobin. Static exercise increases the size of each muscle fibre without affecting the number of muscle fibres present. When a muscle increases in strength, the contractile power of each individual muscle fibre is increased. An increase in the endurance of a muscle after dynamic exercise training results from a number of different factors such as increased numbers of capillaries, increased myoglobin concentrations and increased activity levels of many enzyme systems.

During physical activity, the trained heart is able to deliver a greater amount of blood to the muscles due to an increased cardiac output. Thus more oxygen is delivered

to the muscle. Increased myoglobin concentrations and increased mitochondrial enzyme activities also increase the capacity of muscles to take up oxygen.

Two different types of exercise give rise to two different types of response in the muscle. When a person performs dynamic exercise, e.g. running, swimming, cycling, rowing, etc., a definite change in muscle length will be noted with little change in muscle tension. Whereas, when a person is involved in static exercise, e.g., lifting, carrying and pushing weights, the activity will principally cause a change in muscle tension with little change in length. Static exercises do not lead to excessive tiredness so that exercise sessions may be quite long in duration before the child experiences discomfort (Berger, 1963).

The capacity of a person to perform dynamic exercise is determined foremost by the ability to transport oxygen to the active muscles. If these muscles do not receive their oxygen requirements, fatigue quickly sets in (Dehn and Mitchell, 1979; Hartley, 1977).

Maximal oxygen consumption ( $\dot{V}O_2\text{max}$ ) represents the maximal circulatory transport of oxygen from the lungs to the active muscle tissues. It is physiologically defined as the product of maximal cardiac output times the amount of oxygen extracted by the tissues of the body per unit of blood (the arteriovenous oxygen difference) (Dehn and Mitchell, 1979; Jorgenson, Gobel, Taylor and Wang, 1977).

Much evidence exists that maximal oxygen consumption rates are positively correlated with the level of physical activity in the individual (Astrand and Rodahl, 1977; Costill, 1967; Spino, 1979). Increases in maximal oxygen consumption of up to 33% have followed physical exertion programmes (Dehn and Mitchell, 1979). The magnitude of the increase is determined by a combination of various factors including the intensity, duration and frequency of the physical conditioning. As would be expected, a decrease in activity causes an immediate drop in maximal oxygen consumption (Saltin, 1977). Because the maximum oxygen consumption measures the maximum capacity for oxygen delivery by the heart and the maximum oxygen uptake capacity by the muscles, the maximal oxygen uptake is accepted as the best physiological reference for functioning capacity of the circulation and is a standard measure of cardiovascular fitness (Astrand and Rodahl, 1977; Dehn and Mitchell, 1979).

Since the aim of oxygen transport training is to improve endurance, the training exercises must involve dynamic muscle contractions. Intense and prolonged programmes involving static exercise lead to no significant increase in maximal oxygen consumption or endurance.

The choice of running in the exertion therapy programme, above any other exercise is due to its high rate of energy demand, thus creating a high rate of oxygen consumption required to produce a training effect. A training effect is said to occur when there is (1) an increase in the maximum oxygen consumption, and (2) a decrease

in heart rate and blood pressure during a standard exercise.

During training for the development of increased oxygen transport capacity, the work load on the oxygen transport system should be at between 60-85% of the maximum. It has been found, that  $\text{VO}_2$  max may be predicted at a sub-maximal running speed, which causes less discomfort for sedentary individuals not used to intense training.

Three factors seem to be necessary in order to overload the system. The duration of the effort is one, the amount of muscle tissue involved is another and the pumping action provided by the rhythmic contractions and relaxations of the muscles is a third factor. Thus development of cardiovascular endurance is best achieved by strenuous efforts which involve large muscle groups in rhythmic activity as found in walking, running and swimming.

Adaptive changes that increase cardiovascular endurance may be central or peripheral, the latter being more prominent. The efficiency with which the heart can increase its stroke volume and the lungs can exchange respiratory gases is a central function. Peripheral adaptive changes include the improved return of blood to the heart, a rise in oxygen consumption and an increase in myoglobin and mitochondria concentrations in the exercised muscle cells. ("The Physiological Effects of Training", 1979). The functions of the heart and lungs do not constitute the limiting factors in cardiovascular endurance unless they suffer from disease (Kuttgen, 1979; Sloan, Koeslag and Bredel, 1973; Strauss 1979).

The heart being a muscle is also susceptible to change due to an individual's involvement in physical activity. The heart volume (kg/body weight) is found to be larger in athletes in endurance events than in athletes trained for strength, e.g., weightlifters or in people with a sedentary lifestyle. The increased heart size is thought to have a definite influence on the larger stroke volume as there is a positive correlation between heart size and maximum oxygen consumption.

It has been established that heart rate at rest, during exercise as well as during the recovery following the exercise is lowered in persons who are endurance trained (Astrand and Rodahl, 1977; Koeslag and Sloan, 1976; Wallin and Schendel, 1969). Due to an increase in the strength of the heart muscle, a greater maximal stroke volume is possible so that a given cardiac output can be achieved with a slower heart rate.

In terms of general energy metabolism the brain (in terms of relative weight) consumes the most energy of all the organs in the body. This is reflected in its very large blood supply and oxygen uptake. Thus, although the human brain comprises only about 2% of the total body weight, it utilizes approximately 25% of all the oxygen taken up by the body under conditions of complete mental and physical rest (Iversen, 1979).

It is also known that neurons can only make use of one fuel - blood glucose. Permanent damage results quite soon after the glucose supply is interrupted. Ismail and Trachtman (1973) suggest that increased circulation

to the brain increases the availability of glucose which is essential to cerebral metabolism. As functional activity of the brain runs parallel to its oxygen consumption, it has been postulated that physical exertion therapy will increase the amount of blood reaching the brain.

A recent study by Forrester (1979) confirms that blood flow to the brain may be increased during exercise. He has found that active skeletal muscle, cardiac muscle and brain tissue set free very large concentrations of ATP (adenosine triphosphate - an energy rich complex) and markedly increase the local blood flow.

Gutin (1966) has postulated that the capacity to carry more oxygen should manifest itself in the ability to withstand and recuperate from physical and mental fatigue.

Ismail (1972) believes that motor performance training is able to stimulate the central nervous system so that underdeveloped, dead or dying cells will be regenerated or their function is taken over by newly developed cells. An interesting finding was made by De Vries and Gray (1963) while studying the effect of exercise on general metabolic rate. The results showed a significant increase in the rate for nearly 6 hours after the termination of the exercise. Tentatively, this points to the beneficial after-effects of physical exercise.

#### Essential requirements of training programme

Many investigators are of the opinion that maximal oxygen uptake (aerobic power) is the best physiological

measurement for determining cardiovascular endurance (Custer and Chaloupka, 1977; Dishman, 1978; Wilmore, 1969). Measurements of the  $\dot{V}O_2$  max need sophisticated techniques and equipment so that many studies have been undertaken to try and provide easy field tests for the prediction of maximal oxygen consumption (Custer and Chaloupka, 1977; Getchell, Kirkendall and Robbins, 1977; Katch, Pechar, McArdle and Weltman, 1973; Kearney and Byrnes, 1974; Wiley and Shaver, 1972). Most researchers have found good correlation between maximum oxygen consumption and distance run during extended running times, i.e. longer than 10 minutes.

Other studies have made use of submaximal heart rate to gauge endurance performance (Faulkner, Greey and Hunsicker, 1963; Gutin, Fogle and Stewart, 1976; Stewart and Gutin, 1976).

Tests only based on heart rate must beware of increased results that may arise due to the effect of emotion on heart rate response (Antel and Cumming, 1969).

In order to bring about the positive changes associated with cardiovascular endurance an intense activity programme has to be worked out (Sharkey and Holleman, 1967).

Conditioning for cardiovascular fitness requires workouts of from thirty minutes to two hours three times a week, with exercises demanding a high oxygen uptake. To develop endurance both the oxygen transport system and the oxidative processes of the muscle cells need to be taxed (Knuttgen, 1979). If the workload (as measured by heart rate) is

below its optimum level the active muscles and the heart will not be sufficiently stressed (Spino, 1979).

It was reported by Harper, Billings and Matthews (1969) that a programme using running produced greater physical fitness in less time than a programme utilizing calisthenics and marching.

It is of interest that sprinters and other athletes whose events are of short duration (i.e., less than 60 seconds) and who must therefore make use of high percentage of anaerobic respiratory power (respiration in the absence of free oxygen) do not exhibit the changes of cardiovascular fitness, i.e. the enlarged hearts, low resting and exercise heart rates, nor the high maximal oxygen uptakes typical of endurance athletes ("The Physiological Effects of Training", 1979).

Lussier and Buskirk (1977) point out that brief bouts of interval training are probably related to the normal activity patterns of children and must therefore be complemented by continuous and intensive training.

Ismail and Trachtman (1972) and Brown et al (1978) believe that the intensity, duration and frequency of the physical activity are of utmost importance. The placement of the training sessions during the week was found by Moffat, Stamford and Neill (1977) to be of not great influence on aerobic capacity.

It has been ascertained that the factor of motivation plays a significant role in the improvement of physical performance measures (Strong, 1963).

Postulated benefits of exercise in mentally subnormal children

People involved with the education of mentally subnormal children have slowly come to recognise the tremendous contribution that physical activity can make towards the development of adjustment and fulfilment of the child. Many studies have shown that physical exercise may positively affect the mentally retarded child's growth progress in the social, emotional and academic sphere.

An examination of the educational objectives for typical children reveals that priority is placed on intellectual and academic development. The objectives apparently receiving the least attention in the curriculum of the normal child are the social and physical objectives. When the educational objectives of mentally subnormal children are reviewed carefully, it becomes clear that because of their mental handicap greater importance must be given to the social and physical aims, i.e. the priority of objectives needs to be reversed ("Physical Education for the Mentally Retarded", 1979; Upton, 1979).

Many educators involved with the physical and recreational aspects of the mentally subnormal group have come to believe that the education of the whole child may be best through the physical realm (Moran, 1977). Physical education should be seen as a yet unmatched opportunity to enhance the individual's growth and development.

The child needs to be treated as an entity, the physical emotional, social and intellectual aspects of its personality

blending into one another. In the mentally subnormal child debility in one of these areas usually has an influence on other aspects of behaviour. This does not mean, however, that the child will automatically also have a deficiency in its drives, needs and recreational demands. Physical education should be thus seen as a stimulus that may initiate and further improvements other than physical fitness.

Daniels and Davies (1975) asked "if such a strong case for physical education can be built because of its contribution to the development of youth, cannot a stronger case be built for a program of physical education adapted to the needs of the exceptional" (p.20).

As the mentally subnormal child will always lag behind its normal counterpart academically it is evident that these individuals will have to grow up and be dependent on the efficient use of their hands and physical skills rather than on their mental ability. Auxter (1966) maintained that the physical educator can therefore lay the foundation for future vocational training of the mentally subnormal child. The competent use of their body will help them to fulfill a useful function in a sheltered environment.

In order to perform basic operations in life a certain amount of cardiovascular endurance, flexibility, co-ordination, strength, speed, balance, and agility is required. Many motor skills will be inadequately performed due to a subminimum level of required physical fitness.

Physical exercise may also bring about improved posture, and more graceful and controlled movements. Regular exercise is a means in helping the mentally subnormal children to co-ordinate their supply of energy which in some instances is too abundant and in others too limited (Sherborne, 1979).

As it has been shown that physically subnormal children are more like their normal peers in physical ability than in other realms, physical education programmes offer vast opportunities for new experiences to be gained through the physical activity with groups of mixed mental ability.

Oliver (1957) has stated that mentally subnormal children have many similar needs as normal children. He believes that especially among boys the urge for esteem and significance may well be attained through the achievement of an increased level of physical fitness and improved stamina.

Involving mentally subnormal children in a running programme is a way of " 'feeding in' bodily experiences to children who have become used to inactivity and who are deprived of sensory-motor stimulation" (Sherborne, 1979, p.18).

Movement experiences are believed to have a definite influence on perceptual awareness. Theories have been proposed that all learning is based on perception which in turn is developed through the individual's physical interaction with the environment (Moran, 1977).

The development of social maturity is a major objective of participation in a physical education programme. As opportunities for social interaction are usually very limited in mentally subnormal children, exercise in a group setting gives these children a very necessary chance to come into contact with other mentally retarded children or even normal children.

During the physical activity session the child learns to accept guidelines for behaviour, obey rules and regulations required for the harmonious interaction in a group, and adhere to decisions made by the majority. The child will also experience a sense of belonging, and experience the feeling of acceptance by others due to his participation in the physical exercise.

Children that are kept occupied tend to become more cooperative and begin to accept responsibility. Self-help skills, self-discipline and self-direction which all contribute towards social development have been enhanced through extensive physical exercise programmes.

Through the intense physical interaction in the group setting, the opportunity for friendship formation is given. Such a newly established relationship can make a major contribution towards social development.

Physical training initiates emotional development resulting in the ability to accept oneself and others in everyday life situations. Through physical activity the child learns about himself. The child begins to become aware of his body in relation to the space around him. Physical

education is a process by which an individual learns to appreciate the versatility of his body. Pleasure may be expressed through it or derived from it (Cooper, 1969). Body image is believed to affect personality as well as behaviour. If the child experiences success in a physical activity he is likely to develop a positive body image while failure will contribute to a negative body image (Drowatzky, 1971).

Oliver suggested that a system of carefully graded physical exercises will give the mentally subnormal child the opportunity to experience success. A child that has consistently failed in the academic sphere will be able to find new self-confidence and self-esteem in the field of physical education where he is capable of achieving success for he will be dealing in more concrete terms.

Physical training is well suited for the mentally subnormal child to come to terms with himself and gain in self-realization. Physical activity allows far more freedom for expression and movement than other school subjects. The child may follow the exercises at his own rate and increase initiative and resourcefulness by developing variations of given exercises.

Physical fitness can affect the growth of personality in several ways. It can influence what a person can do, and thus affect the response of others to his actions. It may also be responsible for how he looks and thus affect the response of others to his appearance. An improvement in posture, speech, confidence and even a notable change in facial structure was recorded by Cox (1979) in mentally

subnormal children after an extensive running programme.

Physical exercise gives mentally retarded children the opportunity to learn to cope with their environment.

Ismail and Trachtman (1972), and Greist et al (1978) have suggested that changes in behaviour may occur when an individual confronts a challenge, (e.g., a strenuous exercise programme) and overcomes it. The positive outcome, or mastery of the challenge, provides a sense of accomplishment and self-control.

There is a definite link between physical activity and intellectual functioning and similarly, improved intellectual functioning can contribute to a more efficient physical functioning. A child may perform badly because he cannot comprehend or remember the many components that make up the exercise before it may be accomplished. Sometimes the child cannot even understand the instructions given and thus seems completely incapable. During physical activity the mentally subnormal child will have to listen to instructions, many of which will be repeated at regular intervals. This in combination with the modelling of the required exercise gives the child a chance to increase his capacity to listen and to react to the coaching by the physical educator. Scope for language development is given.

It is well known that mentally subnormal children show a shorter attention span than normal children. This is often due to the fact that many activities are too difficult to comprehend and therefore the child loses interest very fast. While undergoing an exercise programme, the child

is confronted by simple challenges which he is able to meet. The child may find a new purpose in what he is doing (Moran and Kalakian, 1977). Cox (1979) observed that mentally subnormal children became more visually alert and were able to concentrate better after attending the physical exertion sessions. He postulated that this permits faster absorption of intellectual information, resulting in the ability to assemble data, organize information, and remember, i.e., the intellectual development is fostered.

Heightened motivation due to success in physical exercise programmes has been seen to carry over into the academic sphere (Oliver, 1957). Similarly, the training of sequential movements in a physical exercise is believed to foster sequential thinking in intellectual tasks (Moran and Kalakian, 1977).

Finally, physical exercise programmes may be seen as an enrichment in the life of the mentally subnormal child. Through physical activity the child is given the opportunity to change its often dismal and forlorn existence into a worthwhile life to live.

### Hypotheses

The following is hypothesized:

1. Dynamic physical exertion therapy significantly increases physical fitness in mentally subnormal children.

2. Dynamic physical exertion therapy significantly raises social and intellectual functioning of mentally subnormal children.
3. Physiological and psychological changes due to dynamic physical exertion therapy will be significantly greater than those brought about by static physical exertion therapy.
4. Static physical exertion therapy significantly increases physical fitness in mentally subnormal children.
5. Static physical exertion therapy significantly raises social and intellectual functioning of mentally subnormal children.

## METHOD

Two treatment conditions were used in order to assess the effect of dynamic versus static exercise on physical fitness, social and intellectual functioning of mentally subnormal children. In the dynamic physical exertion therapy group, the subjects were required to run with the experimenter, initially for short bursts of time, gradually culminating in continuous exhausting running. Muscle tension exercises developed by Hennenhofer and Heil (1976), Moran and Kalakian (1977), and Spino (1979) were applied in the static physical exertion therapy group. The two treatment conditions composed a two-factor multivariate design. Figure 1 illustrates the design lay-out.

### Subjects

Permission was granted by the Director-General of the Department of Health, Welfare and Pensions to execute the research programme at the Alexandra Care and Rehabilitation Centre, Maitland (see Appendix). Subjects were chosen through the scrutiny of the existing classification/diagnostic information available in the children's wards at the centre.

In consultation with the resident Clinical Psychologist equal numbers of mentally subnormal children from each of the following four diagnostic sub-categories used at Alexandra Care and Rehabilitation Centre were chosen to partake in the research programme:

- (a) Organic brain-damaged;
- (b) Down's syndrome;
- (c) Epileptic;
- (d) Unspecified.

Form letters (see Appendix) were posted to the parents of the selected children and after their approval for the participation of their children had been gained, the resident Medical Practitioner was called upon to examine the children and nominate those judged as physically capable of taking part in the exertion therapy. Matched on age, sex, existing diagnostic classifications, and the recommendation of the Medical Practitioner in regard to the physical capacities of the children, equal numbers were assigned to the static and dynamic physical exertion therapy groups. Matching was achieved through strict progressive elimination and complementarity. At the onset of the research programme 32 children took part, 16 boys and 16 girls, with ages ranging from 6 to 18 years.

#### Assessment

Prior to the treatment programmes, the following series of measurements was obtained from each child:

- (a) Heart rate at rest;
- (b) Heart rate at submaximal workload;
- (c) Maximum oxygen intake rate estimates (Frederick and Henderson, 1974);

DYNAMIC PHYSICAL EXERTION THERAPY PROGRAMME

PRE-POST  
DISCREPANCY  
VALUES  
ON 6  
MEASURES

IDENTICAL  
6  
MEASURES

DYNAMIC  
PHYSICAL  
EXERTION  
THERAPY

GOODENOUGH  
OSAIS  
VINELAND  
VO2 MAX ESTIMATE  
HR SUBMAXIMAL  
HR REST

STATISTICAL  
ANALYSIS

POST-THERAPY  
MEASURES

PRE-POST  
DISCREPANCY  
VALUES  
ON 6  
MEASURES

IDENTICAL  
6  
MEASURES

STATIC  
PHYSICAL  
EXERTION  
THERAPY

GOODENOUGH  
OSAIS  
VINELAND  
VO2 MAX ESTIMATE  
HR SUBMAXIMAL  
HR REST

STATIC PHYSICAL EXERTION THERAPY PROGRAMME

INTRODUCTORY  
PROGRAMME

100

- (d) Vineland Social Maturity Scale (Doll, 1965);
- (e) Goodenough Draw-a-Man test (Goodenough, 1926);
- (f) Old South African Individual Scale.

The same series of measurements was obtained after 6 months at the end of the treatment programmes. Difference scores of (a), (b), (c) served as measures of relative changes of physical fitness. Difference scores of (d), (e), (f) indicated changes in social and intellectual functioning. Changes on the three psychological measures were revealed to the experimenter only at the completion of the programme.

#### Physiological Assessment

The Department of Physiology at U.C.T. Medical School made their Sport Science Laboratory B42 available for the pre- and post-treatment assessment sessions. A treadmill with adjustable speed and gradient was used to simulate the required workload conditions. Oxygen consumption rates were planned to be assessed by indirect calorimetry (Pyke, 1979). This method involved subjects running to exhaustion on the treadmill while samples of expired air were collected for analysis. Problems with the oxygen sample collector were experienced during trial runs with some children. After several adaptations to the mouthpiece of the collector gear, this method of obtaining the maximal oxygen consumption rate ( $\dot{V}O_2$  max expressed in ml/kg x min) was abandoned as the procedure still presented a traumatic component to the assessment session. Some children expressed

extreme discomfort at wearing the oxygen sample collector; others, especially the younger children, refused outright to try and breathe through the mouthpiece of the apparatus. It was then decided to use a method that did not involve the impeding mouthpiece or any other kind of constraining apparatus to obtain  $VO_2$  max. The alternative method demanded the children to run as far as possible in 15 minutes. The distance was recorded by a K & R Universal PEDO Pedometer in metres and thus provided the basic measurement for the calculation of an estimate of the maximal oxygen consumption rate. A formula suggested by Daniels (cited in Frederick and Henderson, 1974) was utilized:

$$VO_2 \text{ max estimate} = \left[ \left( \frac{\text{metres run in 15 minutes}}{15} \right) - 133 \right] \times (0,172) + 33,3$$

Heart rate was recorded at differing workloads by a Hitachi desk-type ECG machine. Changes in heart rate and maximal oxygen consumption rate over a 6-month treatment period served as relative measures of physical fitness for each child.

#### Psychological assessment

All psychological tests employed in this study were in extensive use at Alexandra Care and Rehabilitation Centre. The resident Psychometrist administered the battery of tests.

Vineland Social Maturity Scale scores were obtained

in collaboration with the nursing staff in charge of the childrens' wards. The scale was developed to furnish the educator with an exact profile of detailed performances in respect to which children exhibit a progressive capacity for caring for themselves and for engaging in those activities which lead towards definitive independence as adults (Doll, 1965). Successive revisions and standardizations throughout the history of the scale produced no major changes in the original format and the scale has been applied effectively since 1935 (test reliability coefficient = 0,87).

Progressive maturation of a child is understood as progressive development in social competence, establishing itself in increasing proficiency on the following criteria: self-help, self-direction, locomotion, occupation, communication and social relations. In this study the scale provided a qualitative index of variation in development of the mentally subnormal subjects as well as a sound measure of improvement following the treatment programmes.

The level of general intelligence (IQ) of the children was assessed by the Old South African Individual Scale (OSAIS). Although the National Bureau of Educational and Social Research published the New South African Individual Scale in 1964 (Huysamen, 1980), the old scale has been efficaciously in use at the Alexandra Care and Rehabilitation Centre ever since its release in 1939 by Dr. M.L. Fick (test reliability coefficient range = 0,6 - 0,97). Based primarily on Terman's 1916 revision of the Stanford-Binet

Scale the items of the OSAIS requiring different kinds of tasks were clustered together for each of the various age groups. As all past testing of general intelligence at Alexandra Care and Rehabilitation Centre had been based on the OSAIS, the IQs derived from this test yielded a comparison between the change due to the intensive treatment programmes and the change recorded during the history of the children's stay at the institute.

A further IQ index (intellectual maturity = MA) was obtained by the administration of the Goodenough Draw-a-Man Test (Goodenough, 1926), usually analysed in conjunction with the OSAIS at Alexandra Care and Rehabilitation Centre. This index provided a measure of intellectual maturity that correlated substantially with tests of general intelligence, and relates to the ability to do abstract thinking (Harris 1963; test reliability coefficient = 0,90; McCarthy, 1924). The opportunity of cross-reference to previously recorded Goodenough Draw-a-Man Tests was utilized and critically evaluated.

### Procedure

All children took part in an introductory programme teaching them how to perform the static and dynamic physical exertion exercises, as well as how to achieve a basic flexibility and muscular endurance capacity. The resident Physiotherapist was in attendance during the entire introductory programme. This programme was held before the pre-exertion therapy assessment period to allow

the children to accommodate to the physical tasks required of them and to develop a trusting relationship with the experimenter.

#### Introductory programme

The inclusion of flexibility exercises aimed to compensate for the large flexibility loss experienced by institutionalized children tending to lead a sedentary life. This minimized the risk of muscle strain and allowed the children to move through normal ranges of motion. Figure 2 depicts a variety of flexibility exercises.

General muscular endurance exercises followed the flexibility training to counteract fatigue and enhance the children's continuing persistence of effort. Examples of this kind of exercise are illustrated in Figure 3.

Individual attention was given to children experiencing difficulties in modelling the elementary static physical exertion exercises (strength exercises). Wherever possible the experimenter guided the children's limbs in a shadow fashion so that the exercises could be learned through shaping. Successive approximations towards the terminal response were encouraged by praise from the Physiotherapist and the experimenter. Examples of strength exercises are shown in Figure 4.

The training for the dynamic physical exertion exercises (cardiovascular endurance exercises) concentrated on the development of rhythm, skill in foot placement, and co-ordinated arm swing with leg action. Once this was achieved

the ability to run skilfully in a straight line and lean forward in order to maintain forward momentum was coached. Figure 5 gives examples of a variety of cardiovascular endurance exercises.

During the introductory programme, 64 half-hour sessions took place evenly distributed over a 6-week interval. Per session children in groups of 4 were seen after a minimum of 1 hour resting period following lunch. On average each child joined 8 introductory sessions, scheduled in regular time intervals. The introductory programme was followed by the pre-therapy assessment period.

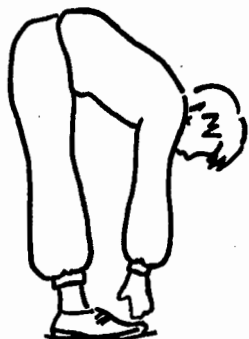
#### Pre-therapy assessment

For the two-week duration of the pre-therapy sessions four children were taken to the Physiology Laboratory B42 at U.C.T. Medical School each day in the mornings (08h30). To acquaint the children with the new environment the experimenter lead the children through the laboratory demonstrating the use of the treadmill and the way the electrodes would have to be attached to the body to register the heart-beat. Initially, the children were allowed to roam about and handle the equipment with the assistance of the experimenter. Any queries about the apparatus were promptly answered in as fundamental a way as possible to disperse any uneasiness expressed and foster interest in the proceedings. Under the supervision of a research assistant three children were occupied by supplying them with drawing materials in the adjacent room. The remaining child

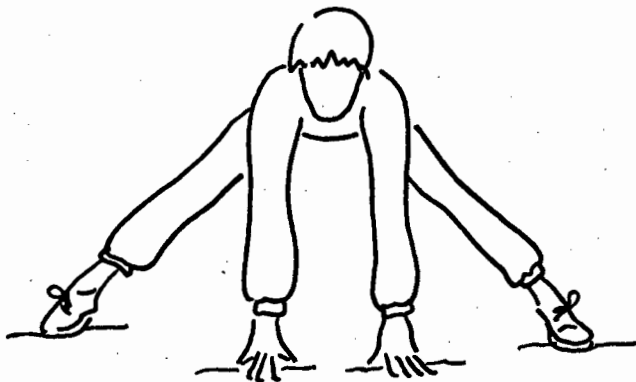
FIGURE 2

FLEXIBILITY EXERCISES

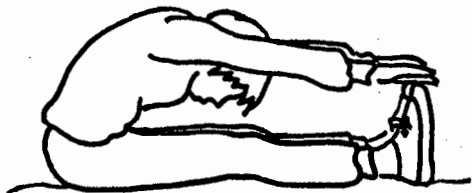
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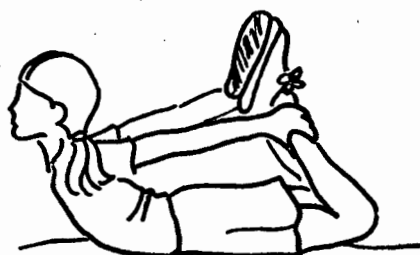
TOUCHING TOES  
Do not bend knees



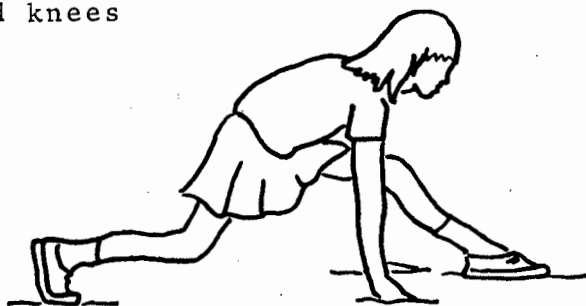
LEGS SPREAD  
As far as possible,  
initially use hands for support



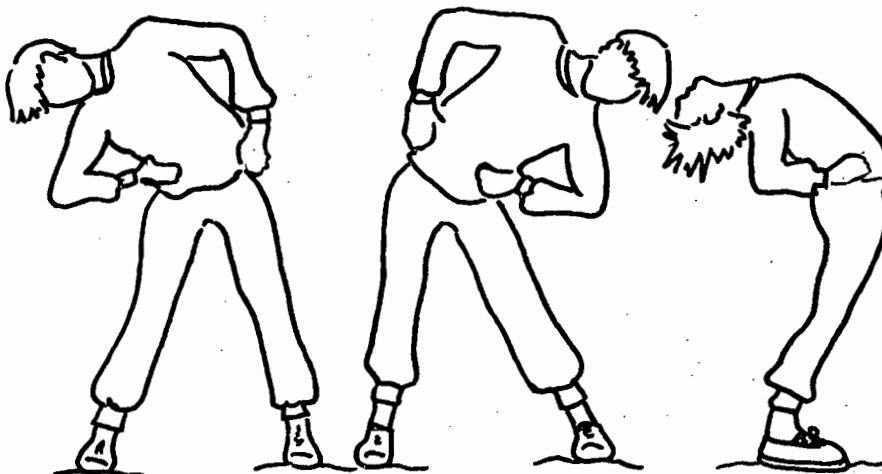
REACH  
Do not bend knees



TUMMY ROCKING



SPLIT  
Use hands for support

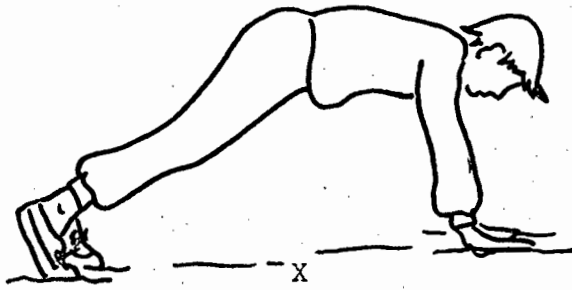


BEND  
Right left and backward

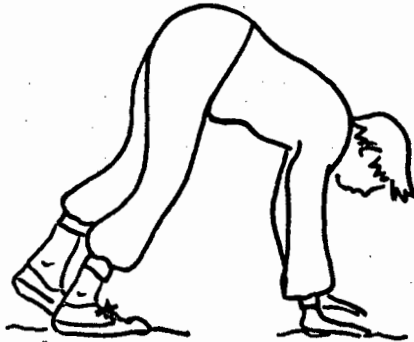
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FIGURE 3

MUSCULAR ENDURANCE EXERCISES



Feet walk forward  
line, arms remain  
stationary

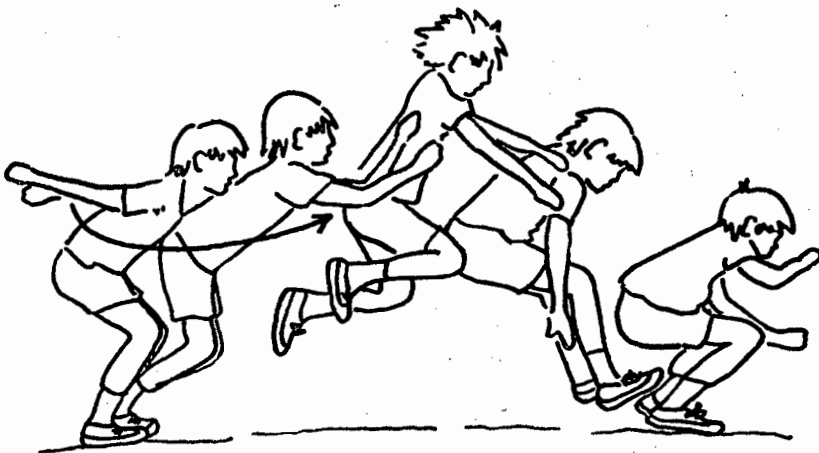


Arms walk forward  
feet remain  
stationary

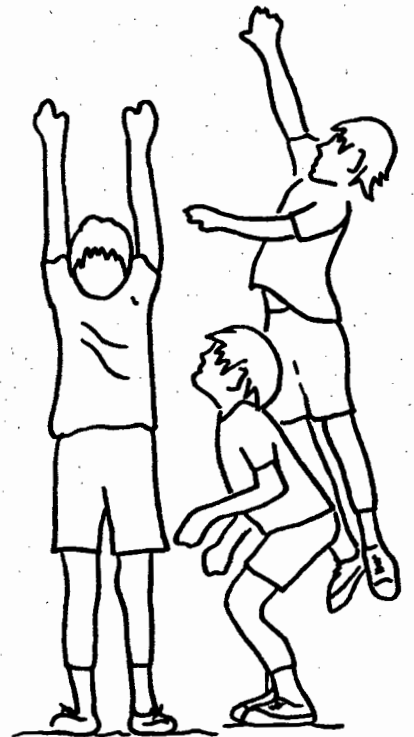
X = reference point



INCH WORM



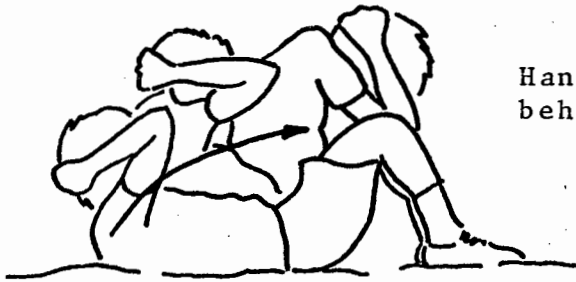
STANDING LONG JUMP



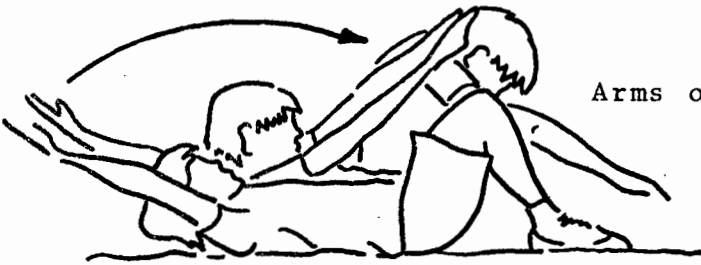
VERTICAL JUMP

FIGURE 4

STATIC EXERCISES (STRENGTH EXERCISES)

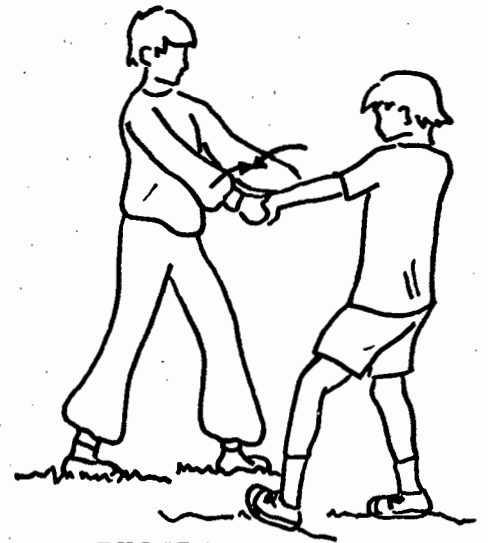


Hands clasped behind head



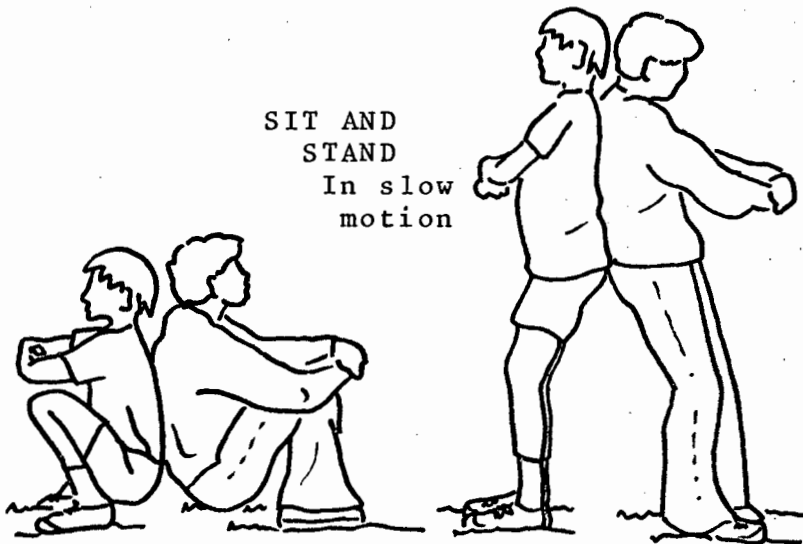
Arms outstretched

SIT-UPS

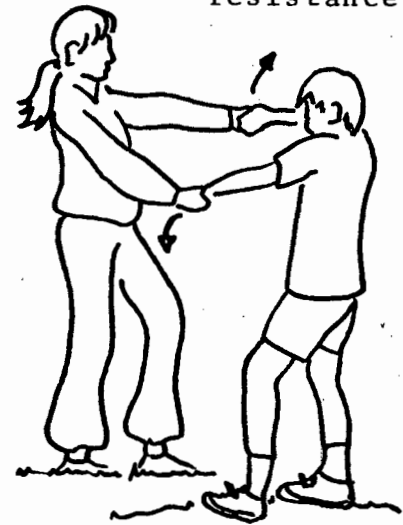


PUSHING  
Against

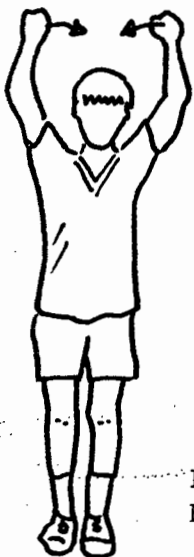
resistance



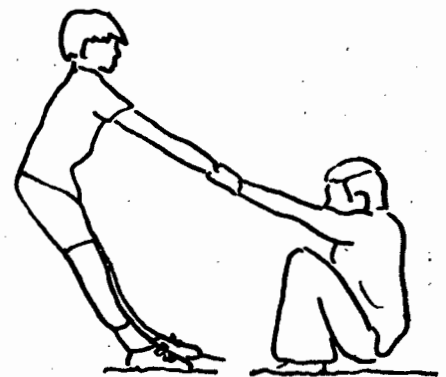
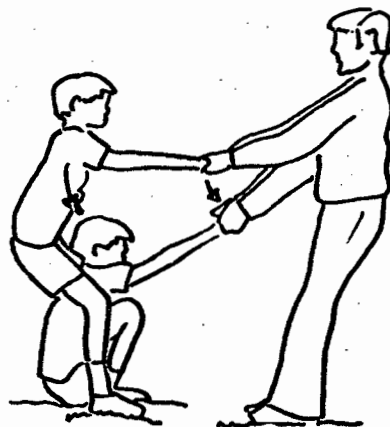
SIT AND  
STAND  
In slow  
motion



PULLING  
Arms apart, against  
resistance

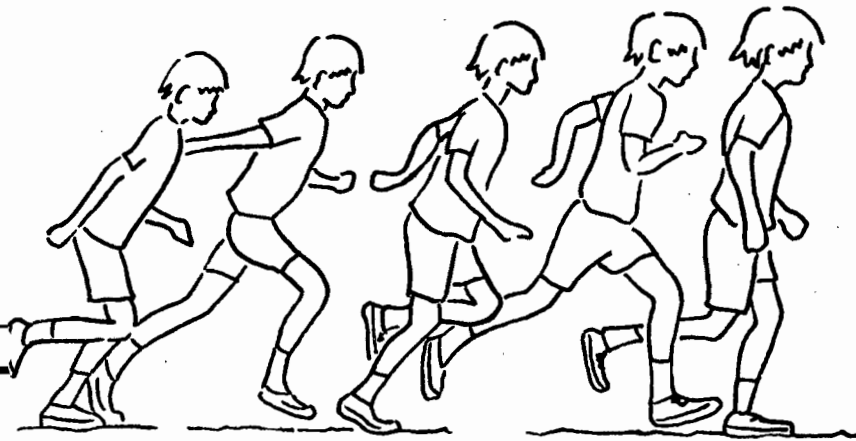


PRESSING  
Hands together overhead



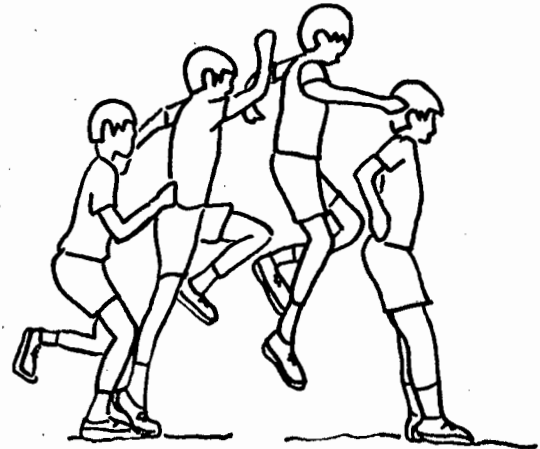
SEE-SAW  
In slow motion

DYNAMIC EXERCISES (CARDIOVASCULAR ENDURANCE EXERCISES)



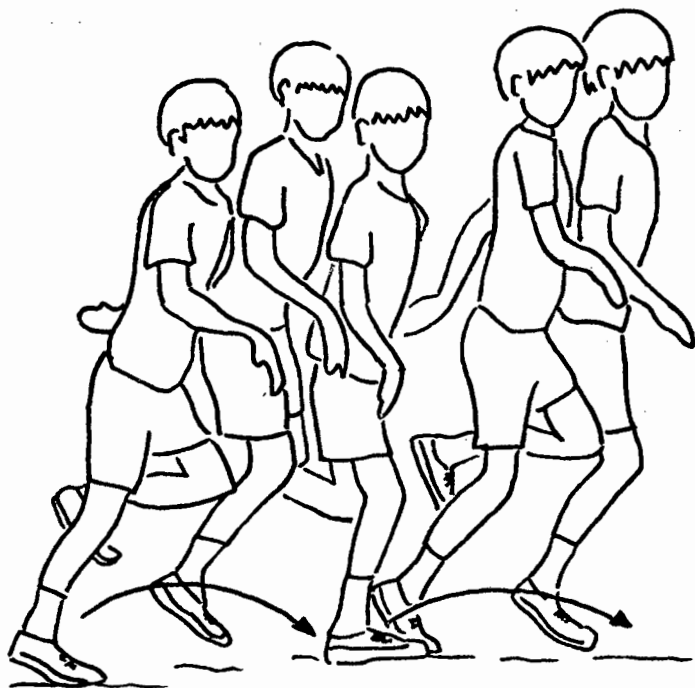
RUN

Body breaks contact with surface

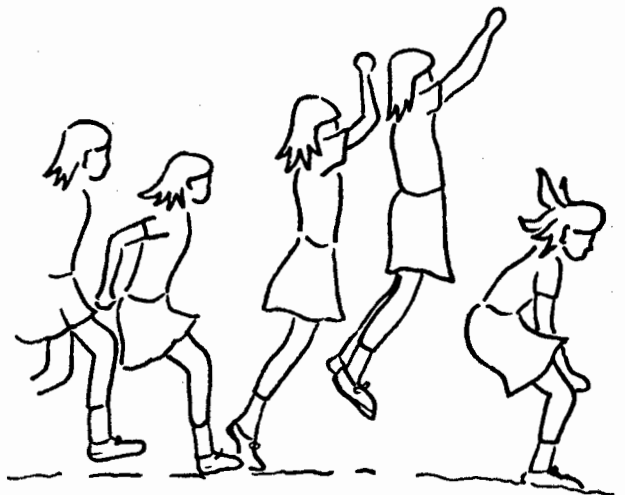


JUMP

One-foot take-off



ONE FOOT HOP

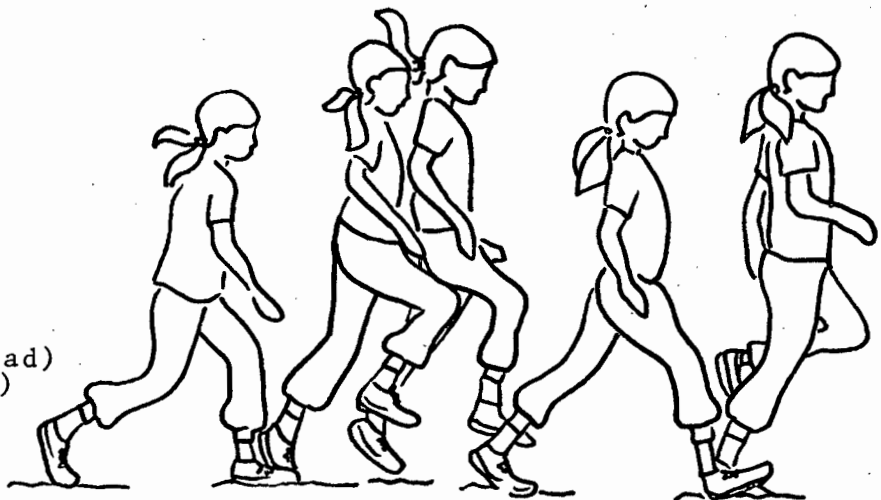


JUMP

Two-foot take-off

SKIPPING

Step (Left foot lead)  
 Hop (Left foot hop)  
 Step ((Right foot lead)  
 Hop (Right foot hop)



was seated comfortably on a chair and the silver-silver chloride electrodes were attached in the standard positions on each side of the body over the rib cage a few centimetres above the waistline, in locations free from excess fatty tissue and muscle, thus reducing the amount of movement artifact in the electrocardiogram (Robert et al, 1980).

In the relaxed posture, the child's heart rate (HR rest) was recorded. Next the child was placed on the treadmill with the experimenter standing behind to guard against possible fall and injury in case the child did not respond when the apparatus was activated at its slowest pace. Over a period of five minutes, the speed of the treadmill was increased steadily to 5 km/h. The submaximal heart (HR submax) could be recorded after 10 minutes at this easy running pace. Thereafter, the treadmill was brought to a swift steady halt. After a few minutes rest the child and the group of children in the adjacent room were involved in drawing activities. The apparatus was readied for the next recording. Two and a half hours were required to process the recording of four children.

In the afternoon the  $VO_2$  max estimate measurement took place in the Recreational Hall and the Alexandra Care and Rehabilitation Centre. As each child had to be urged to do his/her best in a 15 minute run and cover as much ground as possible, individual assessment was called for. The resident Physiotherapist and the experimenter encouraged the children verbally to perform at their optimum. The distances covered were recorded by a K & R Universal PEDO

pedometer and the  $VO_2$  max estimates calculated by means of the Daniels' Formula.

The following day the resident Psychometrist assessed the same group of children on the OSAIS and the Goodenough Draw-a-Man Test. Vineland scores were obtained with the assistance of the nursing staff.

At the conclusion of the psychological and physiological assessment periods, equal numbers of children were assigned to the static and dynamic physical exertion therapy groups, matched on age, sex, existing diagnostic classifications and the recommendations of the resident Medical Practitioner and Physiotherapist in regard to physical capabilities of the children.

#### Static physical exertion therapy

Sixteen children were accommodated in four groups which met every day, resulting on average in 15 half-hour sessions for each child for the first three months of treatment. By that stage three children had been withdrawn from the programme. One child had to leave early in the afternoon to meet his parents and two children proved to be entirely unco-operative. Their initial enthusiasm faded rapidly and they seriously interfered with the group's progress. The decision to remove the two children was only taken after repeated efforts on the resident Physiotherapist's and experimenter's side to harmonise their upsetting behaviour. For the remaining three months of the programme the four groups were combined into two

groups of seven and ~~six~~ children respectively. The group met every second day in the afternoon (15h00), accumulating 30 half-hour sessions per child. As during the introductory programme, flexibility and muscular endurance exercises preceded the intensive strength exercises for five minutes. Thereafter concentrated strength exercises followed for 10 minutes. The exercises were presented in a variety of sequences so that the children's interest and concentration were preserved at an optimal level. This pattern of five minutes flexibility and muscular endurance/10 minutes of intense strength exercises was carried out twice during an afternoon session. The experimenter demonstrated all exercises to the children. Once the groups were combined children were encouraged to engage in exercises with each other rather than wait for the experimenter to initiate action during the sessions. Positive verbal reinforcement was given throughout. Figure 6 depicts time continuum diagrams illustrating the sequence of the static, as well as the dynamic physical exertion conditions.

#### Dynamic physical exertion therapy

Identical to the static physical exertion condition four children initially made up a group. There were four groups. The dynamic physical exertion groups commenced immediately after the static physical exertion groups had finished, thus the same frequency of therapy sessions were

held. For the first three months each child on average experienced 15 sessions and thereafter 30 more sessions for the succeeding three months.

At the time of the amalgamation of the groups, two children had to retire from the programme due to sickness. One child hindered the growth of the group by her consistent refusal to collaborate and was subsequently withdrawn from the programme. Persistent efforts to make the child share the experiences of the other children met with more intractable behaviour displays.

The session began with five minutes of flexibility and muscular endurance exercises presented in a variety of ways not to allow the meetings to become a fixed, monotonous routine. Thereafter came 10 minutes of concentrated running. This pattern was repeated for the second half of the session. Straight forceful running was interspersed with concentrated bouts of jumping, hopping or skipping. The experimenter demonstrated all activities and persistently encouraged the children verbally.

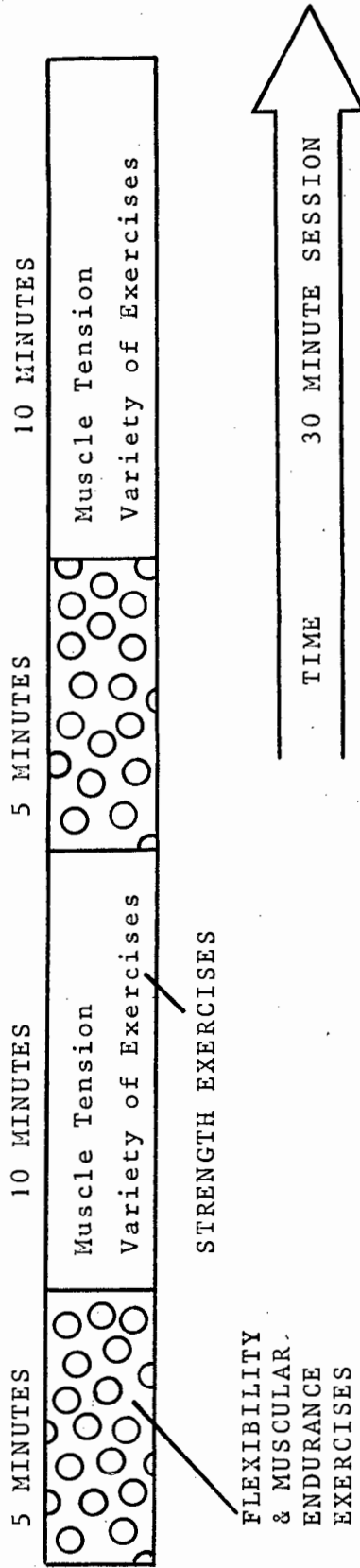
#### Post-therapy assessment

The post-therapy assessment sessions were identical to the pre-therapy assessment sessions. During the two-week period spent at U.C.T. Medical School for the physiological evaluation and the appraisal of the  $VO_2$  max estimates at Alexandra Care and Rehabilitation Centre the children were administered an identical battery of psychological tests.

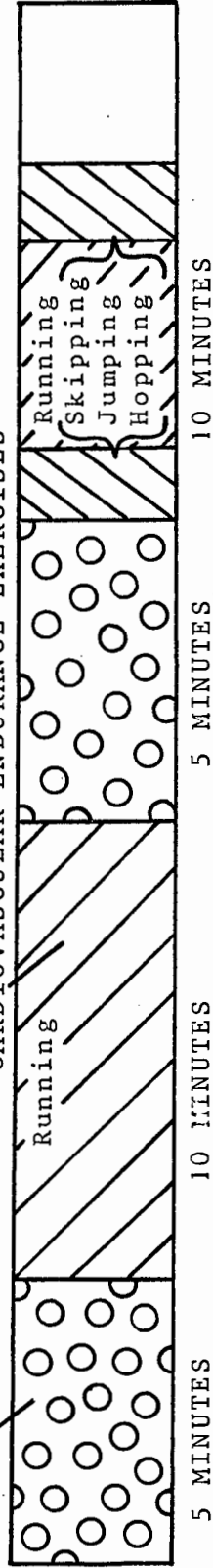
FIGURE 6

TIME CONTINUUM DIAGRAMS ILLUSTRATING THE SEQUENCE OF THE TWO EXERTION THERAPY CONDITIONS

STATIC PHYSICAL EXERTION THERAPY SESSION



CARDIOVASCULAR ENDURANCE EXERCISES



DYNAMIC PHYSICAL EXERTION THERAPY SESSION

The results of the pre- and post psychological evaluations were revealed to the experimenter only at the completion of the physical exertion therapy programme.

In total, 304 half-hour exertion therapy sessions were held, 64 sessions during the introductory programme and 120 each during the static and dynamic physical exertion therapy programmes. On average, each child participated in 53 sessions.

## RESULTS

The data of the investigation were analysed by means of a multivariate Hotelling's T Squared analysis for independent samples (Myers, 1979).

The evaluation involved a two-sample case with difference scores on six distinct measures: heart rate at rest (HR rest), heart rate at submaximal workload (HR submax), maximum oxygen intake rate estimate ( $VO_2$ max estimate), Vineland Social Maturity Quotient (social quotient), OSAIS intelligence quotient (OSAIS IQ), and Goodenough Draw-a-Man mental age (MA).

The first sample originated from the dynamic physical exertion therapy condition, the second from the static physical exertion therapy condition.

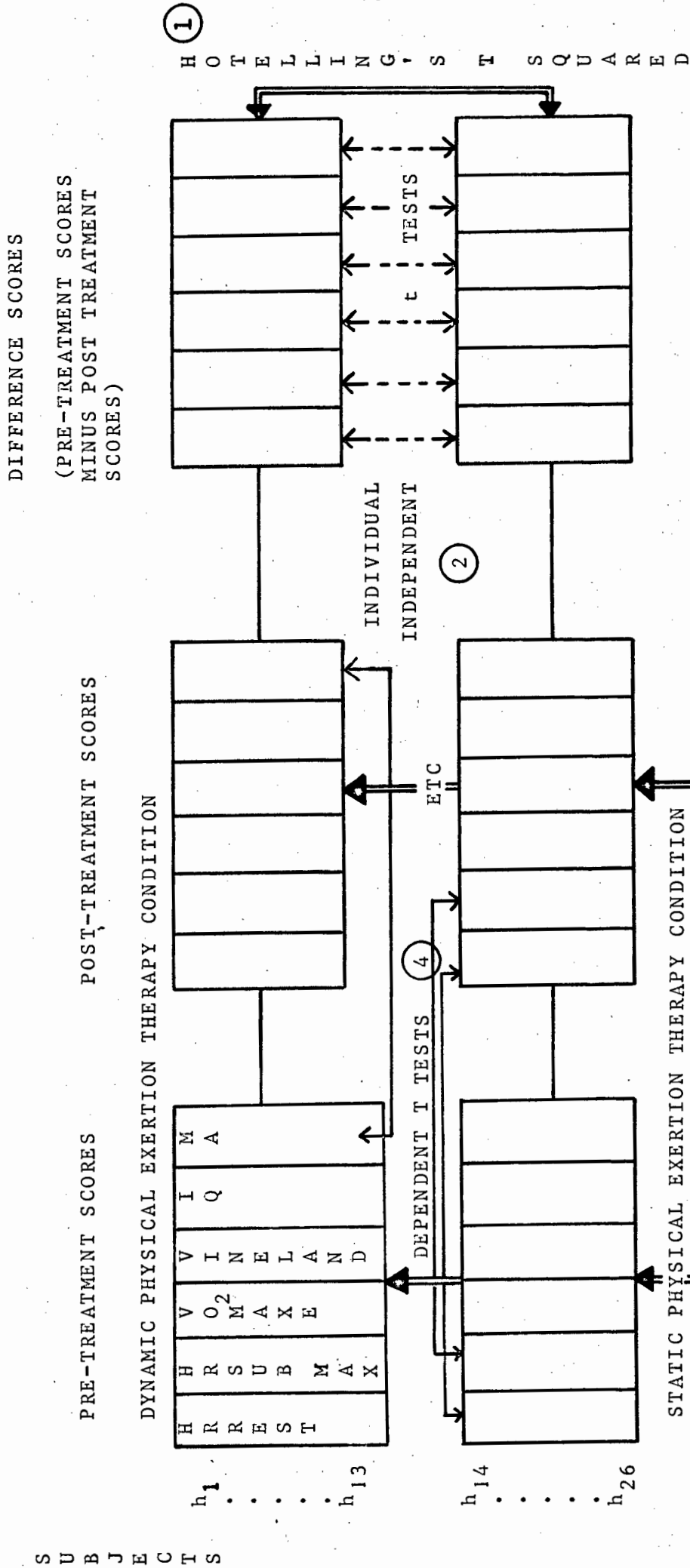
Pre-treatment scores subtracted from post-treatment scores generated the index for relative change on all measures: the difference scores. The overall analysis sequence is displayed in Figure 7.

Additional multivariate Hotelling's T Squared analyses for dependent samples were executed to assess pre/post changes for each of the two cases separately.

Table 4 summarises the results of the multivariate Hotelling's T Squared analyses.

FIGURE 7

SEQUENCE OF THE OVERALL STATISTICAL ANALYSIS OF THE EXERTION THERAPY INVESTIGATION



THE NUMBERS IN ○ DENOTE THE SEQUENCE OF THE OVERALL ANALYSIS

TABLE 4SUMMARY TABLE OF HOTELLING'S T SQUARES

	OVERALL DIFFERENCE SCORES	PRE/POST DYNAMIC DIFFERENCE SCORES	PRE/POST STATIC DIFFERENCE SCORES
$T^2$	102,775	352,169	421,896
p	<0,01	<0,01	<0,01

Hotelling's T Squared for independent samples

A highly significant  $T^2$  was obtained and it was concluded that the two samples (relative change of dynamic and static physical exertion therapy conditions) came from different populations. The relative changes recorded overall the six measures were uniformly greater for the dynamic exertion therapy condition than for the static one.

To analyse the significant  $T^2$  and establish which variables contributed to its significance, t tests for testing hypotheses about two independent means were employed.

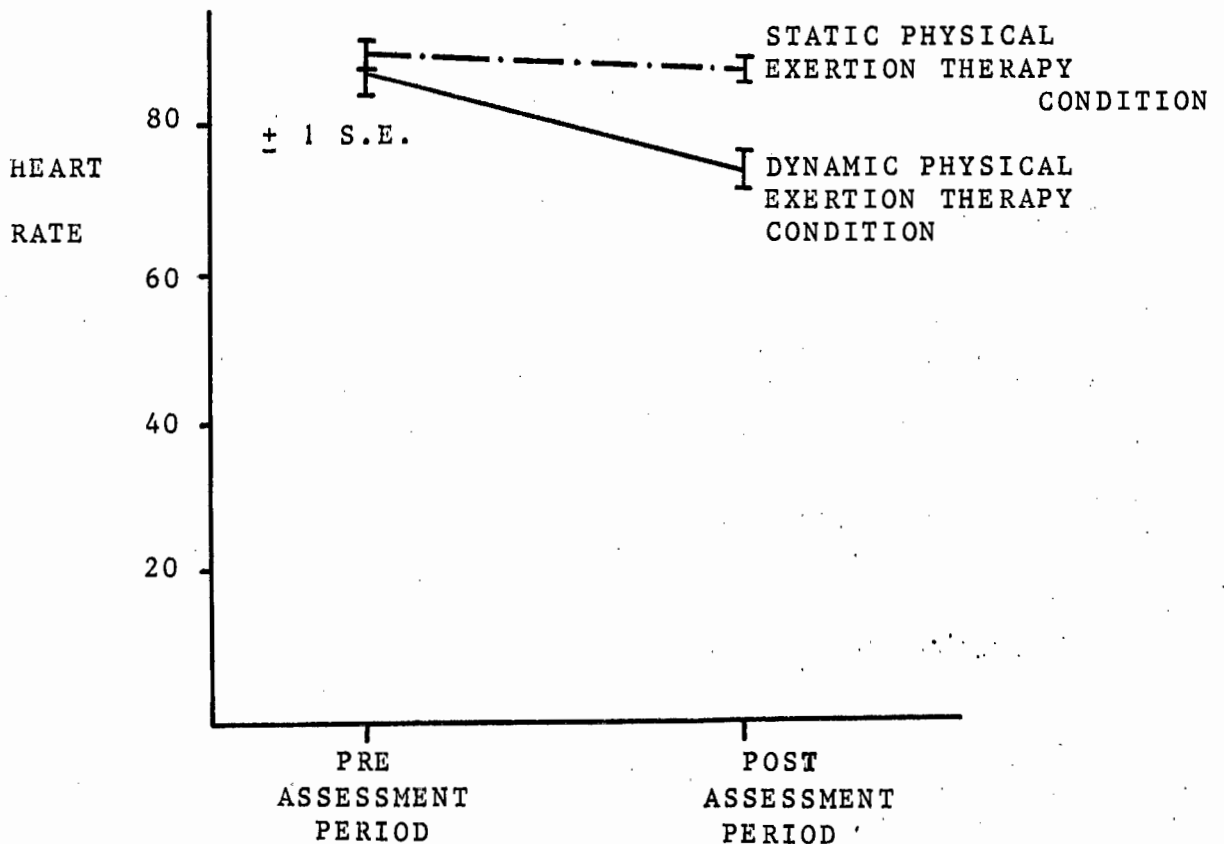
When the squared t values were compared to the critical value of  $T^2$  used in the overall evaluation, the following

picture emerged considered in isolation relative changes in HR rest, HR submax, and  $VO_2$  max estimate perceptibly distinguished dynamic from static exertion therapy subjects, whereas social quotient, OSAIS IQ and MA did not reach significance. In this case, the last three variables contributed to the overall statistically significant finding only when considered in combination.

As significant differences were expected on all measures on theoretical grounds (see Introduction: Postulated benefits of exercise in mentally subnormal children) it was permissible to refer the t values to standard tables of student's t (Gilbert, 1977). In this condition

FIGURE 8

AVERAGE HEART RATE AT REST BEFORE AND AFTER  
EXERTION THERAPY PROGRAMME



all  $t$  values exceeded the critical value of  $t$  at the 0,01 level of significance. On the basis of this argument all six variables when considered in isolation differentiated the changes of the dynamic from those of the static condition.

The results of the  $t$  tests are depicted in Table 5. Corresponding profiles for the six variables in both treatment conditions are presented in Figures 8 to 13, revealing the substantial positive changes brought about by the dynamic physical exertion therapy.

FIGURE 9

AVERAGE HEART RATE AT SUBMAXIMAL WORKLOAD  
BEFORE AND AFTER EXERTION THERAPY PROGRAMME

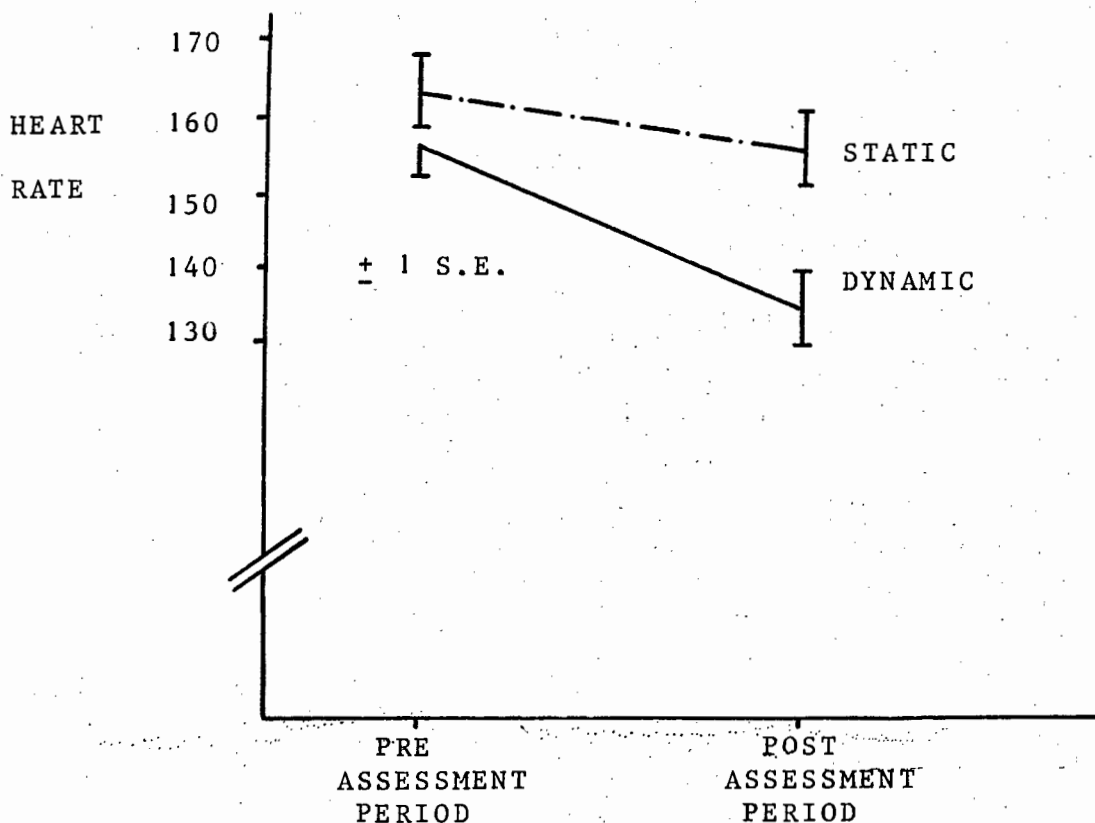


FIGURE 10

AVERAGE VO<sub>2</sub> ESTIMATE BEFORE AND AFTER  
PHYSICAL EXERTION PROGRAMME

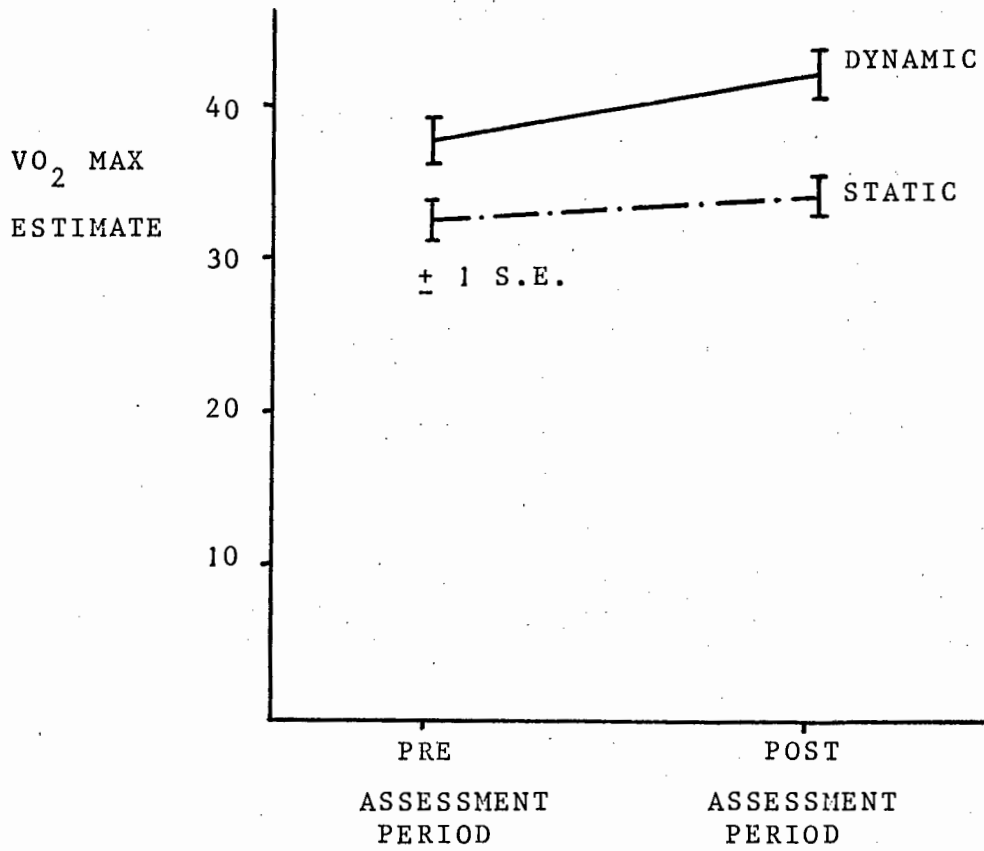


FIGURE 11

AVERAGE VINELAND SOCIAL MATURITY QUOTIENT BEFORE AND AFTER PROGRAMME

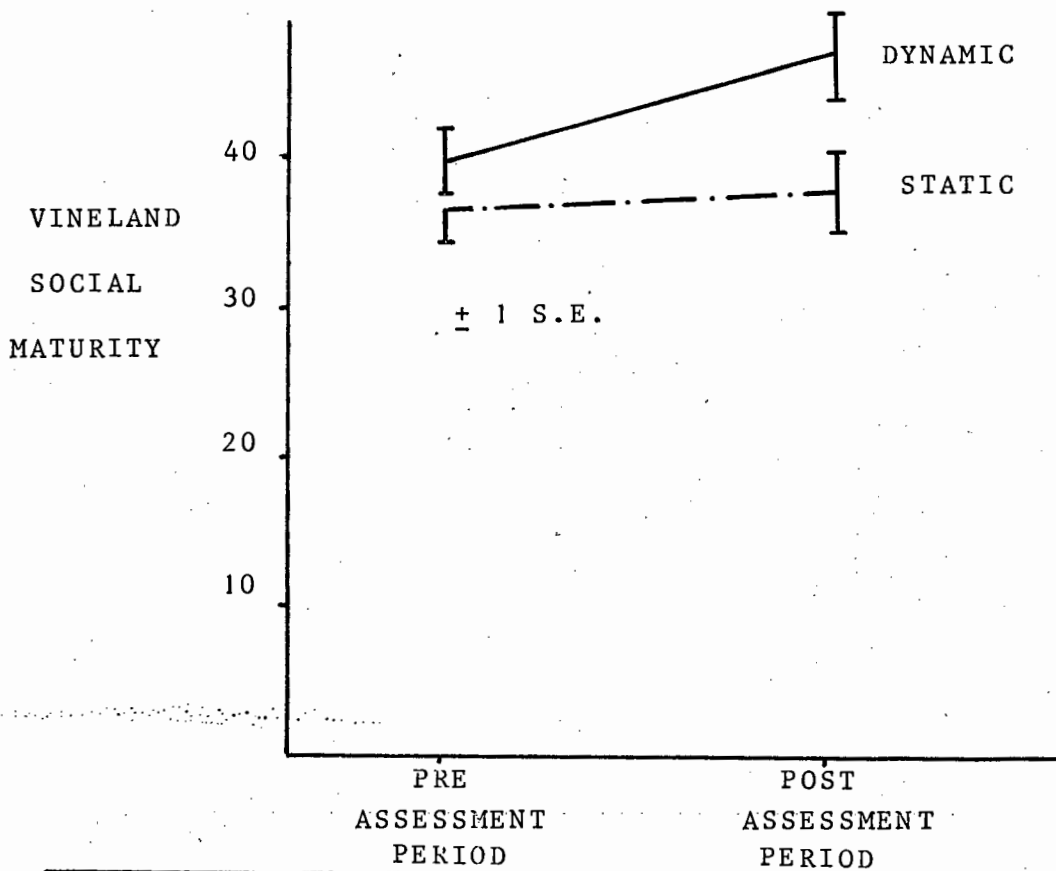


FIGURE 12

AVERAGE OSAIS INTELLIGENCE QUOTIENT BEFORE AND AFTER PROGRAMME

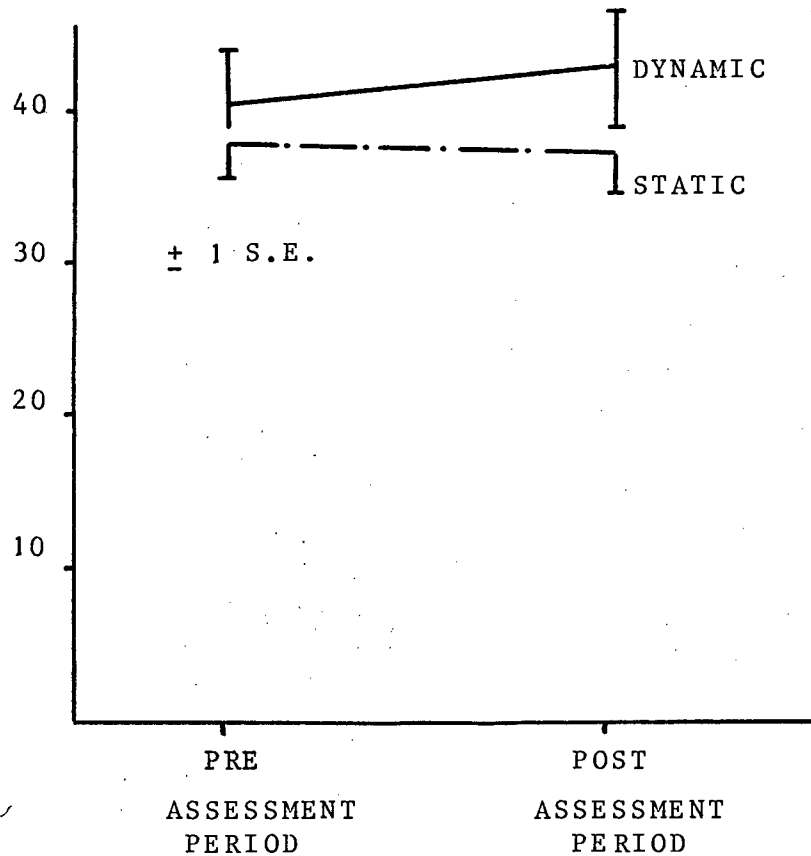


FIGURE 13

AVERAGE GOODENOUGH INTELLECTUAL MATURITY  
BEFORE AND AFTER EXERTION THERAPY PROGRAMME

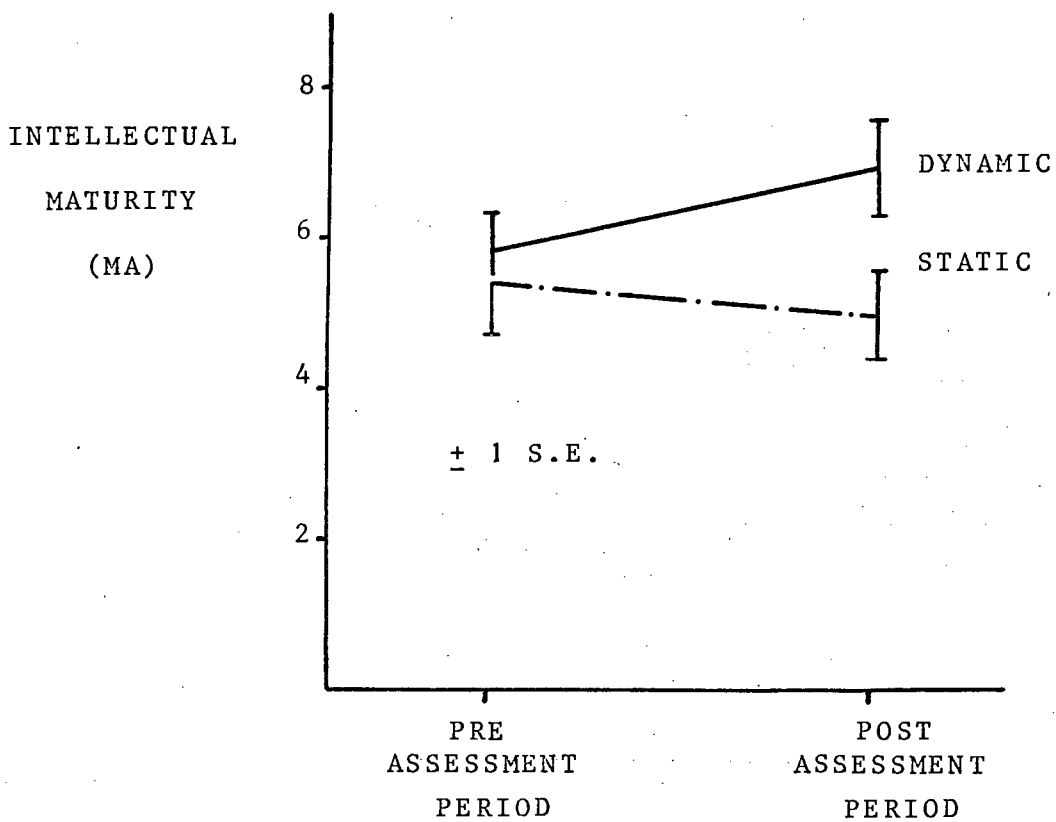


TABLE 5

SUMMARY TABLE OF INDEPENDENT t TESTS

	H R R E S T	H R S U B M A X	V O <sub>2</sub> M A X E S T	V I N E L A N D	O S A I S	D A P
DYNAMIC	-9,692	-20,692	3,424	6,308	2,462	0,900
STANDARD DEVIATION	2,926	7,227	1,049	4,049	3,205	0,956
STATIC	-3,385	-6,692	1,147	1,692	-1,846	-0,177
STANDARD DEVIATION	2,103	3,038	0,936	2,463	3,693	0,722
t	-6,311	-6,439	5,841	3,511	3,176	3,243
p	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01

Additional Hotelling's T Squared analyses for dependent samples.

Statistically significant  $T^2$ s were obtained for both treatment conditions on the pre/post measurement scores.

On theoretical grounds significant differences were expected on all variables for the dynamic condition. Compared to usual tables of student's t all variable's changes of the dynamic condition achieved statistical significance at the 1% level of confidence except for Vineland scores that reached significance at a 5% level. Each variable contributes to the distinct difference of pre- and post measurements when considered in isolation. (See Table 5). Comparison of the calculated t values with the critical values of a usual student's t table for the static condition indicated that OS AIS and DAP pre/post scores contributed to the overall significant difference only when considered in combination. Significant individual contributions were made by the HR rest, HR sub-max and  $VO_2$  max estimate variables at the 1% level of confidence, and by the Vineland variable at the 5% level. The results are shown in Table 6.

Statistical analyses were not performed for the individual diagnostic classificatory sets as the sample size was too small.

TABLE 6

SUMMARY TABLE OF DEPENDENT t TESTS FOR THE DYNAMIC EXERTION THERAPY CONDITION

	H R	H R	V O <sub>2</sub>	V I N E L A N D	O S A I S	D A P
PRE	85,615	157,000	37,328	35,923	40,154	5,838
	MEAN					
	7,911	13,128	5,531	14,563	13,564	2,075
	STANDARD DEVIATION					
POST	75,615	136,308	40,767	46,077	42,615	6,738
	MEAN					
	8,780	15,887	6,429	13,744	14,298	2,494
	STANDARD DEVIATION					
	12,247	10,323	-11,833	-2,500	-2,770	-3,399
	t					
	<0,01	<0,01	<0,01	<0,05	<0,01	<0,01
	P					

TABLE 7

SUMMARY TABLE OF DEPENDENT t TESTS FOR THE STATIC EXERTION THERAPY CONDITION

	H R	H R	V O <sub>2</sub>	V I N E L A N D	O S A I S	D A P
PRE	89,769	162,923	32,82	36,308	36,923	5,308
	MEAN					
	6,990	21,089	4,432	14,505	8,833	2,487
	STANDARD DEVIATION					
POST	86,385	156,231	33,974	38,000	36,615	5,054
	MEAN					
	6,172	22,402	4,835	12,410	9,777	2,252
	STANDARD DEVIATION					
t	5,803	7,942	-4,418	-2,478	0,413	1,360
P	<0,01	<0,01	<0,01	<0,05	NS	NS

Relative percentage change

Relative percentage changes are included at this stage in order to give a lucid picture of the above-mentioned findings: HR rest and HR submaximal decreased by 11,36 and 13,18% respectively;  $VO_2$  max estimates increased by 9,17%; Vineland Social Maturity quotients expanded by 15,86%; OSAIS intelligence quotients advanced by 6,13%; and Goodenough intellectual maturity increased by 15,42%.

Minor positive changes occurred in the static physical exertion therapy condition: HR rest and HR submaximal dropped by 3,77 and 4,11% respectively;  $VO_2$  max estimates increased by 3,49%; and Vineland Social Maturity quotients rose by 4,66%. Slight decreases of 0,83 and 4,79 % were registered for the intelligence quotient and intellectual maturity. Figure 14 summarises the above-mentioned findings for both treatment conditions. Histograms comparing pre/post measures individually for all six variables are shown in Figures 15 to 19.

FIGURE 14

AVERAGE RELATIVE PERCENTAGE CHANGE OF VARIABLE ATTRIBUTABLE TO EXERTION THERAPY PROGRAMME

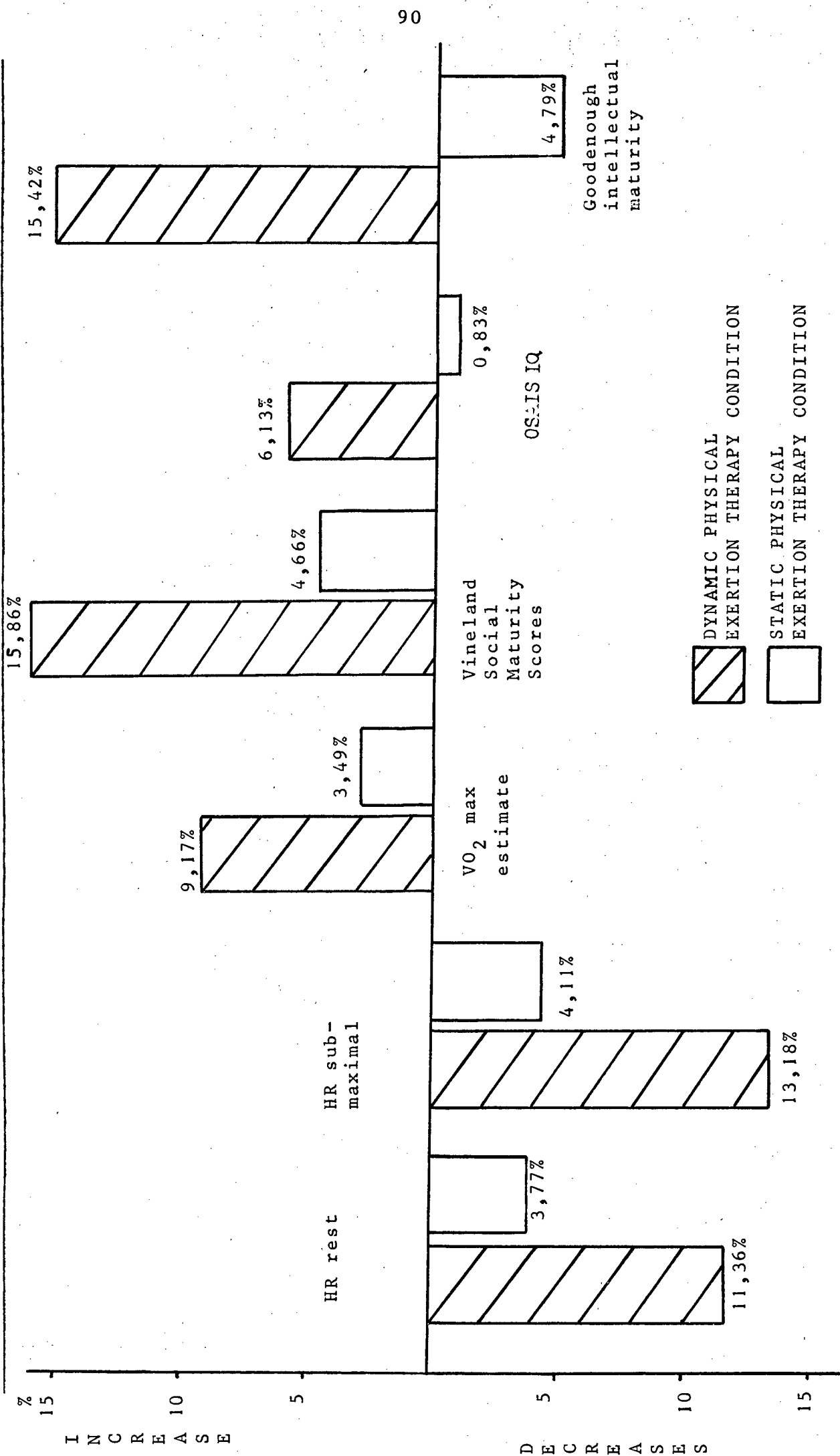
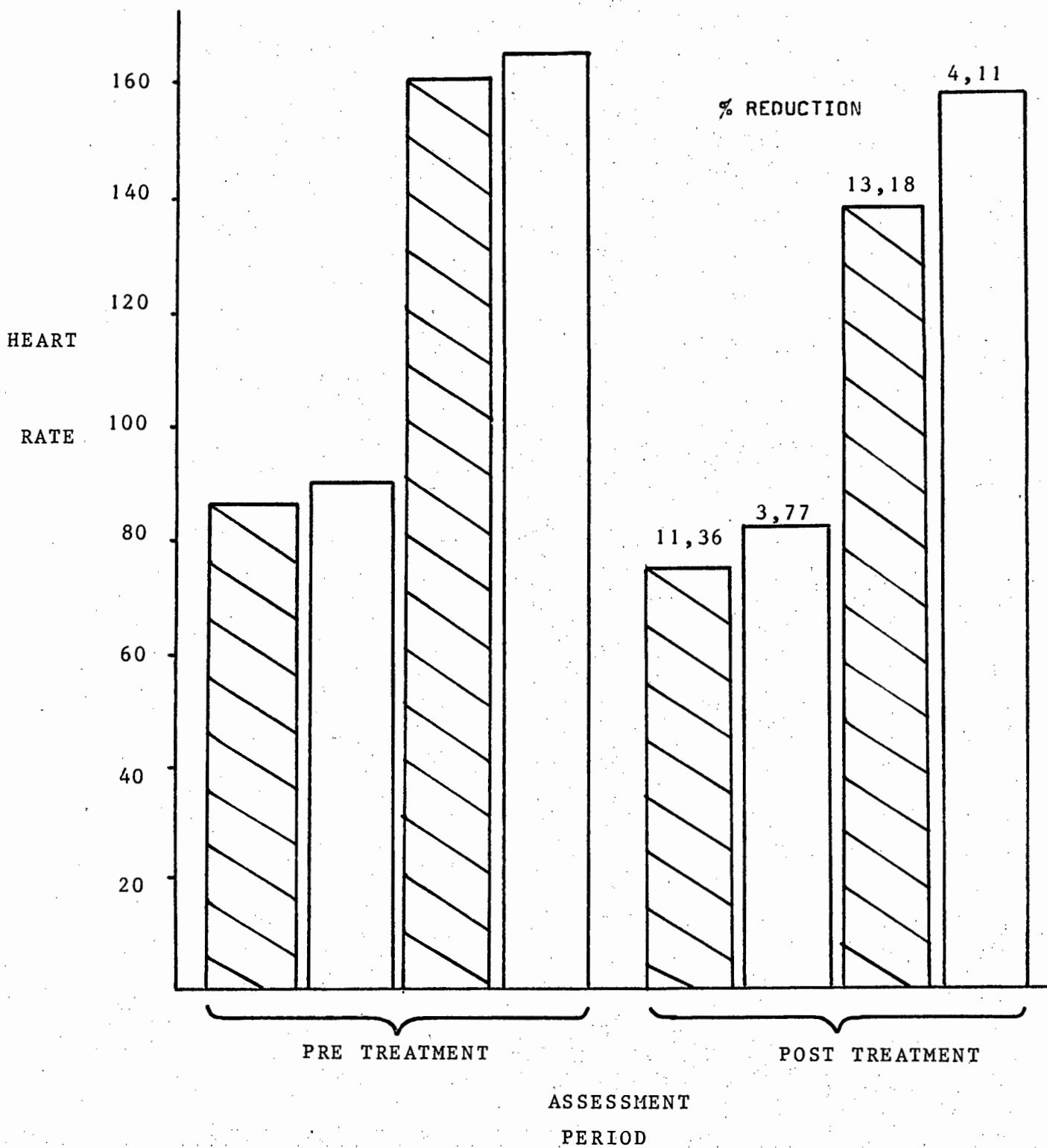


FIGURE 15

HISTOGRAM OF HEART RATE AT REST AND SUBMAXIMAL  
WORKLOAD BEFORE AND AFTER PROGRAMME



 DYNAMIC  
PHYSICAL  
EXERTION

 STATIC  
PHYSICAL  
EXERTION

FIGURE 16

HISTOGRAM OF VO<sub>2</sub> MAX ESTIMATE BEFORE AND AFTER EXERTION THERAPY PROGRAMME

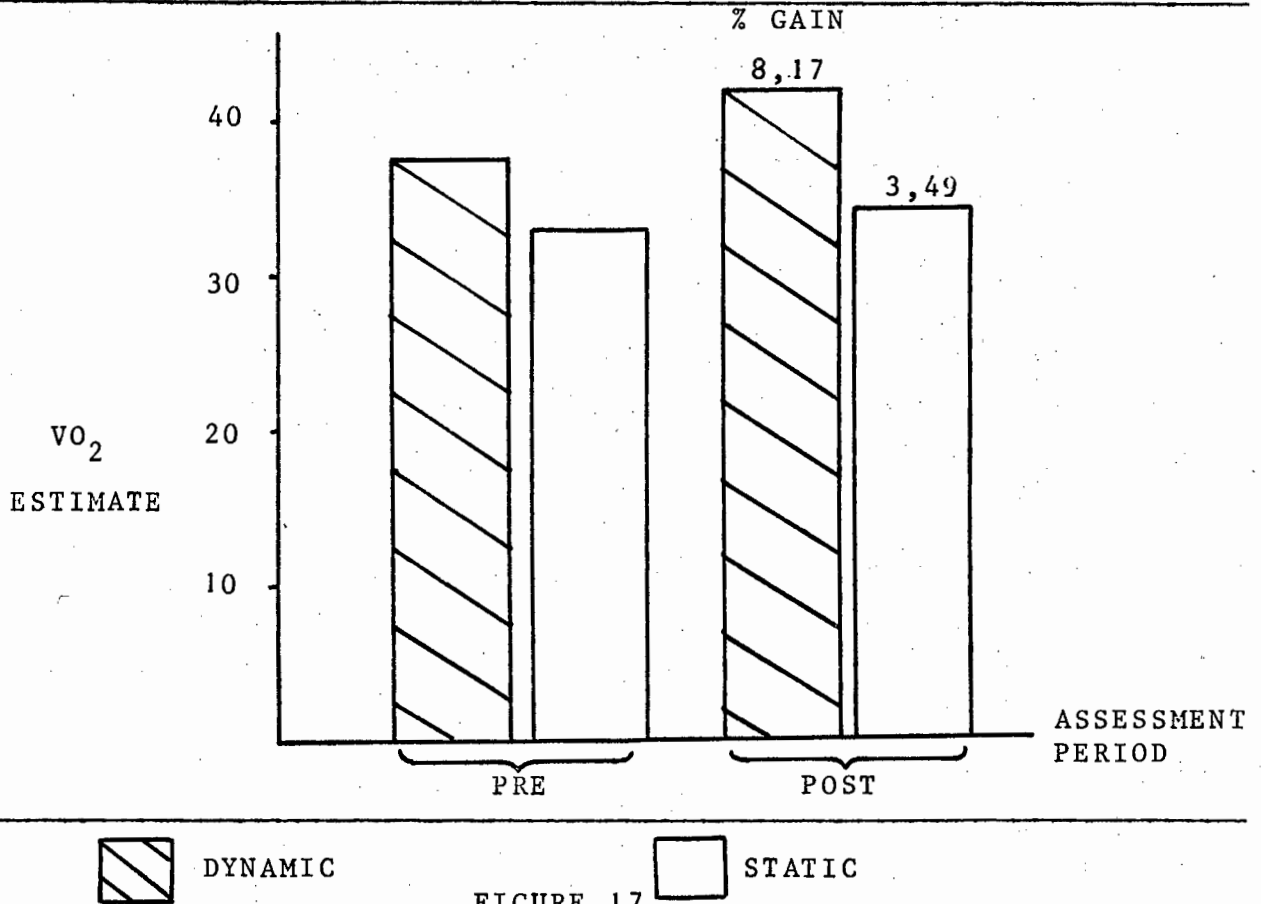
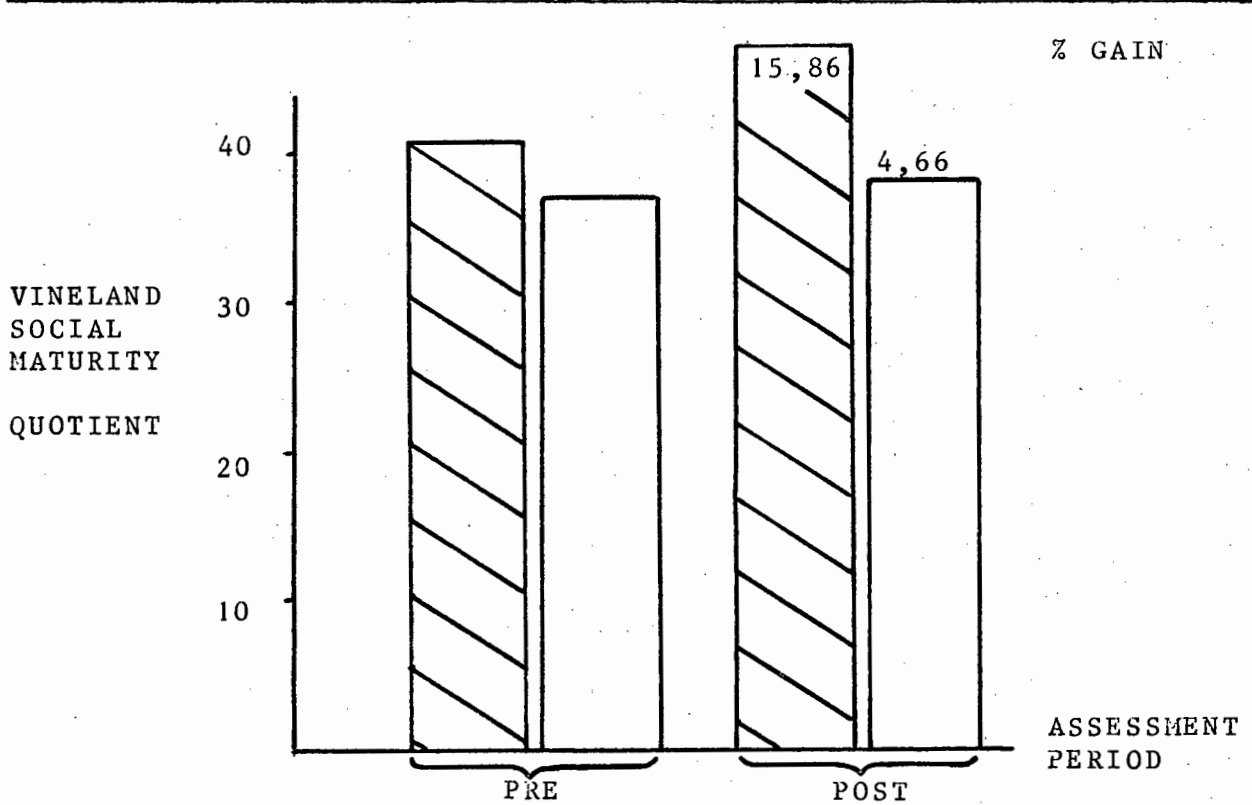


FIGURE 17

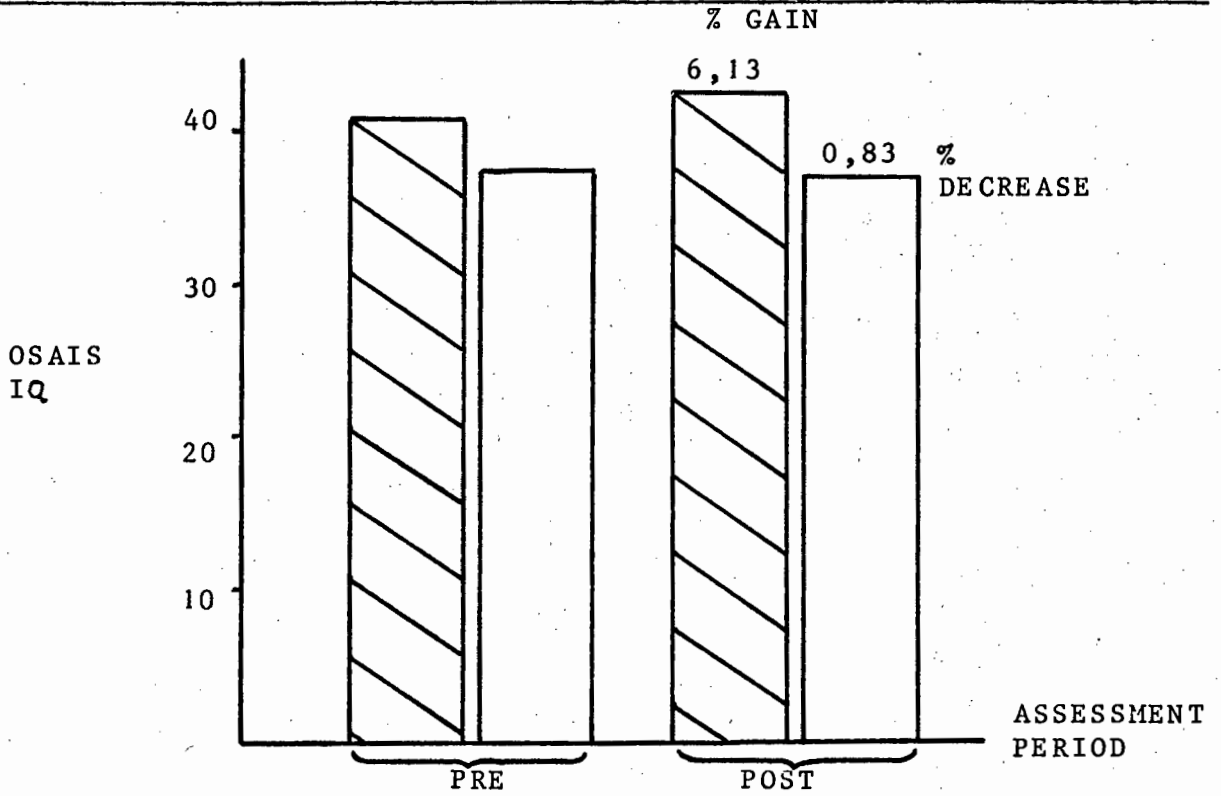
HISTOGRAM OF VINELAND SOCIAL MATURITY QUOTIENT BEFORE AND AFTER PROGRAMME



93  
FIGURE 18

HISTOGRAM OF OSAIS INTELLIGENCE QUOTIENTS

BEFORE AND AFTER EXERTION THERAPY PROGRAMME



DYNAMIC PHYSICAL EXERTION THERAPY

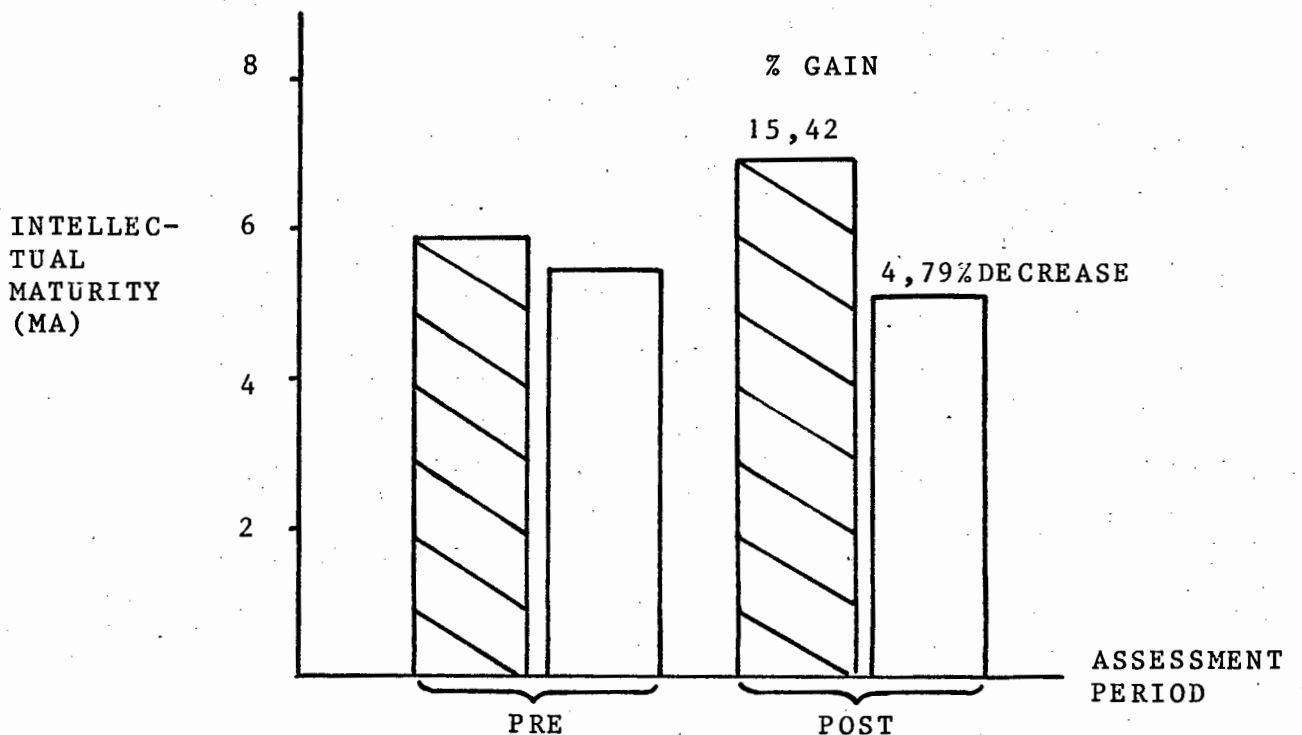


STATIC PHYSICAL EXERTION THERAPY

FIGURE 19

HISTOGRAM OF GOODENOUGH INTELLECTUAL

MATURITY BEFORE AND AFTER PROGRAMME



### Degrees of association among variables

Overall difference score correlations for the physiological measures were statistically significant at the 1% level of confidence. Decreases in HR rest were significantly associated with decreases in HR submaximal and increases in  $VO_2$  max estimate. The highly significant correlation of  $r = -0,865$  between HR submaximal decrease and  $VO_2$  max estimate increase is depicted in Figure 20. At the 5% level of confidence overall correlations between HR submax and OSAIS,  $VO_2$  max estimate and OSAIS, and OSAIS and DAP difference scores achieve statistical significance. Figure 21 shows the positive correlations of  $r = 0,372$  between OSAIS and DAP difference scores.

The negative association between  $VO_2$  max estimate and OSAIS difference scores was of specific interest and is displayed in Figure 22. Overall difference score correlations among all variables are summarized in Table 8.

Among the variables of the dynamic condition, correlations for the physiological measures clearly dominated the picture. Table 9 gives an overview of the correlations for that condition. Correlations between psychological, and psychological and physiological variables were statistically insignificant.

Only the difference score correlation between  $VO_2$  max estimate and the HR submaximal was found to be statistically significant for the static condition at the 1% level of confidence. There existed a negative significant correlation at the 5% level of confidence between  $VO_2$  max

estimate and OSAIS difference scores. Table 10 highlights these findings.

TABLE 3

SUMMARY TABLE OF OVERALL DIFFERENCE SCORE CORRELATIONS AMONG ALL VARIABLES

	H R R R E S T	H R S U B M A X	V O <sub>2</sub> M A X E S T	V I N E L A N D	O S A I S	D A P
HR REST	1,000					
HR SUBMAX	0,532+	1,000				
VO <sub>2</sub> MAX EST	-0,568+	-0,865+	1,000			
VINELAND	0,157	-0,150	0,043	1,000		
OSAIS	0,288	0,347++	-0,376++	0,071	1,000	
DAP	-0,025	-0,170	0,134	0,098	0,372++	1,000

+ p < 0,01

++ p < 0,05

TABLE 9

SUMMARY TABLE OF DIFFERENCE SCORE CORRELATIONS AMONG VARIABLES OF THE DYNAMIC CONDITION

	HR REST	HR	HR SUBMAX	VO <sub>2</sub> MAX EST	VINELAND	OSAIS	DAF
HR REST	1,000						
HR SUBMAX	0,712+	1,000					
VO <sub>2</sub> MAX EST	-0,845+	-0,918+	1,000				
VINELAND	0,076	-0,285	0,201	1,000			
OSAIS	0,383	0,321	-0,259	0,083	1,000		
DAF	-0,063	-0,301	0,264	0,162	0,447	1,000	

+ p < 0,01

TABLE 10

SUMMARY TABLE OF DIFFERENCE SCORE CORRELATIONS AMONG VARIABLES OF THE

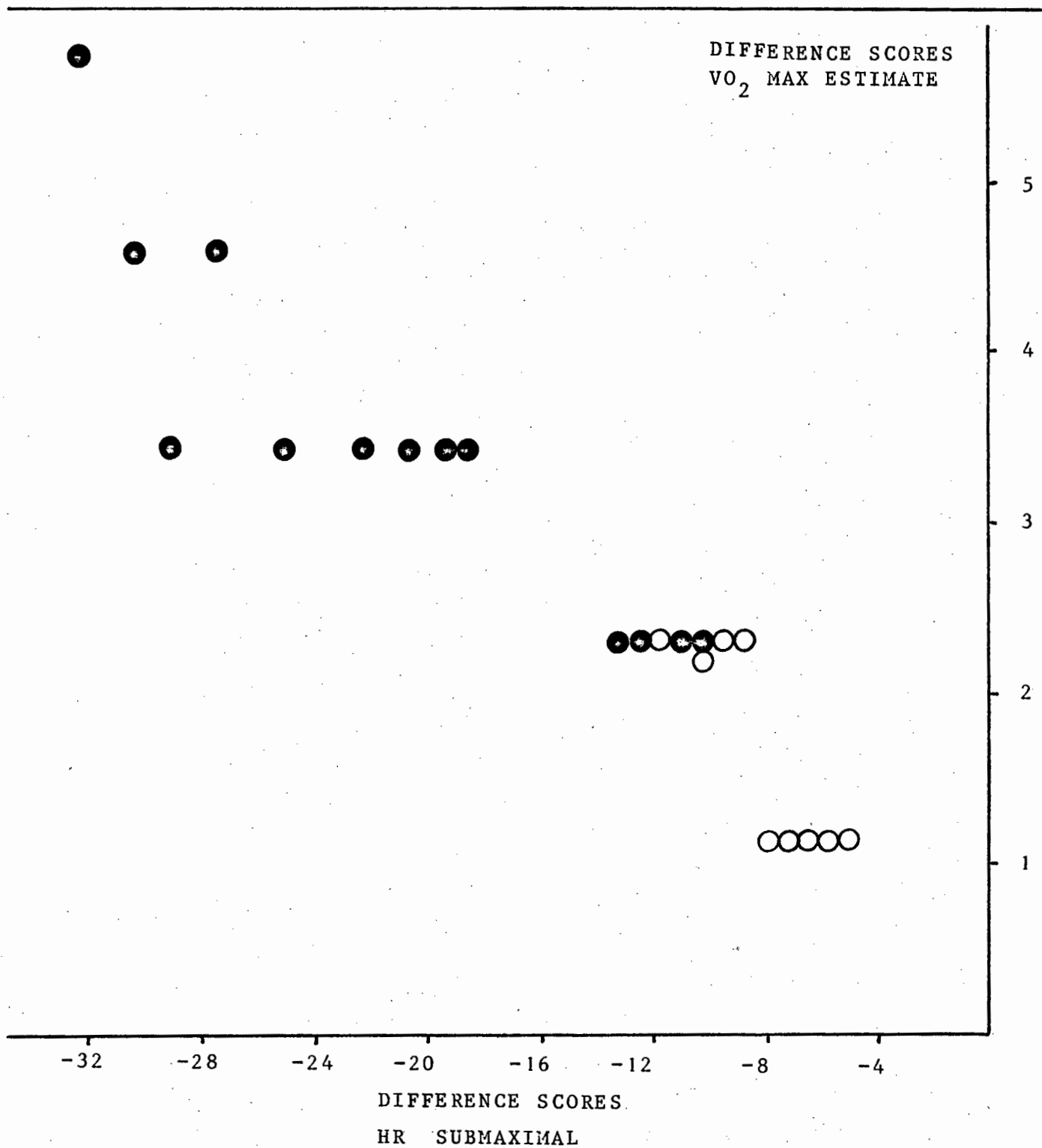
STATIC CONDITION

	HR REST	HR SUBMAX	VO <sub>2</sub> MAX EST	VINELAND	OSAIS	DAP
HR REST	1,000					
HR SUBMAX	-0,006	1,000				
VO <sub>2</sub> MAX EST	-0,145	-0,907+	1,000			
VINELAND	0,345	0,370	-0,246	1,000		
OSAIS	0,191	0,523	-0,496++	0,299	1,000	
DAP	0,045	0,217	-0,57	-0,038	0,305	1,000

+ p < 0,01    ++ p < 0,05

FIGURE 20

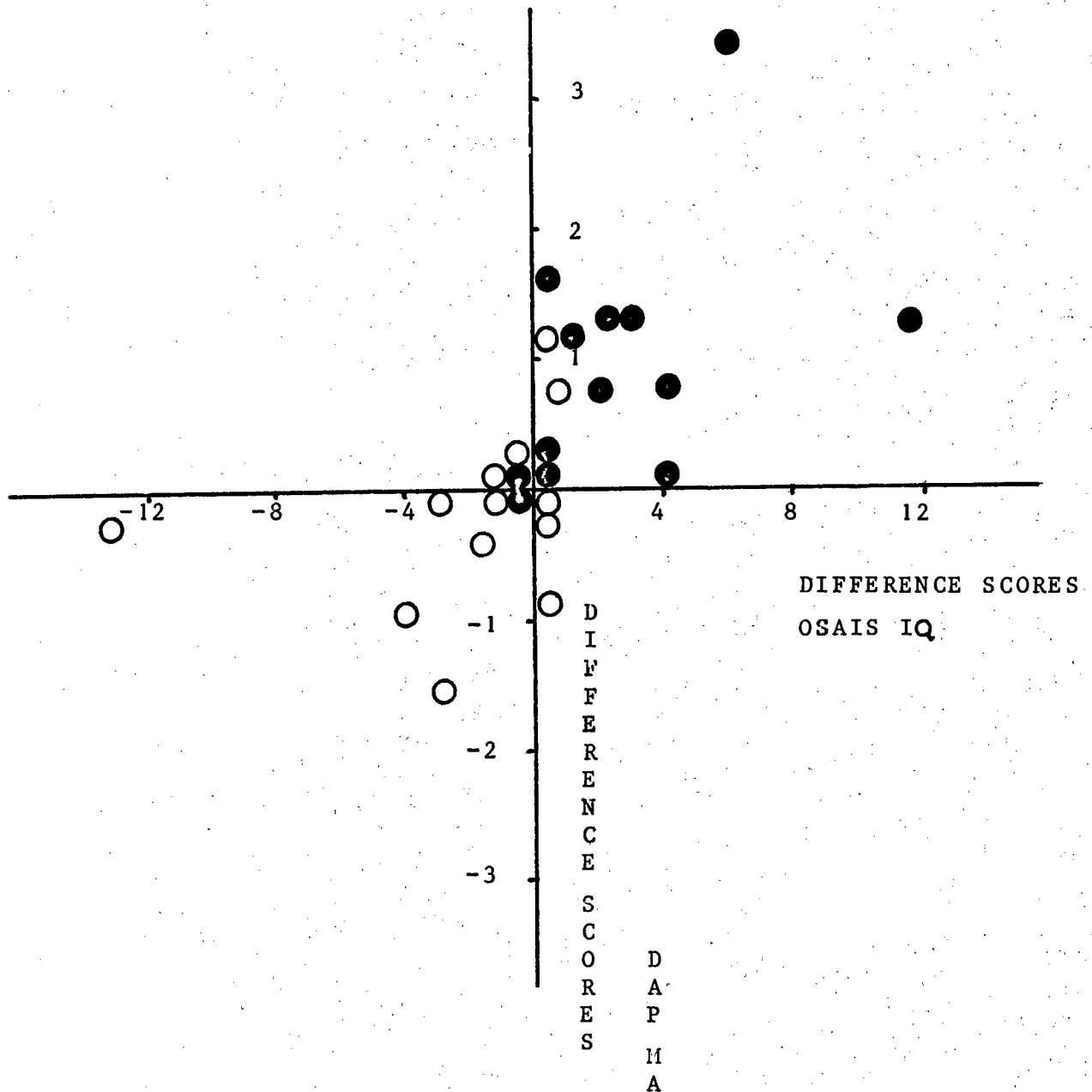
SCATTER DIAGRAM OF DIFFERENCE SCORES  
FOR VO<sub>2</sub> MAX ESTIMATE AND HR SUBMAXIMAL



- Dynamic physical exertion condition  $r = -0,918$
- Static physical exertion condition  $r = -0,907$
- $r$  Combined =  $-0,865$

FIGURE 21

SCATTER DIAGRAM OF DIFFERENCE SCORES FOR OSAIS IQ  
AND DAP INTELLECTUAL MATURITY

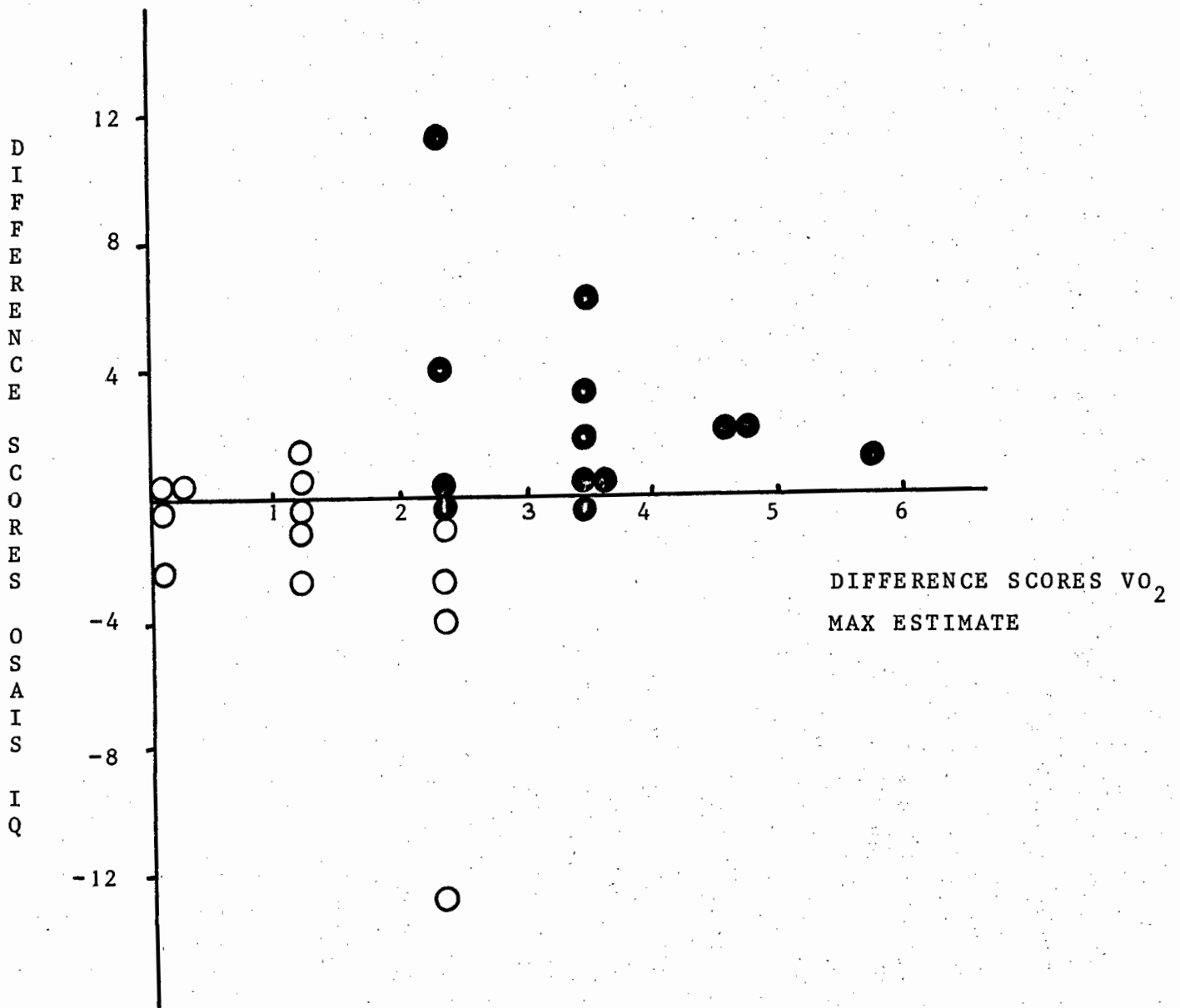


- Dynamic physical exertion condition  $r = 0,447$   
○ Static physical exertion condition  $r = 0,305$   
 $r$  Combined =  $0,372$

FIGURE 22

SCATTER DIAGRAM OF DIFFERENCE SCORES FOR

VO<sub>2</sub> MAX ESTIMATE AND OSAIS IQ



● Dynamic physical exertion therapy condition  $r = -0,259$   
 ○ Static physical exertion therapy condition  $r = -0,496$   
 $r$  Combined =  $-0,376$

## DISCUSSION

The overall trend of the results is convincing. All but the last hypothesis have been confirmed. Changes brought about by the physical exertion therapy dominate the picture. Static physical exertion therapy generated positive physiological changes, but failed to reach persuasive positive advances in two of the three psychological criteria.

A detailed examination of the transformations recorded for both treatment conditions follows.

### Physiological changes

The Hotelling's  $T^2$  analysis involved the statistical comparison of difference scores from the two treatment conditions. As hypothesised difference scores reported for the dynamic condition were far greater than those for the static condition. This finding was expected on theoretical grounds and its implications will be elaborated on at a later stage. The percentage change recorded for the physiological measures agrees with what can be expected of a programme of such intensity and duration (Wyndham, Strydom, Van Rensburg and Benade, 1969). The average heart rate of the children dropped by 10 beats per minute at rest and by 21 beats per minute at submaximal workload accentuating the increased efficiency of the heart as a pump (training increases the maximal heart stroke volume, allowing increased cardiac output with a slower heart rate). In the static condition an average

reduction of 3-4 and 7 beats per minute for the pulse rate at rest and submaximal workload respectively make up a statistically significant change from the pre- to the post measurement, yet these changes do not rise to the level of changes revealed for the dynamic condition.

Maximal oxygen intake rates for the dynamic condition rose by an average of 3,439 ml/kg x min. Although  $VO_2$  max was obtained by means of an estimate calculation the 9,17% rise is in agreement with maximal percentage increases found by other researchers (Astrand and Rodahl, 1977).

This expansion shows a significant improvement in aerobic fitness. Frederick and Henderson (1974) accept a level of about 40 ml/kg x min as a minimum standard of everyday fitness. This level tends to vary with age and sex of the individual. An average 20-year old male reaches 44 ml/kg x min, a female about 40 ml/kg x min (Pyke, 1978). Once the programme was completed the children in the dynamic condition exceeded the level of  $VO_2$  max regarded as a minimum standard of everyday fitness for normal 20-year olds. Although a 3,49% gain was achieved by children in the static condition, their average level of  $VO_2$  max estimate remained below the minimum level of physical fitness stipulated above. As the children's age range was considerable, the obtained estimates have to be looked upon as relative measures of increase in fitness, rather than absolute fitness levels.

The physiological adaptations are statistically significant for both groups, yet, when one has the choice between dynamic and static physical exertion exercises and is aiming for rapid yields in fitness, the obvious choice is dynamic physical exertion exercise. This result corroborates the hypothesis that physiological changes in response to the dynamic physical exertion therapy will be larger than those in response to the static physical exertion therapy.

The effort and problems experienced in the administration of the treatment techniques will be discussed in subsequent sections.

#### Psychological changes

Comparison of the psychological measures uncovers a different picture. Percentage increases for social and intellectual maturity of 15,86% and 15,42% registered for the dynamic condition are impressive and indicative of the influence physical exertion can have on the children's proficiency in respect to self-help, locomotion, communication, and general social maturation. The same trend was found for the OSAIS IQ scores, rising by an average of 2½ points (6,13%). All of these gains were statistically significant.

In response to the static physical exertion therapy programme the children's social maturity quotient on average accumulated 2 more points (4,16%). This is the only statistically significant change for the static condition.

Contrary to expectations minor decreases occurred on the two IQ indexes of 0,83 and 4,79%, thus the fifth

hypothesis has only partially been supported. The growth in social maturity underlines the children's progressive capacity for caring for themselves and for participating in activities that lead to an increasingly independent life-style. This progress was conjectured to go hand in hand with increases in general intellectual functioning, as Schroth (1975) found IQ to determine the rate of learning a task. The slight decreases did not make up statistically significant results. That means although a drop in IQ and intellectual maturity was unexpected, the change from pre- to post treatment measures can be attributed to random sampling variation.

#### Associated changes.

Physiological transformations occurred hand in hand: for all 3 measurements overall difference correlations turned out statistically significant. Particularly powerful was the degree of association between HR submaximal and  $VO_2$  max estimate changes. As the children's pulse rate at submaximal workload decreased with progressive fitness training their aerobic capacity rose resolutely. The greater the drop in HR submaximal, the greater the gain in  $VO_2$  max estimate. These outcomes stress the documented usefulness of heart rate at submaximal workload and maximum oxygen intake rate as measures of physical fitness.

A moderately strong relationship was found to exist between changes in OSAIS IQ and DAP intellectual maturity. Increases in IQ were matched to a relatively equal degree

by increases in intellectual maturity, and vice versa. This result substantiates the combined use of the two scales as practiced at Alexandra Care and Rehabilitation Centre.

Proportional increases were expected to show up in physical fitness and intellectual functioning. This did not occur. A large gain in physical fitness sometimes initiated only a slight growth in intellectual functioning.

Fluctuations like the one mentioned above and those recorded for the two treatment conditions separately may be attributable to the divergence within the population of children classified as mentally subnormal. It has been decisively established that dynamic physical exertion therapy brings about consequential improvements in physical fitness as well as social and intellectual functioning of mentally subnormal children, but to what proportion these advances will occur in the individual diagnostic classificatory sets has to be determined by future concentrated research. Genetic, prenatal and environmental causes of mental retardation impose dissimilar perimeters on the beneficial impact of dynamic physical exertion therapy.

#### Critical commentary on the programme

One of the main purposes of conducting research is to obtain answers to questions.

The question is: have the appropriate questions been answered?

The executed treatment conditions certainly supplied definite material to answer the question what kind of exercise brings about significant improvements in physical fitness and social and intellectual functioning of mentally subnormal children. The next question is: were the optimal assessment tools used?

Heart rate at various workloads renders a reliable measure of physical fitness. This has been documented extensively in the introduction. Maximal oxygen consumption rates measured by indirect calorimetry do the same. But  $VO_2$  max measurement by calorimetry proved an impossibility. Estimate calculation of  $VO_2$  max offered a fitting alternative. The method was relatively simple, evoking no fear or anxiety in the subjects when tested. Nevertheless, the formula used tends to underestimate the aerobic power of youngsters and overestimates those of older people (Daniels, cited in Frederick and Henderson, 1974). This could be discouraging if the estimate is seen as an absolute measure of aerobic capacity. Fortunately, in this study  $VO_2$  max estimates served as an index of change in the aerobic power of mentally subnormal children. For that purpose the  $VO_2$  max estimate furnished a legitimate measure. Even when one deals with normal subjects the calorimetry method of obtaining the  $VO_2$  max is intricate and can only be performed in a well-equipped laboratory. Older individuals and persons with respiratory diseases should not be asked to perform a maximal test. With this in mind Astrand and Ryhming (1954) developed a nomogram for calculation of aerobic capacity from pulse rate during

submaximal workload. This method offers a further alternative to calorimetry. It has to be noted, however, that the nomogram is based on results from experiments with healthy subjects 18-30 years of age and the validity of the nomogram when testing younger or subnormal children is as yet not known. To obtain  $VO_2$  max estimate the children were to run as far as possible in 15 minutes. This raises the question whether the required task was too motivationally demanding? Did the children slow down at an early onset of fatigue and stop trying harder? This did not happen. Judging from the effectiveness of the constant verbal encouragement and the enthusiastic reception "races" enjoyed it can be said that the children gave what they possibly could. Martens, Burmitz and Newell (1972) emphasised how far verbal reinforcement facilitates performance after the skill has been learned. As the introductory programme catered for the learning of the novel motor skills, the assessment period took place when verbal reinforcements attained a significant role not only in keeping the children at their tasks but also in maintaining positive interpersonal relations between the children and the experimenter. Motivation was at a peak during testing periods. Speakman (1977) lists several specially developed physical fitness tests for the mentally subnormal. Of these the most widely used is the Special Fitness Test published by the American Alliance for Health, Physical Education and Recreation (AAHPER). The norms of the AAHPER test are considered to be American national norms. As incentives and recognition to children who demonstrate amelioration

on the Special Fitness Test, AAHPER sponsors an awards programme. This is seen as a very effective way of keeping the mentally subnormal child interested in keeping fit. Tests like the above-mentioned were developed as motor fitness tests for normal individuals did not prove suitable for several reasons. Items on normal fitness tests were found to be too difficult physically as well as too complex for mentally subnormal children to perform. To produce absolute maximal effort the subject has to be extremely motivated. Access to the Physiology Laboratory made special tests superfluous.

The levels of physical fitness before the programme were naturally quite diverse. This raises the question whether each child was in the position to improve his performance in equally substantial ways. Wells and Baumgarten (1974) report on the Hales' exponential method for evaluating improvements according to the difficulty of progressing which is determined by the individual's initial performance:

An individual with a very good initial performance is less likely to improve his score the vast amount that an individual with a poor initial performance. Thus, in the Hales' method, the better the individual's initial score the more credit he is given for progressing any fixed amount. (p.460)

The Hales' method provides a practical alternative to the use of absolute final improvement measures and, at the same time, offers an unprejudiced measure for relative progress. Its applicability to studies involving mentally

subnormal subjects has yet to be examined. The range of improvement in physical fitness in the present investigation was multiform, yet the level of functioning at the onset was generally low so that the question of bias against probable initial high performances and their relatively narrow range for improvement did not materialize.

Nevertheless, the exponential method by Hale and Hale raises a pertinent issue. Could a similar method be validly applied to the psychological improvement scores? For example, does a child with an IQ of 110 have the same range of improvement as a child with an IQ of 80? An exponential method seems feasible in regard to the implications of the concept of the normal distribution of psychological measures like IQs for example. The absolute range of improvement for high achievers certainly has a limit, but does the low achiever necessarily possess a larger range? For psychological dimensions it appears deducible to attribute the widest range of possible improvement to those situated in the middle. The question warrants research.

The psychological measures utilized in the present study brought one major advantage with them. It was credible to compare the relative change due to physical exertion programme to the standing records of the children's change during their stay at the Alexandra Care and Rehabilitation Centre. In consultation with the resident Psychologist it was noted that no major changes occurred in the past four years on all scales used in the assessment of the children. During the time of the programme children not partaking

had the afternoon to play with the nursing staff in attendance. This was a regular event within the children's daily schedule. Unchanged intellectual and social functioning over the long periods of time reported and the afternoon play time made the establishment of a special control group expendable.

The question that remains to be answered is whether the psychological scales used were sensitive enough to detect the changes that were taking place in the children during the intervention.

The Vineland Social Maturity Scale turned out to be the most competent instrument providing the experimenter with a responsive qualitative index of variation in development as well as a measure of improvement following the treatment. The scale concentrates on the detailed detection of fluctuations in adaptive behaviour. To facilitate administration the particular items of the scale are arranged according to general similarity of content. This makes the scale a sound instrument for relatively quick appraisal of the position of the subject examined in respect to each of the major aspects of social competence. Doll (1965) emphasised that possible limitations imposed by intelligence level, emotional attitudes, social conditioning and disposition are postulated to be adequately reflected in the scale itself and need not be otherwise allowed for.

OSAIS intelligence quotients and Goodenough intellectual maturity scores exhibited a fair amount of change. Reservations about these instruments were nevertheless expressed by the resident Psychometrist testing the children. The

to be available. In such a situation the DAP may supply important additional evidence of severe intellectual and conceptual retardation.

Here the major function of the DAP was seen as a supportive measure to the OSAIS. Harris (1965) advanced an adaptation of the original test with ample evidence to show that the child's drawing reflects his concepts which grow with his mental level, experience and knowledge. Harris (1965), and Gilbert (1980) support the use of the DAP to get an initial impression of a child's general ability level. In that way the DAP was utilized in the present investigation. As most children like to draw, the test proved to be valuable in gaining the child's co-operation for more complex tasks to follow.

It would have been desirable to be in the position to make conclusive statements about the performance of individual diagnostic classificatory groups, but the sample size inhibits this. Mental retardation is not understood as a disease entity, but a combination of symptoms derived from genetic and/or nongenetic causes. Of interest would be whether physical exertion therapy has similar effects on such distinct populations as for example children classified as Down's syndrome or epileptic. As parental approval had to be obtained the already limited number of subjects was further reduced to 32. Future studies will have to concentrate on the comparison of unvarying populations within the overall category of mental retardation.

### Implications and need for future research

The present study has shown that a programme of intense physical activity can make an important contribution to the physical, social and intellectual development of mentally subnormal children. Although a growing number of researchers have become involved in the field of physical education for the mentally subnormal child, many questions have remained open.

It is thus of utmost importance that the effort which has been made to study the effects of intense physical exercise on mentally subnormal children be continued. Urgently needed are more well-planned, fully controlled and clearly structured experimental designs. This present study was set out to contribute to this need.

The marked overall improvement in physical fitness in both dynamic and static physical exercise groups confirms the research undertaken by Oliver (1958), Corder (1966), Solomon and Pangle (1978), and Geddes (1968), that the physical fitness levels of mentally subnormal children can be increased through a programme of physical education.

The results of researchers who have tried to establish the effect of improved physical fitness on social maturity and intellectual levels have not been entirely conclusive. This may be in part due to the following inconsistencies.

Many researchers have used the terms motor ability, motor fitness, cardiovascular fitness, physical proficiency, motor efficiency, motor skill, cardiovascular endurance etc.

as synonymous and have failed to recognise that these terms need to be defined and that they measure quite different characteristics ("Recreation and Physical Activity", 1966). The use of specific criteria to measure physical fitness would avoid much confusion.

Several researchers (Oliver, 1957; Salvin, 1958; Tofte, 1950) have based their conclusions on personal impressions. Although improved behaviour traits, e.g., greater enthusiasm and initiative are difficult to measure, a greater use must be made of standardized tests. If these tests prove to be inappropriate in measuring the subtle changes that have been observed, specific diagnostic tools need to be developed to incorporate these characteristics. A demand arises to be able to measure or determine the effect of participation on body-image, confidence, co-operation, helpfulness, and self-concept.

As one works with severely and profoundly retarded persons and notes their responses to people and things - and they do respond, although the response may be only a slight fleeting smile or a frown, a flicker of the eyelid, a brief visual tracking of an object, or intensification of already apparent withdrawal - one realizes that some thought processes are in action. In most instances their cognitive development surpasses that of a neonate, yet because it is difficult to elicit their responses to standard test items, they frequently are regarded as untestable and are treated as though they operate from an intellectual vacuum.

However, if one observes their behaviour and locates the level and type of observed activity on a scale of cognitive development, an individually appropriate basis is supplied for interaction with objects and people.

(Stephens, 1976, p.174)

Layman (1972) believes that some experimenter bias could be removed by making use of "blind" evaluations in test situations.

Ricki (1976) found that the experimenter's sex, age, appearance, personality and knowledge of expected outcome may have a definite influence of the behaviour of subjects. Harney and Parker (1972) came to similar conclusions. In the present study the resident Psychometrist was not involved in the execution of the programme and was called in only to administer the testing. The psychological measures can therefore be regarded as objective.

The difference in sample size and sample population may also contribute to the varying outcomes of research that set out to test the effect of a physical education programme on the social and intellectual development of mentally subnormal children. As the group of mentally subnormal children is so very heterogeneous in composition, subjects chosen merely on IQ may produce misleading results. Children matched on IQ may have completely different potentials for improvement due to the origin or cause of their ability. Cox (1979) described the positive changes of only two subjects, and Keogh and Oliver (1966) worked

with only 10 boys. More desirable studies have involved sample sizes up to 30. Availability of children matched on age, sex and diagnostic classification present in the same institution or school presents a problem. With the right funding it should be feasible to conduct research over a broader range.

Problems that have been met by workers in their research on the relationship between physical fitness and intellectual development have been listed by Ismail (1972). He believes the problems to be the result of failure to take into account the preceding experience of the child relative to the test items, to standardize procedures for the management of test items, to reflect on the quality of measurement as well as the quantity and to carefully choose a good design.

Oliver (1958) who found that he had significantly improved physical fitness and intelligence test scores of mentally subnormal boys after an extensive 10-week training programme believed the results to be largely due to emotional factors: a combination of the improved feeling of well-being due to the increased fitness and improved confidence gained by experiencing challenges and succeeding to overcome them, as well as a general feeling of importance by taking part in the programme and being given added attention. It is likely that all of the above factors played a role in the improvement of social and intellectual functioning of the children in the present study.

Courses in the general education of the child should not be seen in isolation:

Physical education should be conceived rather as an angle of approach, a particular viewpoint for the scanning of the child as a whole. An awareness of the physical approach should be present in the minds of all teachers whatever their specialisms.

(Tibble, cited in Oliver, 1957, p.34)

Physical ability and social maturity in the mentally subnormal child are components that will contribute to a successful occupation in a sheltered environment. It is therefore very important that a greater emphasis be placed on physical education programmes and far more time devoted to physical activity. Much greater physical demands should be made on these children.

Running is our fastest method of moving and is a vital constituent of many physical education and recreational activities. This programme has helped many children to learn to run or to run faster and more efficiently. This has wide implications in accommodating mentally subnormal children in recreational activities which in turn contributes to the social and emotional needs of the participant.

The present study involving mentally subnormal children in intensive physical training sessions lasted over a period of six months. This is far longer than most research undertaken in this field. As both Corder (1966)

and Oliver (1958) recorded increases in mental scores after four weeks and 10 weeks of training respectively, further research needs to be undertaken to assess if there is an optimum length of programme which allows for maximum gain in social maturity and intellectual functioning. Further, studies need to be undertaken to determine the amount of physical exercise necessary per session and its duration in relation to the general daily activities.

No conclusive cause and effect relationship has as yet been offered in the studies undertaken to improve social and intellectual maturity through physical activity in mentally subnormal children, but some interesting research is presently being undertaken in the biochemical world. Forrester (1979) has been able to show that active skeletal muscle, cardiac muscle and brain tissue are capable of affecting the rate of flow of blood in these regions by the release of a large number of the complex molecules ATP. Experiments done on cats and baboons showed that when  $10^{-6}$  mole/min of ATP was infused into the carotid artery the blood flow to the brain was doubled. Of high interest and significance to the present study was the finding that the oxygen consumption increased by one and a half times after the addition of the ATP. Forrester points out that it might be possible for circulating ATP molecules and its derivatives to enhance the arterial blood flow sufficiently and hence influence cerebral functioning. The ancient saying of "mens sana in corpore sano" may soon find more direct application in the educational programme of the mentally subnormal child.

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APPENDIX

Copies of the "Test Manuals" for the OSAIS and Goodenough Draw-A-Man Test are filed as they were specific adaptations used at Alexandra Care and Rehabilitation Centre.

The Vineland Social Maturity Scale manual was employed in its original 1965 edition.

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(Z 14)

G.P.-S. (F-B)

REPUBLIEK VAN SUID-AFRIKA



REPUBLIC OF SOUTH AFRICA

Verw. Nr./Ref. No. M.S.31

NAVRAE/ENQUIRIES: DR. BERRANGÉ

Tel. No. 51-2141

KANTOOR VAN DIE—OFFICE OF THE  
ALEXANDRA CARE AND REHABILITATION CENTRE  
PRIVATE BAG XI  
MAITLAND

7405

8th September, 1980

Mr. H.H. Schomer  
Department of Psychology  
University of Cape Town  
RCNDEBOSCH  
7700

Dear Mr. Schromer

APPLICATION TO CONDUCT CLINICAL RESEARCH

The Department of Health, Welfare and Pensions has approved your application to conduct clinical research at this Centre. Your attention is drawn to the remarks in Paragraph C of the attached copy of your application.

Yours faithfully

MEDICAL SUPERINTENDENT

# UNIVERSITY OF CAPE TOWN

(WITH WHICH IS INCORPORATED THE SOUTH AFRICAN COLLEGE)

DEAN & PROFESSOR OF MEDICAL EDUCATION

PROFESSOR D. MCKENZIE  
M.B., Ch.B., M.Med. (Path.) (CAPE TOWN), Dip.Bact. (LOND)

TELEPHONE 55-8969



THE DEAN OF THE FACULTY OF MEDICINE

MEDICAL SCHOOL

OBSERVATORY 7925

CAPE

8 August 1980

Mr. Hein Helgo Schomer  
Department of Psychology  
University of Cape Town

Dear Mr. Schomer

I am pleased to inform you that no objection has been raised by the Core Committee of the Ethical Review Committee to the investigation proposed by you to evaluate the applicability of Exertion Therapy to sub-normal children.

Yours sincerely

A handwritten signature in black ink, appearing to read 'J P de V. van Niekerk'.

Dr. J P de V. van Niekerk  
Chairman - ERRRA Committee

81/172589  
(Z. 14.)

REPUBLIEK VAN SUID-AFRIKA.



REPUBLIC OF SOUTH AFRICA.

Verw. Nr./Ref. No.

NAVRAE: ENQUIRIES: DR. BERRANGÉ

Tel. No 51-2141

KANTOOR VAN DIE—OFFICE OF THE  
ALEXANDRA CARE AND REHABILITATION CENTRE  
PRIVATE BAG XI  
MAITLAND  
7405

31st March, 1980

H.H. Schomer Esq.  
Department of Psychology  
University of Cape Town  
RONDEBOSCH  
7700

Dear Mr. Schomer

MASTER'S THESIS

Thank you for your letter of the 19th March, 1980.

You are welcome to do your project at this Centre. Would you please contact Mr. Francois Schrödel regarding ages, diagnoses and numbers of patients required, so that he can help you get started?

Before you commence the project, please send me details of your proposals.

Yours sincerely

MEDICAL SUPERINTENDENT

TEL: 51-2141

Alexandra Care and Rehabilitation Centre  
Private Bag X1  
MAITLAND  
7405

1980 June 18

Dear Mr/Mrs *M. V. H. Wiggett*.....

We would like ... *MARC SIDNEY*... to be included in a program of physical exercise which will be conducted over a six month period. The aim of this program is to investigate the possible effect of physical exercise on mental functioning.

At no cost you he/~~she~~ will be taken by us to the Medical Faculty at the University of Cape Town before the program starts and after six months in order to be physically assessed.

We would really appreciate your consent for him/~~her~~ to participate in this program and to be transported to and from the Medical Faculty.

Kindly complete the bottom part of this letter and return in the enclosed envelope as soon as possible.

If you require any further information, please contact Mr. F. Schrödel, our Clinical Psychologist.

Yours sincerely

*F. Schrödel* ←

MEDICAL SUPERINTENDENT

I, *MARC SIDNEY*... the parent / guardian of *MARC SIDNEY WIGGETT* hereby give my consent that he/she be included in the physical exercise program.

SIGNED: *M. V. H. Wiggett* DATE: *22/7/80*

*M. V. H. WIGGETT (MRS.)*

*No sorry we are on holiday in Transvaal & this has just reached us. Thank you Mrs Wiggett*

APPENDIXList of SubjectsDynamic physical exertion therapy group

	3 months of therapy		3 months of therapy		
Belinda Gerre	} GROUP 1	}	COMBINED GROUP A		
Teresa Thiart					
Talana Hanekom					
Tascha de Ronde					
Imelda Ellard	} GROUP 2			}	COMBINED GROUP B
Mercia Meyer					
Mathilda Van Rhyn (Elize Burger) <sup>+</sup>					
Jonathan Petzer	} GROUP 3	}	COMBINED GROUP B		
Christian Lourens					
Stephanus Swart (Mark Kaesner)					
Wayne O'Gorman	} GROUP 4			}	COMBINED GROUP B
Pieter Van Zyl					
Johannes Geldenhuys (Marius Pretorius)					

<sup>+</sup> Subjects listed in ( ) had to be withdrawn from the programme during the first 3 months of exertion therapy for various reasons. (See METHOD section).

Static physical exertion therapy group

	3 months of therapy	3 months of therapy
Babeth Van Schalkwyk Zelda Groenewald Cornelia Stevenson Debbie Fouche	GROUP 5	COMBINED GROUP C
Catherine Germishuys Johanna Coetzee Debra Jooste (Maritza Stolz)	GROUP 6	
Garth Kiekemoer Leon Lourens Gary Broadway (Pieter Loubser)	GROUP 7	COMBINED GROUP D
Jacques Prins Gerbus Louw Mathys Du Toit (Gert De Wet)	GROUP 8	

APPENDIXHEART RATE AT REST

	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	1	81	69	-12
	2	101	90	-11
	3	83	74	-9
	4	89	80	-9
D	5	90	82	-8
Y	6	89	81	-8
N	7	81	75	-6
A	8	90	77	-13
M	9	83	74	-9
I	10	89	81	-8
C	11	69	60	-9
	12	88	81	-7
	13	76	59	-17

	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	14	104	98	-6
	15	84	82	-2
	16	84	82	-2
	17	90	87	-3
S	18	82	76	-6
T	19	99	92	-7
A	20	91	90	-1
T	21	89	84	-5
I	22	94	92	-2
C	23	92	88	-4
	24	94	91	-3
	25	84	81	-3
	26	80	80	0

APPENDIXHEART RATE AT SUBMAXIMAL WORKLOAD

	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	1	170	140	-30
	2	182	169	-13
	3	159	132	-27
	4	170	151	-19
D	5	140	118	-22
Y	6	160	141	-19
N	7	145	132	-13
A	8	152	125	-27
M	9	166	141	-25
I	10	151	140	-11
C	11	141	121	-20
	12	163	152	-11
	13	142	110	-32

	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	14	181	173	- 8
	15	130	120	-10
	16	170	164	- 6
	17	185	180	- 5
S	18	163	152	-11
T	19	175	175	0
A	20	190	186	- 4
T	21	181	172	- 9
I	22	171	164	- 7
C	23	131	121	-10
	24	140	136	- 4
	25	162	156	- 6
	26	139	132	- 7

APPENDIXVO<sub>2</sub> MAXIMAL ESTIMATE

	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	1	39,09	43,68	4,59
	2	33,36	35,65	2,29
	3	33,36	36,8	3,44
	4	35,65	39,09	3,44
D	5	39,09	42,53	3,44
Y	6	39,09	42,53	3,44
N	7	32,21	34,5	2,29
A	8	45,97	50,56	4,59
M	9	33,36	36,7	3,34
I	10	36,8	39,09	2,29
C	11	33,36	36,7	3,34
	12	33,36	35,65	2,29
	13	50,56	56,29	5,73
	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	14	33,36	34,5	1,14
	15	33,36	35,65	2,29
	16	39,09	40,24	1,15
	17	28,77	28,77	0
S	18	37,94	40,24	2,30
T	19	25,33	25,33	0
A	20	32,21	32,21	0
T	21	28,77	31,06	2,29
I	22	27,62	28,77	1,15
C	23	35,65	37,94	2,29
	24	34,5	34,5	0
	25	39,09	40,24	1,15
	26	31,06	32,21	1,15

APPENDIXVINELAND SOCIAL MATURITY QUOTIENT

	SUBJECT	PRE-SCORE	POST SCORE	DIFFERENCE SCORE
	1	60	67	7
	2	26	29	3
	3	59	70	11
	4	30	36	6
D	5	30	33	3
Y	6	40	57	17
N	7	35	38	3
A	8	41	48	7
M	9	28	35	7
I	10	41	43	2
C	11	54	61	7
	12	29	34	5
	13	44	48	4
	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	14	73	68	-5
	15	39	39	0
	16	26	29	3
	17	37	39	2
S	18	48	50	2
T	19	17	21	4
A	20	30	32	2
T	21	37	39	2
I	22	17	20	3
C	23	40	41	1
	24	36	39	3
	25	44	44	0
	26	28	33	5



APPENDIXGOODENOUGH INTELLECTUAL MATURITY

	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	1	7,3	8	0,7
	2	3	3	0
	3	5	6,6	1,6
	4	4,7	5	0,3
D	5	6,6	7,9	1,3
Y	6	7,3	8,0	0,7
N	7	5,6	6,9	1,3
A	8	6,0	7,3	1,3
M	9	3	3	0
I	10	6,6	6,6	0
C	11	5,6	9	3,4
	12	4,3	4,3	0
	13	10,9	12	1,1

	SUBJECT	PRE-SCORE	POST-SCORE	DIFFERENCE SCORE
	14	3	3	0
	15	6	5	-1
	16	3	3	0
	17	5,6	5,3	-0,3
S	18	8,9	7,3	-1,6
T	19	3	3	0
A	20	3	3	0
T	21	5,4	6,6	1,2
I	22	3,9	3,9	0
C	23	7,9	7,6	-0,3
	24	6	5	-1
	25	10,3	11	0,7
	26	3	3	0

FILE NAME \* CTSPR\$\$\$\$\$\$

```

90 DIM H(10),S(10,10),A(4)
100 DIM T(10,10),U(10),Y(10),X(10)
110 PRINT
120 PRINT
130 PRINT
140 PRINT 'HOTELLING'S TSQ TEST FOR INDEPENDENT SAMPLES'
150 PRINT
160 PRINT 'NO OF VARIABLES (MAX=10) ' ;
170 INPUT P1
180 LET A(1)=P1
190 PRINT 'NO OF SUBJECTS IN SAMPLE 1 (NO MAX) ' ;
200 INPUT N1
210 LET A(2)=N1
220 MAT M=ZER
230 MAT S=ZER
240 MAT T=ZER(P1,P1)
250 MAT U=ZER(P1)
260 MAT Y=ZER(P1)
270 PRINT
280 PRINT 'ENTER THE DATA SUBJECT BY SUBJECT'
290 PRINT
300 FOR K1=1 TO N1
310 PRINT
320 PRINT 'SUBJ';K1
330 FOR I1=1 TO P1
340 INPUT X(I1)
350 NEXT I1
360 PRINT 'ERROR ' ;
370 INPUT I1
380 IF I1>0 THEN 310
390 FOR I1=1 TO P1
400 LET Y(I1)=Y(I1)+X(I1)
410 LET U(I1)=U(I1)+X(I1)**2
420 FOR J1=1 TO P1
430 LET T(I1,J1)=T(I1,J1)+X(I1)*X(J1)
440 NEXT J1
450 NEXT I1
460 NEXT K1
470 FOR I1=1 TO P1
480 FOR J1=1 TO P1
490 LET T(I1,J1)=T(I1,J1)-Y(I1)*Y(J1)/N1
500 LET S(I1,J1)=T(I1,J1)
510 LET T(I1,J1)=T(I1,J1)/(N1-1)
520 NEXT J1
530 LET U(I1)=SQR((U(I1)-Y(I1)**2/N1)/(N1-1))
540 NEXT I1
550 FOR I1=1 TO P1
560 FOR J1=1 TO P1
570 LET T(I1,J1)=T(I1,J1)/(U(I1)+U(J1))
580 NEXT J1
590 LET Y(I1)=Y(I1)/N1
600 LET H(I1)=Y(I1)
610 NEXT I1
620 PRINT
630 PRINT
640 PRINT 'MEANS AND ST DEVIATIONS'
650 PRINT
660 FOR I1=1 TO P1

```

## HOTELLING'S T-SQUARE (INDEPENDENT)

```

670 PRINT I1;Y(I1);U(I1)
680 NEXT I1
690 PRINT
700 PRINT 'CORRELATIONS (X 1000)'
710 PRINT
720 PRINT
730 FOR I1=1 TO P1
740 PRINT
750 PRINT 'VARIABLE #';I1
760 FOR J1=1 TO I1
770 PRINT INT(Y(I1,J1)*1000+.49);
780 NEXT J1
790 NEXT I1
800 LET P1=A(1)
805 PRINT
806 PRINT
810 PRINT 'NO OF SUBJECTS IN SAMPLE 2 (NO MAX)';
820 INPUT N1
830 LET A(3)=N1
840 LET A(4)=A(2)+N1-2
850 MAT T=ZER(P1,P1)
860 MAT U=ZER(P1)
870 MAT Y=ZER(P1)
880 PRINT
890 PRINT 'ENTER THE DATA SUBJECT BY SUBJECT'
900 PRINT
910 FOR K1=1 TO N1
920 PRINT
930 PRINT 'SUBJ';K1
940 FOR I1=1 TO P1
950 INPUT X(I1)
960 NEXT I1
970 PRINT 'ERROR';
980 INPUT I1
990 IF I1<0 THEN 920
1000 FOR I1=1 TO P1
1010 LET Y(I1)=Y(I1)+X(I1)
1020 LET U(I1)=U(I1)+X(I1)**2
1030 FOR J1=1 TO P1
1040 LET T(I1,J1)=T(I1,J1)+X(I1)*X(J1)
1050 NEXT J1
1060 NEXT I1
1070 NEXT K1
1080 FOR I1=1 TO P1
1090 FOR J1=1 TO P1
1100 LET T(I1,J1)=T(I1,J1)-Y(I1)*Y(J1)/N1
1110 LET S(I1,J1)=(S(I1,J1)+T(I1,J1))/A(4)
1120 LET T(I1,J1)=T(I1,J1)/(N1-1)
1130 NEXT J1
1140 LET U(I1)=SGR((U(I1)-Y(I1)**2/N1)/(N1-1))
1150 NEXT I1
1160 PRINT
1170 FOR I1=1 TO P1
1180 FOR J1=1 TO P1
1190 LET T(I1,J1)=T(I1,J1)/(U(I1)*U(J1))
1200 NEXT J1
1210 LET Y(I1)=Y(I1)/N1
1220 LET M(I1)=M(I1)-Y(I1)
1230 NEXT I1
1240 PRINT
1250 PRINT
1260 PRINT 'MEANS AND ST DEVIATIONS'

```

## HOTELLING'S T-SQUARE (INDEPENDENT)

```

1270 PRINT
1280 FOR I1=1 TO P1
1290 PRINT I1;Y(I1);U(I1)
1300 NEXT I1
1310 PRINT
1320 PRINT
1330 PRINT 'CORRELATIONS (X 1000)'
1340 PRINT
1350 FOR I1=1 TO P1
1360 PRINT
1370 PRINT 'VARIABLE';I1
1380 FOR J1=1 TO I1
1390 PRINT INT(T(I1,J1)*1000+.49);
1400 NEXT J1
1410 NEXT I1
1420 DIM B(10),D(10),Q(10),R(10,10)
1430 LET P1=A(1)
1440 LET N1=A(2)
1450 LET N2=A(3)
1460 LET D1=A(4)
1470 PRINT
1480 PRINT
1490 PRINT 'VECTOR OF MEAN DIFFERENCES'
1500 MAT V=ZER(1,P1)
1510 FOR I1=1 TO P1
1520 LET V(1,I1)=M(I1)
1530 NEXT I1
1540 MAT M=ZER(P1,1)
1550 MAT M=TRN(V)
1560 MAT PRINT V;
1570 PRINT
1580 PRINT 'VECTOR OF STANDARD ERRORS'
1590 FOR I1=1 TO P1
1600 LET D(I1)=S(I1,I1)
1610 PRINT SQR(D(I1))/(N1+N2));
1620 NEXT I1
1630 PRINT
1640 PRINT
1650 PRINT
1660 PRINT
1670 PRINT 'CORRELATIONS (X 1000)'
1680 FOR I1=1 TO P1
1690 PRINT
1700 PRINT
1710 PRINT 'VARIABLE';I1
1720 FOR J1=1 TO I1
1730 PRINT INT(S(I1,J1)/SQR(D(I1)*D(J1))*1000+.49);
1740 NEXT J1
1750 NEXT I1
1760 PRINT
1770 MAT R=ZER(P1,P1)
1780 FOR I1=1 TO P1
1790 FOR J1=1 TO P1
1800 LET R(I1,J1)=S(I1,J1)
1810 NEXT J1
1820 NEXT I1
1830 MAT S=ZER(P1,P1)
1840 MAT S=R
1850 MAT R=INV(S)
1860 MAT Q=ZER(1,P1)
1870 MAT Q=V*R
1880 MAT T=Q*M

```

## HOTELLING'S T-SQUARE (INDEPENDENT)

```
1890 IF N2>0 THEN LET T1 = T(1,1)*N1*N2 / (N1+N2) ELSE LET T1 = T(1,1)*N1
1940 LET F1=T1*(D1-P1+1)/(D1*P1)
1950 PRINT
1960 PRINT
1970 PRINT
1980 PRINT
1990 PRINT 'TSQ=';T1;'F=';F1;'DF=';P1;'D1-P1+1
2000 PRINT
2010 PRINT
2020 STOP
2030 PRINT
2040 PRINT
2050 PRINT
2060 PRINT
2070 PRINT
2080 PRINT
2090 PRINT
2100 PRINT
2110 PRINT
2120 PRINT
2130 PRINT
2140 PRINT
2150 PRINT
2160 PRINT
2170 PRINT
2180 PRINT
2190 END
```

```

      FILE NAME * CTSPR$$$$$$$
90  DIM M(10,1),S(10,10),A(4)
100 DIM U(10),V(10),W(10),X(10),Y(10),Z(10)
110 PRINT
120 PRINT
130 PRINT
140 PRINT 'HOTELLING'S TSQ TEST FOR DEPENDENT SAMPLES'
150 PRINT
160 PRINT 'NO OF VARIABLES (MAX=10) ' ;
170 INPUT P1
180 LET A(1)=P1
190 PRINT 'NO OF SUBJECTS (NO MAX) ' ;
200 INPUT N1
210 LET A(2)=N1
220 LET A(3)=0
230 LET A(4)=N1-1
240 MAT M=ZER
250 MAT S=ZER
260 MAT U=ZER(P1)
270 MAT V=ZER(P1)
280 MAT Y=ZER(P1)
290 MAT Z=ZER(P1)
300 PRINT
310 PRINT 'ENTER DATA SUBJECT BY SUBJECT'
320 PRINT 'FOR EACH, GIVE PAIRED DATA BY VARIABLE'
330 PRINT
340 FOR K1=1 TO N1
350 PRINT
360 PRINT 'SUBJ';K1
370 FOR I1=1 TO P1
380 INPUT W(I1),X(I1)
390 NEXT I1
400 PRINT 'ERROR ' ;
410 INPUT I1
420 IF I1>0 THEN 350
430 FOR I1=1 TO P1
440 LET M(I1,1)=M(I1,1)+W(I1)-X(I1)
450 LET U(I1)=U(I1)+W(I1)**2
460 LET V(I1)=V(I1)+X(I1)**2
470 LET Y(I1)=Y(I1)+W(I1)
480 LET Z(I1)=Z(I1)+X(I1)
490 FOR J1=1 TO P1
500 LET S(I1,J1)=S(I1,J1)+(W(I1)-X(I1))*(W(J1)-X(J1))
510 NEXT J1
520 NEXT I1
530 NEXT K1
540 FOR I1=1 TO P1
550 FOR J1=1 TO P1
560 LET S(I1,J1)=(S(I1,J1)-M(I1,1)*M(J1,1)/N1)/A(4)
570 NEXT J1
580 LET U(I1)=SQR((U(I1)-Y(I1)*Y(I1)/N1)/A(4))
590 LET V(I1)=SQR((V(I1)-Z(I1)*Z(I1)/N1)/A(4))
600 LET Y(I1)=Y(I1)/N1
610 LET Z(I1)=Z(I1)/N1
620 NEXT I1
630 FOR I1=1 TO P1
640 LET M(I1,1)=M(I1,1)/N1
650 NEXT I1
660 PRINT

```

## HOTELLING'S T-SQUARE (DEPENDENT)

```

670 PRINT 'SAMPLE 1 - MEANS & ST DEVS'
680 PRINT
690 FOR I1=1 TO P1
700 PRINT I1;Y(I1);U(I1)
710 NEXT I1
720 PRINT
730 PRINT 'SAMPLE 2 - MEANS & ST DEVS'
740 PRINT
750 FOR I1=1 TO P1
760 PRINT I1;Z(I1);V(I1)
770 NEXT I1
780 DIM B(1,10),D(10),T(1,1),Q(1,10),R(10,10)
790 LET P1=A(1)
800 LET N1=A(2)
810 LET N2=A(3)
820 LET D1=A(4)
830 PRINT
840 PRINT
850 PRINT 'VECTOR OF MEAN DIFFERENCES'
860 MAT B=ZER(1,P1)
870 FOR I1=1 TO P1
880 LET B(1,I1)=M(I1,1)
890 NEXT I1
900 MAT M=ZER(P1,1)
910 MAT M=TRN(B)
920 MAT PRINT B;
930 PRINT
940 PRINT 'VECTOR OF STANDARD ERRORS'
950 FOR I1=1 TO P1
960 LET D(I1)=S(I1,I1)
970 PRINT SQR(D(I1)/(N1+N2));
980 NEXT I1
990 PRINT
1000 PRINT
1010 PRINT
1020 PRINT
1030 PRINT 'CORRELATIONS (X 1000)'
1040 FOR I1=1 TO P1
1050 PRINT
1060 PRINT
1070 PRINT 'VARIABLE';I1
1080 FOR J1=1 TO I1
1090 PRINT INT(S(I1,J1)/SQR(D(I1)*D(J1))*1000+.49);
1100 NEXT J1
1110 NEXT I1
1120 PRINT
1130 MAT R=ZER(P1,P1)
1140 FOR I1=1 TO P1
1150 FOR J1=1 TO P1
1160 LET R(I1,J1)=S(I1,J1)
1170 NEXT J1
1180 NEXT I1
1190 MAT S=ZER(P1,P1)
1200 MAT S=R
1210 MAT R=INV(S)
1220 MAT Q=ZER(1,P1)
1230 MAT Q=B*R
1240 MAT T=Q*M
1250 IF N2>0 THEN 1270
1260 GOTO 1290
1270 LET T1=T(1,1)*N1*N2/(N1+N2)
1280 GOTO 1300

```

## HOTELLING'S T-SQUARE (DEPENDENT)

```
1290 LET T1=T(1,1)*N1
1300 LET F1=T1*(D1-P1+1)/(D1*P1)
1310 PRINT
1320 PRINT
1330 PRINT
1340 PRINT
1350 PRINT 'TSQ=';T1;'F=';F1;'DF=';P1;'D1-P1+1
1360 PRINT
1370 PRINT
1380 STOP
1390 PRINT
1400 PRINT
1410 PRINT
1420 PRINT
1430 PRINT
1440 PRINT
1450 PRINT
1460 PRINT
1470 PRINT
1480 PRINT
1490 PRINT
1500 PRINT
1510 PRINT
1520 PRINT
1530 PRINT
1540 PRINT
1550 END
```

HR REST	HR SUB-MAXIMAL	ESTIMATE VO2 MAX	VINELAND	OSAIS	IAP
-12	-30	4.59	7	2	.7
-11	-13	2.29	3	0	0
-9	-27	3.44	11	0	1.6
-9	-19	3.44	6	0	.3
-8	-22	3.44	3	2	1.3
-8	-19	3.44	17	4	.7
-6	-13	2.29	3	11	1.3
-13	-27	4.59	7	2	1.3
-9	-25	3.34	7	0	0
-8	-11	2.29	2	4	0
-9	-20	3.34	7	6	3.4
-7	-11	2.29	5	0	0
-17	-32	5.73	4	1	1.1

---

-6	-8	1.14	-5	-3	0
-2	-10	2.29	0	-4	-1
-2	-6	1.15	3	0	0
-3	-5	0	2	-2	-.3

-6	-11	2.3	2	-3	-1.6
-7	0	0	4	0	0
-1	-4	0	2	0	0
-5	-9	2.29	2	0	1.2
-2	-7	1.15	3	0	0
-4	-10	2.29	1	-13	-.3
-3	-4	0	3	0	-1
-3	-6	1.15	0	1	.7
0	-7	1.15	5	0	0

FILE NAME \* PR

ENTER THE DATA SUBJECT BY SUBJECT

SUBJ 1

SUBJ 2

SUBJ 3

SUBJ 4

SUBJ 5

SUBJ 6

SUBJ 7

SUBJ 8

SUBJ 9

SUBJ 10

SUBJ 11

SUBJ 12

SUBJ 13

MEANS AND ST DEVIATIONS

1	-9.6923076	2.9264489
2	-20.692307	7.2270861
3	3.423846	1.0486384
4	6.3076923	4.0493748
5	2.4615384	3.204564
6	.89999998	.95481237

CORRELATIONS (X 1000)

VARIABLE 1  
1000

VARIABLE 2  
712 1000

VARIABLE 3  
-845 -918 1000

VARIABLE -4  
76 -285 201 1000

VARIABLE 5  
383 321 -259 -83 1000

VARIABLE 6  
-63 -301 264 162 447 1000

ENTER THE DATA SUBJECT BY SUBJECT

SUBJ 1

SUBJ 2

SUBJ 3

SUBJ 4

SUBJ 5

SUBJ 6

SUBJ 7

SUBJ 8

SUBJ 9

SUBJ 10

SUBJ 11

SUBJ 12

SUBJ 13

MEANS AND ST DEVIATIONS

1	-3.3846154	2.1031112
2	-6.6923077	3.0382181
3	1.1469231	.93591652
4	1.6923077	2.4625399
5	-1.8461538	3.6933759
6	-.17692307	.72244243

CORRELATIONS (X 1000)

VARIABLE 1	1000					
VARIABLE 2	-6	1000				
VARIABLE 3	-145	-907	1000			
VARIABLE 4	345	370	-246	1000		
VARIABLE 5	191	523	-496	299	1000	
VARIABLE 6	45	217	-57	-38	305	1000

VECTOR OF MEAN DIFFERENCES

-6.3076923 -14 2.276923 4.6153846 4.3076922 1.076923

## VECTOR OF STANDARD ERRORS

.4997534 1.0871765 .19491528 .65723106 .67809484 .16603925

## CORRELATIONS (X 1000)

VARIABLE 1  
1000

VARIABLE 2  
532 1000

VARIABLE 3  
-568 -865 1000

VARIABLE 4  
157 -150 43 1000

VARIABLE 5  
288 347 -376 71 1000

VARIABLE 6  
-25 -170 134 98 372 1000

TSR= 102.77547 F= 13.560652 DF= 6 , 19

QBASIC.R HELCO.

HOTELLING'S TSO TEST FOR DEPENDENT SAMPLES

NO OF VARIABLES (MAX=10) ?

ENTER DATA SUBJECT BY SUBJECT  
FOR EACH, GIVE PAIRED DATA BY VARIABLE

SUBJ 1

SUBJ 2

SUBJ 3

SUBJ 4

SUBJ 5

SUBJ 6

SUBJ 7

SUBJ 8

SUBJ 9

SUBJ 10

SUBJ 11

SUBJ 12

SUBJ 13

SAMPLE 1 - MEANS & ST DEVS

1	85.615384	7.9113691
2	37.327691	5.5309594
3	157.13.127579	
4	38.692307	10.964979
5	40.153846	13.563715
6	5.8384614	2.0750658

SAMPLE 2 - MEANS & ST DEVS

1	75.615384	8.7800775
2	40.766922	6.429409
3	136.30769	15.887022
4	46.076923	13.744463
5	42.615385	14.29766
6	6.7384613	2.4930389

VECTOR OF MEAN DIFFERENCES

10 -3.4392308 20.692307 -7.3846154 -2.4615384 -.89999999

## VECTOR OF STANDARD ERRORS

.81649657	.29065671	2.004433	1.59542	.88878615	.2648173
-----------	-----------	----------	---------	-----------	----------

## CORRELATIONS (X 1000)

VARIABLE 1	1000
------------	------

VARIABLE 2	-837	1000
------------	------	------

VARIABLE 3	744	-922	1000
------------	-----	------	------

VARIABLE 4	79	144	-101	1000
------------	----	-----	------	------

VARIABLE 5	468	-256	321	166	1000
------------	-----	------	-----	-----	------

VARIABLE 6	-68	278	-301	645	447	1000
------------	-----	-----	------	-----	-----	------

TSQ= 352.16922 F= 34.238674 DF= 6 , 7

TIME : .172

@BASIC,R HELGO.

## HOTELLING'S TSQ TEST FOR DEPENDENT SAMPLES

NO OF VARIABLES (MAX=10) ?

ENTER DATA SUBJECT BY SUBJECT  
FOR EACH, GIVE PAIRED DATA BY VARIABLE

SUBJ 1

SUBJ 2

SUBJ 3

SUBJ 4

SUBJ 5

SUBJ 6

SUBJ 7

SUBJ 8

SUBJ 9

SUBJ 10

SUBJ 11

SUBJ 12

SUBJ 13

## SAMPLE 1 - MEANS &amp; ST DEVS

1	89.76923	6.9899248
2	32.826922	4.4316069
3	162.92300	21.08895
4	36.307692	14.505003
5	36.923077	8.8831445
6	5.3076921	2.4867858

## SAMPLE 2 - MEANS &amp; ST DEVS

1	86.384615	6.1716903
2	33.973845	4.8345711
3	156.23077	22.402211
4	38.12.409674	
5	36.615385	9.7770016
6	5.0538461	2.2522641

## VECTOR OF MEAN DIFFERENCES

3.3846154 -1.146923 6.6923077 -1.6923077 .3076923 .25384614

## VECTOR OF STANDARD ERRORS

.58329811 .25957652 .84265009 .68298566 .7457969 .18660784

## CORRELATIONS (X 1000)

VARIABLE 1  
1000VARIABLE 2  
-145 1000VARIABLE 3  
-6 -907 1000VARIABLE 4  
345 -246 370 1000VARIABLE 5  
80 76 43 236 1000VARIABLE 6  
25 -62 204 44 276 1000

TSQ= 421.89589 F= 41.017656 DF= 6, 7

TIME : 159

ENTER THE DATA

SAMPLE 1

\*\*\* REST \*\*\*

MEAN = -9.6923076 SDEV = 2.9264489

SAMPLE 2

MEAN = -3.3846154 SDEV = 2.1031112

T = -6.3108047 DF = 24

F MAX = 1.9362321 DF = 13 , 13

SUGGESTED DF = 23

STUDENT'S T-TEST FOR INDEPENDENT SAMPLES

SAMPLE MEANS & SDEVS ALREADY KNOWN ?

ENTER THE DATA

SAMPLE 1

\*\*\* CO2-MAX \*\*\*

MEAN = -20.692307 SDEV = 7.2270861

SAMPLE 2

MEAN = -6.6923077 SDEV = 3.0382181

T = -6.438697 DF = 24

F MAX = 5.6583337 DF = 13 , 13

SUGGESTED DF = 16

STUDENT'S T-TEST FOR INDEPENDENT SAMPLES

SAMPLE MEANS & SDEVS ALREADY KNOWN ?

ENTER THE DATA

SAMPLE 1

\*\*\* SUB-MAX \*\*\*

MEAN = 3.423846 SDEV = 1.0486384

SAMPLE 2

MEAN = 1.1469231 SDEV = .93591652

T = 5.8408015 DF = 24

F MAX = 1.2553861 DF = 13 , 13

SUGGESTED DF = 25

STUDENT'S T-TEST FOR INDEPENDENT SAMPLES

SAMPLE MEANS & SDEVS ALREADY KNOWN ?

ENTER THE DATA

SAMPLE 1

\*\*\* VINELAND \*\*\*

MEAN = 6.3076923 SDEV = 4.0493748

SAMPLE 2

MEAN = 1.6923077 SDEV = 2.4625399

T = 3.5112345 DF = 24

F MAX = 2.704017 DF = 13 , 13

SUGGESTED DF = 21

STUDENT'S T-TEST FOR INDEPENDENT SAMPLES

SAMPLE MEANS & SDEVS ALREADY KNOWN ?

ENTER THE DATA

SAMPLE 1

\*\*\* OSAIS \*\*\*

MEAN = 2.4615384 SDEV = 3.204564

SAMPLE 2

MEAN = -1.8461538 SDEV = 3.6933759

T = 3.1763198 DF = 24  
F MAX = 1.3283396 DF = 13 , 13

SUGGESTED DF = 25

STUDENT'S T-TEST FOR INDEPENDENT SAMPLES

SAMPLE MEANS & SDEVS ALREADY KNOWN ?

ENTER THE DATA

SAMPLE 1  
\*\*\* DAP \*\*\*  
L

MEAN = .89999998 SDEV = .95481237

SAMPLE 2

MEAN = -.17692307 SDEV = .72244243

T = 3.2429773 DF = 24  
F MAX = 1.7467453 DF = 13 , 13

SUGGESTED DF = 24

STUDENT'S T-TEST FOR INDEPENDENT SAMPLES

SAMPLE MEANS & SDEVS ALREADY KNOWN ?  
PROGRAM STOPPED.  
TIME : .122

	MEAN	SDEV	** REST **
SAMPLE 1	85.615384	7.9113691	
SAMPLE 2	75.615384	8.7800775	
DIFFERENCE	10	2.9439203	
CORRELATION = .94304828			
T = 12.247449 DF = 12			

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** REST **
SAMPLE 1	89.76923	6.9899248	
SAMPLE 2	86.384615	6.1716903	
DIFFERENCE	3.3846154	2.1031112	
CORRELATION = .95649494			
T = 5.8025475 DF = 12			

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** CO2-MAX **
SAMPLE 1	37.327691	5.5309594	
SAMPLE 2	40.766922	6.429409	
DIFFERENCE	-3.4392308	1.0479777	
CORRELATION = .99590795			
T = -11.832623 DF = 12			

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** CO2-MAX **
SAMPLE 1	32.826922	4.4316069	
SAMPLE 2	33.973845	4.8345711	
DIFFERENCE	-1.146923	.93591645	

CORRELATION = .98334635

T = -4.4184391 DF = 12

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** SUB-MAX **
SAMPLE 1	157	13.127579	
SAMPLE 2	136.30769	15.887022	
DIFFERENCE	20.692307	7.2270861	

CORRELATION = .8930364

T = 10.323272 DF = 12

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** SUB-MAX **
SAMPLE 1	162.92308	21.08895	
SAMPLE 2	156.23077	22.402211	
DIFFERENCE	6.6923077	3.0382181	

CORRELATION = .99205633

T = 7.941978 DF = 12

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** VINELAND **
SAMPLE 1	35.923077	14.562861	
SAMPLE 2	46.076923	13.744463	
DIFFERENCE	-10.153846	14.644943	
CORRELATION = .46591244			
T = -2.4998536 DF = 12			

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** VINELAND **
SAMPLE 1	36.307692	14.505083	
SAMPLE 2	38	12.409674	
DIFFERENCE	-1.6923077	2.4625399	
CORRELATION = .99535186			
T = -2.4778089 DF = 12			

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** OSAIS **
SAMPLE 1	40.153846	13.563715	
SAMPLE 2	42.615385	14.29766	
DIFFERENCE	-2.4615384	3.204564	
CORRELATION = .97491208			
T = -2.7695512 DF = 12			

	MEAN	SDEV	** DSAIS
SAMPLE 1	36.923077	8.8831445	
SAMPLE 2	36.615385	9.7770016	
DIFFERENCE	.3076923	2.689009	

CORRELATION = .96297207

T = .41256816 DF = 12

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** DAP **
SAMPLE 1	5.8384614	2.0750658	
SAMPLE 2	6.7384613	2.4938389	
DIFFERENCE	-.9	.95481236	

CORRELATION = .9288586

T = -3.3985692 DF = 12

## STUDENT'S T-TEST FOR DEPENDENT SAMPLES

	MEAN	SDEV	** DAP **
SAMPLE 1	5.3076921	2.4867858	
SAMPLE 2	5.0538461	2.2522641	
DIFFERENCE	.25384614	.67282413	

CORRELATION = .9644975

T = 1.3603183 DF = 12

INSTRUCTIONS AND ALLOCATIONS OF MARKS  
FOR THE INDIVIDUAL SCALE OF THE  
NATIONAL BUREAU OF EDUCATIONAL RESEARCH


YEAR III.

1. Show me your mouth. Where is your mouth?  
Same with eye, nose, hair. (3 out of 4).
2. Listen and say:  
8-1, 9-4, 3-7. (A little faster than 1 digit per second).  
(1 out of 3).
3. Are you a boy or a girl? (For a boy; vice versa for a girl).
4. What is your name? If only Christian name is given, e.g. John.  
Say John who? What is your other (full) name?
5. What is this? What have I here?  
Pocket knife, door key, cent, box of matches, pencil, watch,  
felt hat. (4 out of 7).
6. Here is a pretty picture. Tell me what you can see in the  
picture, or - Look at the picture and tell me what you can see  
in it. (At least three objects or people in each picture).

YEAR IV

7. Listen and say: (See No. 2).  
6-4-1, 3-5-2, 8-3-7. (1 out of 3).  
(A little faster than 1 digit per second).
8. You see these two lines? Show me which is the longer.  
(3 out of 3 or 5 out of 6).
9. You see these cents. Count them and tell me how many there are.  
Count them aloud and point with your finger. (Counting must  
correspond with pointing of finger. Two attempts allowed).
10. What have I here? What is this?  
pocket knife, door key, cent, box of matches, pencil, felt hat,  
watch. (No error).
11. What must you do when you are tired?  
What must you do when you are hungry?  
What must you do when you are cold?  
(2 out of 3. Any reasonable answer. To cry is always wrong).
12. Listen and say this just as I say it:-
  - (a) I am cold and hungry.
  - (b) His name is Jack. He is such a naughty dog.  
(Year V: 10 syllables).
  - (c) It is raining outside and Tom is working hard.  
(Year VI: 12 syllables).
  - (d) We are going for a walk; will you give me that pretty  
bonnet? (Year VII: 16 syllables).
  - (e) We should never be cruel to birds. It is night and we  
are all going to bed. (Year XI: 20 syllables).
  - (f) The other morning I saw in the street a tiny yellow dog.  
Little Maurice has spoilt his new apron.  
(Year XVI: 26 syllables). (One error except mis-  
pronunciation due to speech defect).

YEAR V

13. You see this? (Show square on form). I want you to make one just like this. Make it here on this paper with this pencil. I know you can do it nicely. (Lines need not be too straight. Corners must not be too rounded. Ask child if his is correct or what is wrong).
14. How old are you?
15. Ten syllables (see No. 12).
16. Listen and say: (Slightly faster than one digit per person). 4-9-3-7, 2-8-5-4, 7-2-6-1.
17. Which of these two faces is the uglier (ugliest)? Show just one pair at a time. (No error).
18. (Lay the triangles thus . I want you to put these two pieces together (point) so that they will look just like this one (point). (If the child turns over one of the triangles the task must be started afresh). (A single trial may involve a number of unsuccessful changes of position in two triangles but these changes may not consume altogether more than one minute).
19. (Two weights 3 grammes and 12 or 15 grammes placed on table). You see these boxes. They look just alike, but one is light and the other is heavy. Give me the heavier (heaviest)..... Feel them and give me the heavier (2 out of 3).
20. What colour is this? What is the name of this colour? (No error).

YEAR VI.

21. You have seen a chair? Now, what is a chair? (Encourage if necessary, e.g. I am sure you know what a chair is. Tell me what is a chair). (4 out of 6 in terms of use).  
Chair, doll, table, pencil, horse, fork.
22. I want you to do something for me. First put this key on that chair, then shut the door and then bring me that box (point). Do you understand? Put that key on that chair, shut the door and bring me that box (point again). Do not repeat any more. All three commissions in order given.
23. What should you do:-  
(a) If it is raining when you start for school?  
(b) If you find that your house is on fire?  
(c) If you are going somewhere and the wheel of your motor car or wagon breaks? (2 out of 3).
24. What is this picture about? What is this a picture of? (Description by means of sentences: 2 out of 3 pictures).
25. What is this? ..... Yes, but what do we call this coin?  
5c 1c 10c 2½c (no error)
26. Twelve syllables. (See No. 12). (1 error).
27. Show me your right hand, left eye, right ear. (3 out of 3 or 5 out of 6).

28. (Thirteen cents). You see these cents. Count them and tell me how many there are. Count them aloud and point with your finger. (Counting must correspond with pointing. Two attempts allowed).

YEAR VII

29. Place four of the five boxes used in Test 49 in a row and say to the pupil: "I want you to tap these little boxes in exactly the same way as I do. Watch carefully". Tap the boxes with the fifth (generally the lightest) in the following order-
- A. 1.2.3.4
  - B. 1.2.3.4.3
  - C. 1.2.3.4.2
  - D. 1.3.2.4
  - E. 1.3.4.2.3.1. (Always start with A).
30. There is something wrong with this face. Look carefully at it and tell me what has been left out. (3 out of 4).
31. How many fingers have you on your right hand? Left hand? Both hands? (without counting). No error, sometimes child does not include thumb, consider this correct).
32. Sixteen syllables (see No. 12).
33. I want you to make one just like this point). (1 out of 3).  
~~XX~~ (Follow Terman's diagram for scoring).
34. Place model before subject with wings pointing to right and left and say:- You know what kind of knot this is don't you? It is a bow-knot. I want you to take this other piece of string and tie the same kind of knot round my finger. (The examiner can use the bow-knot on his one shoe and have the string on the other one tied). Double bow-knot in one minute for full credit. One bow-half credit. Usual plain common knot which precedes bow-knot must not be omitted and bow-knot should be drawn tight).

YEAR VIII

35. What should you do:-
- (a) When you have broken something which belongs to someone else?
  - (b) When you are on your way to school and notice that you may be late for school?
  - (c) If a playmate hits you without meaning to do so?  
(2 out of 3). (See Terman).
36. Name the days of the week..... (after child has given those say "What day comes before Tuesday, before Thursday, before Friday? (No error in enumerating days and 2 out of 3 of last questions).
37. You can count backwards, can't you? Begin at 20 and count backwards till you come to 1. (If no response begin with 20 and count backwards 20, 19, 18 and then let the child go on). (One uncorrected error allowed in about 30 seconds).
38. Three digits (backwards).  
I am going to say some figures and when I have finished you must say them backwards. If I say 1.2.3. you say 3.2.1. Understand? Now listen. 2-8-3, 4-2-7, 9-5-8 (1 out of 3).

39. What is the difference between water and milk?  
You know what water is and you have seen milk. Now tell me what is the difference between water and milk.  
(Then a stone and an egg and wood and glass). (2 out of 3 actual differences, see Terman).
40. Five digits (See No. 2)  
Listen and say:  
5-2-9-4-7, 6-3-8-5-2, 9-7-3-1-8. (1 out of 3).

YEAR IX

41. (Give pen, ink and paper). Will you write this down for me on this piece of paper? "See the little boy". (The phrase is to be uttered as a whole but it may be repeated. The words must be written by child separately and sufficiently legibly for a person who did not know what had been dictated - spelling sufficiently accurate too).
42. I am going to name two things which are alike in some way and I want you to tell me in what way they are alike:-  
dog-horse, wood-coal, apple-peach, iron-silver.
43. I want you to make up a sentence for me with these three words in it.  
(a) Man-horses-cart  
(b) Boy-river-stone  
(c) Work-money-men  
(Indicate to child he can use additional words in sentence if there is no response). (One minute each, 2 out of 3).
44. Suppose you have lost your ball in this big field (point). You don't know in what part of the field it is. All you know is that it is in the field. Take this pencil and mark a path to show me how you would go so as to be sure you will not miss it. Begin at the gate and remember it is a big field and you must be sure not to miss the ball. (Inferior plan. See Terman).
45. Knox D. (First attempt) (See No. 29).

YEAR X

46. What is a horse, chair, table, fork? Definitions in terms superior to use, i.e. reference to class or genus or description. (3 out of 4).
47. Arithmetic 1 and 2.  
Read this sum and give me the answer. (Both right in two minutes).  
(Peter plays marbles. He starts with 15. First he loses 8 and then wins 6. How many has he then? John's grandmother is 86 year old. If she lives, in how many years will she be 100 years old?)
48. Can you tell me all the months of the year?  
(One error in about 15 seconds).
49. Do you see those boxes? They all look the same but they don't weigh the same. Some are heavy and some are light. I want you to find the heaviest and put it here. Then find the one which is a little less heavy and place it next; then the one which is still less heavy; then the one which is lighter still and last, the one which is the lightest here. (2 out of 3 in 3 minutes).

50. I want you to put these blocks in this frame so that all the space will be filled up. If you do it right they will all fit in and there will be no space left open. Go ahead. (Three times in a total of five minutes for the three trials).
51. I am going to read you something which has something foolish in it. Some nonsense. Listen carefully and tell me what is foolish in it.
- (a) I have three brothers; John, William and myself.  
(What is foolish about that?)
  - (b) The road from my farm to the town is downhill all the way to town and downhill all the way to the farm.  
(What is foolish about that?)
  - (c) Once the body of a poor girl was found in a wood, cut into eighteen pieces. They say that she killed herself.
  - (d) An engine driver said that the more carriages and trucks he had in his train the faster he could go.
  - (e) One day a man fell off his bicycle on to his head, and was killed instantly. He was taken to hospital and they fear he may never get better. (3 out of 5).

YEAR XI

52. Calculating change.  
"You go to the shop to buy a pencil (or anything else) that costs 6c. You give the shopkeeper 25c. How much change must he give you?"
53. There are two easy drawings on this card. I want you to look at them very carefully until I take them away; and then try if you can draw them both from memory on this paper afterwards. You will see them for a few seconds only. Now look at them both carefully. (Expose for 10 seconds. See Terman scoring).
54. Four digits (backwards)  
I am going to say some figures and when I have finished, I want you to say them backwards.  
6-5-2-8, 4-9-3-7, 8-5-2-9 (1 out of 3).
55. Six digits (See no. 2)  
Listen and say:  
2-5-0-3-6-4, 8-5-3-9-1-6. 4-7-1-5-8-2 (1 out of 3).
56. You know what a rhyme is of course? A rhyme is a word which sound like another word. Two words rhyme if they end in the same sound. Understand? Take the two words hat and cat. They sound alike and so they rhyme. Hat, rat, cat, bat and all thyme with one another. Now I am going to give a word and you will have one minute to find as many words as you can that rhyme with it. The word is day. The same with mill and spring. (Three rhyming words within one minute for 2 out of 3 words).
57. Will you read this for me? (2 seconds after the reading is finished, remove the passage and say: Tell me what you have been reading about). (8 memories, see Terman). Johannesburg. 5 September. A fire last night burned three houses near the centre of the city. It took some time to put it out. The loss was fifty thousand

Rand and seventeen families lost their homes. In saving a girl who was asleep in bed a fireman was burnt on the hand.

YEAR XII

58. Twenty syllables (See no. 12).
59. I want to see how many different words you can say in three minutes. Now when I say ready, you must begin and name the words as fast as you can and I shall count them. Be sure to do your very best and remember that just any words will do, like clouds, dog, chair, happy skyn, run, (English or Afrikaans or mixed). (60 words exclusive of repetitions in 3 minutes).
60. (a) Why should you save some of the money you earn, instead of spending all of it?  
 (b) What ought you to do before undertaking (beginning) something very difficult?  
 (c) Why should we judge a person more by his actions than by his words? (2 out of 3 correct).
61. Ball and Field (Superior Plan - see Terman).

YEAR XIII

62. I am going to name 3 things that are alike in some way. I want you to tell me how they are alike.  
 (a) Snake, cow, bird.  
 (b) Book, teacher, newspaper.  
 (c) Wool, cotton, leather.  
 (d) Knife-blade, cent, piece of wire.  
 (e) Rose, potato, tree. (Score 3 out of 5. See Terman).
63. Here is a sentence that has the words all mixed up so that they don't make sense. If the words were put in the right order, they would make a good sentence. Look carefully and see if you can tell me how the sentence ought to read.  
 (a) A defends dog good his bravely master.  
 (b) For the started an we early country at hour.  
 (c) To asked paper my teacher correct I my.  
 (2 out of 3 in 1 minute each).
64. Tell me what this picture is about. Explain this picture. (3 pictures out of 4 must be satisfactorily interpreted or emotion described).
65. Listen and try to understand what I read:-  
 (a) A man in the veld came upon a dog lying before a hole, and it seemed very tired. What do you think happened shortly before?  
 (b) A Coloured who had come to town for the first time in his life saw a white man riding along the street. As the white man rode by the Coloured said:- "The white man is lazy; he walks sitting down." What was the white man riding on that caused the Coloured to say he walks sitting down?

(c) My neighbour has been having queer visitors. First a doctor came to his house, then a lawyer, then a minister (preacher or priest). What do you think happened there? (2 out of 3)

66. Vocabulary (21 words correct).  
What does this word mean? (Show word to pupil).

- |             |                   |                   |
|-------------|-------------------|-------------------|
| 1. orange   | 18. chrysanthemum | 35. finally       |
| 2. grip     | 19. rogue         | 36. vitality      |
| 3. steamer  | 20. household     | 37. timorous      |
| 4. parent   | 21. strain        | 38. refinement    |
| 5. four     | 22. heroism       | 39. authorise     |
| 6. search   | 23. overdue       | 40. sentiment     |
| 7. rabbit   | 24. prank         | 41. synopsis      |
| 8. lord     | 25. isolate       | 42. nullify       |
| 9. report   | 26. aloe          | 43. epoch         |
| 10. tower   | 27. recharge      | 44. offspring     |
| 11. suppose | 28. leisurely     | 45. grandiloquent |
| 12. scenery | 29. array         | 46. corona        |
| 13. polo    | 30. fluke         | 47. philology     |
| 14. advance | 31. crest         | 48. monochromatic |
| 15. farther | 32. mutineer      | 49. sidereal      |
| 16. pellet  | 33. barb          | 50. germane       |
| 17. tunic   | 34. sprightly     |                   |

67. What is pity?  
What is honesty?  
What is justice?  
What is envy?  
What is revenge? (3 out of 5 words. See Terman).

68. You know what a fable is? A fable is a little story and is meant to teach a lesson. I am going to read a fable to you. Listen carefully and when I have finished I will ask you to tell me what lesson the fable teaches us.

A. HERCULES AND THE WAGONER.

A man was driving along a country road, when the wheel suddenly sank in a deep rut. The man did nothing but look at the wagon and call loudly to Hercules to come and help him. Hercules came up, looked at the man, and said: "Put your shoulder to the wheel, my man, and whip up your oxen." Then he went away and left the driver.

B. THE MILKMAID AND HER PLANS.

A milkmaid was carrying her pail of milk on her head, and was thinking to herself thus: "The money for this milk will buy 4 hens; the hens will lay at least 100 eggs will produce at least 75 chicks; and with the money which the chicks will bring, I can buy a new dress to wear instead of the ragged one I have on". At this moment she looked down at herself, trying to think how she would look in her new dress, but as she did so, the pail of milk slipped from her head and dashed upon the ground. Thus, all her imaginary schemes perished in a moment.

C. THE FOX AND THE CROW.

A crow, having stolen a bit of meat, perched on a branch and held it in her beak. A fox, seeing her, wished to secure the meat and spoke to the crow thus:-

"How handsome you are, and I have heard that the beauty of your voice is equal to that of your form and feathers. Will you not sing for me, so that I may judge whether this is true?"

The crow was so pleased that she opened her mouth to sing and dropped the meat, which the fox immediately ate.

D. THE FARMER AND THE STORK.

A farmer set some traps to catch cranes which had been eating his seed. With them he caught a stork. The stork, which had not really been stealing begged the farmer to save his life, saying that he was a bird of excellent character, that he was not at all like the cranes, and that the farmer should have pity on him. But the farmer said: "I have caught you with those robbers, the cranes and you have got to die with them".

E. THE MILLER, HIS SON AND THE DONKEY.

A miller and his son were driving their donkey to a neighbouring town to sell him. They had not gone far when a child saw them and cried out: "What fools those fellows are to be trudging along on foot when one of them might be riding!" The old man, hearing this, made his son get on the donkey while he himself walked. Soon they came upon some men. "Look" said one of them, "see that lazy boy riding while his old father has to walk". On hearing this the miller made his son get off and he climbed upon the donkey himself. Further on they met a company of women, who shouted out: "Why, you lazy old fellow, to ride along so comfortably while your poor boy there can hardly keep pace by the side of you". And so the good-natured miller took his boy up behind him and both of them rode. As they came to the town a citizen said to them: "Why you cruel fellows, you two are better able to carry the poor little donkey than he is to carry you". "Very well" said the miller "we will try". So both of them jumped to the ground, got some ropes, tied the donkey's legs to a pole and tried to carry him. But as they crossed the bridge the donkey became frightened, kicked loose and fell into the stream. (For scoring see Terman. 4 points for credit).

69. Reasoning test - 1. (a or b correct)

Read this for me. At the end you will find a question. When you have read the question, look over the sentence again and see if you can answer it for me.

1. (a) Jack said to his sisters: "Some of my flowers are buttercups". His sisters knew that all buttercups are yellow. Ann said: "All your flowers should be yellow". Mary said: "Some of your flowers are yellow". Hester said: "None of your flowers are yellow". Which girl was right?

2. (b) My brother wrote to me: "Today I have walked from Rietfontein where I had an accident yeaterday and broke one of my limbs. Can you find out from this what he had probably broken - his right arm, left arm, right leg or left leg?"
70. If I have a large box here, with 2 smaller boxes inside, and each one of the smaller boxes contains a little tiny box, how many boxes are there altogether, counting the big one? Remember first the large box, then the two smaller ones and in each of the smaller ones one tiny box. How many altogether. (Same with the boxes arranged thus:-
- 1-2-2  
1-3-3  
1-4-4  
1-4-2 Half a minute for each answer. (3 out of 5).

YEAR XV.

71. Knox E. (first or second attempt) (See No. 29)
72. Vocabulary (30 words correct. See No. 66).
73. Reasoning Test - No. 2 (See instructions for test 69).  
I started from the door of my house and walked 100 yards. I turned straight to the right and walked 50 yards. I turned straight to the right and walked 100 yards. How far am I from the door of my house?
74. Induction Test: Provide six sheets of thin blank paper, say  $8\frac{1}{2}$  by 11 inches. Take the first sheet and telling the child to watch what you do, fold it once; and in the middle of the folded edge tear out or cut out a small notch; then ask the child to tell you how many holes there will be in the paper when it is unfolded. The correct answer, one, is nearly always given without hesitation. But whatever the answer, unfold the paper and hold it up broadside for the child's inspection. Next, take another sheet, fold it once a before and say: "Now when we folded it this way and tore out a piece, you remember it made one hole in the paper. This time we will give the paper another fold and see how many holes we shall have then". Then proceed to fold the paper again, this time in the other direction and tear out a piece from the folded side and ask how many holes there will be when the paper is unfolded. After the answer is given, unfold the paper, hold it up before the subject so as to let him see the result. The answer is often incorrect and the unfolded sheet is greeted with an exclamation of surprise. The governing principle is seldom made out at this stage of the experiment. But regardless of the correctness or incorrectness of the first and second answers, proceed with the third sheet. Fold it once and say: "When we folded it this way there was one hole". Then fold it again and say: "And when we folded it this way there were two holes". At this point the paper a third time and say: "Now I am folding it again. How many holes will it have this time when I unfold it?" Record the answer and again unfold the paper while the child looks on.

Continue the same manner with sheets, four, five and six, adding one fold each time. In folding each sheet recapitulate the results with the previous sheets, saying (with the sixth, for example): "When we folded it this way there was one hole, when we folded it

again there were two, when we folded it again there were four, when we folded it again there were eight, when we folded it again there were sixteen, now tell me how many holes there will be if we fold it once more". In the recapitulation avoid the expression "When we folded it once, twice, three times," etc. as this often leads the child to double the numeral heard instead of doubling the number of holes in the previously folded sheet. After the answer is given, do not fail to unfold the paper and let the child view the result.

Scoring: The test is passed if the rule is grasped by the time the sixth sheet is reached, that is, the subject may pass five incorrect responses, provided the sixth is correct and the governing rule can then be given.

75. Mental arithmetic:

- (a) If a man's salary is R20 per week and he spends R14 per week, how long will it take him to save R300?
- (b) If 2 pencils cost 5c how many pencils can you buy for 50c?
- (c) At 15c a yard, how much will 7 feet of cloth cost?  
(Pupil must not be given paper and pencil. Problem is to be done mentally. One minute each problem).  
(One minute is allowed for each problem, but the child must not be hurried. While he is busy with one problem, keep the next one covered. If the child gives a wrong answer do not give him a second chance, excepting in the case of No. 3 when it can be seen from his answer that he has read "feet" for "yards". In this case he should be asked to re-read the question carefully. No further help of any description may be given).

YEAR XVI

76. What is the difference between:-  
laziness - idleness  
poverty - misery  
avarice - thrift  
lie - mistake  
character - reputation (3 out of 5).

77. Absurdity - No. 1

There is something foolish about this sentence. Read it aloud and see if you can tell me what is foolish about it. "The three men laughed then stopped suddenly as the eyes of each one met those of the others across the table".

78. Twenty-six syllables (See No. 12).

79. Five digits (backwards).

I am going to say some figures and when I have finished I want you to say them backwards.

6-9-4-8-2. 3-1-8-7-9 (1 out of 2)

YEAR XVII

80. Take a piece of paper about 6 inches square and say: "Watch carefully what I do. See, I fold the paper this way (folding it once over in the middle), then I fold it this way (folding it again in the middle, but at the right angles to the first fold.)"

"Now, I will cut out a notch here". (Indicating). At this point take scissors and cut out a small notch from the middle of the side which presents but one edge. Throw the fragment which has been cut out into the waste basket or under the table. Leave the folded paper exposed to view but pressed flat against the table. Then give the pupil a pencil and a second sheet of paper like the one already used and say: "Take this sheet of paper and make a drawing to show how the other sheet of paper would look if it were unfolded. Draw lines to show the creases in the paper and show what results from the cutting". The pupil is not permitted to fold the second sheet, but must solve the problem by the imagination unaided.

Note that we do not say, "Draw the holes" as this would inform the pupil that more than one hole is expected.

Scoring: The test is passed if the creases in the paper are properly represented, if the holes are drawn in the correct number and if they are located correctly, that is both on the same crease and each about half way between the centre of the paper and the side. The shape of the holes is disregarded.

81. Absurdity No. 2 (Instructions as for Test 77).

Bill Smith, who afterwards married his widow's sister, always said that it was a man's misfortune if he had a bad sister, but his own fault if he had a bad wife.

82. Drawing the reversed triangle.

Materials: Paper and pencil for drawing. An oblong card 10 by 15 cm. (4 by 6 inches) cut across the diagonal, as used for the patience test. The card is first laid on the table before the pupil with the cut edges touching. Say: "Look carefully at the lower piece of this card. Suppose I turn it over and lay this edge (pointing to the line A.C. without moving the card) along this edge (A.B. of the upper triangle) and suppose that this corner (C) is placed just at this point (B) what would it all look like? Now I am going to take this piece away". (Remove the lower triangle from view). "Imagine it all placed as I told you, and draw its shape in the proper position. Begin by drawing the shape of the top triangle".

Evaluation. See Burt, Fig. 8b. The essential points are:-

- (a) ACB must be preserved as a right angle.
- (b) AC must be made shorter than AB.
- (c) Saffiotti adds: BC must retain approximately its original length as the shortest of the 3 lines.

YEAR XVIII

83. Disarranged sentences - D. (Instructions as in 53).

HARDEST THE US SOLUTION GIVES THE SATISFACTION OF PROBLEMS  
GREATEST THE.

84. Filling cans - arithmetic No. 6

Read this problem and see if you can give me the answer. Given a three-pint measure and a five-pint measure, how will you measure out ONE pint exactly using nothing but these two vessels and not

guessing at the amount? Begin by filling the three-pint vessel first. (Time limit 5 minutes).

85. Reasoning test 3. (Instructions as for test No. 69) A pound of meat should roast for  $\frac{1}{2}$  hour. Two pounds of meat should roast for  $\frac{3}{4}$  hour. Three pounds of meat should roast for one hour. Eight pounds of meat should roast for  $2\frac{1}{4}$  hours. Nine pounds of meat should roast for  $2\frac{1}{2}$  hours. From this can you discover a simple rule by which you can tell from the weight of a joint how long it should roast?
86. Seven digits:  
Listen and say these numbers.  
2-1-8-3-4-3-9, 9-7-2-8-4-7-5. (1 out of 2).

#### YEAR XIX

87. Vocabulary (41 words correct). (See test No. 66)
88. Disarranged sentences - E. (See test 63).  
NOT GOOD WORTH BE OF EASILY A OVERESTIMATED THE NAME CAN.
89. Absurdity 3. (Instructions as for test No. 77). Every rule, even this one itself, has an exception.
90. Six digits backwards. (Instructions as for 79).  
4-7-1-9-5-2, 5-8-3-2-9-4. (1 out of 2).

#### YEAR XX

91. Filling cans - arithmetic No. 7  
Given a three-pint vessel and a five-pint measure out exactly 7 pints.
92. Eight digits.  
Listen and say these numbers.  
7-2-5-3-4-8-9-6, 4-9-8-5-3-7-6-2. (1 out of 2).
93. Seven digits (backwards)  
I am going to say some numbers and when I have finished I want you to say them backwards.  
4-1-6-2-5-9-3, 3-8-2-6-4-7-5. (1 out of 2).

#### SUMMARY OF SIMILAR TESTS

Syllables - see test 12 in the Instructions.

Knox tests - see test 29 in the instructions.

Repeating digits:

2. 8-1, 3-7, 9-4 (1 out of 3)
7. 6-4-1, 3-5-2, 8-3-7. (1 out of 3).
16. 4-9-3-7, 2-8-5-4, 7-2-61 (1 out of 3).
40. 5-2-9-4-7, 6-3-8-5-2, 9-7-3-1-8. (1 out of 3).
55. 2-5-0-3-6-4, 8-5-3-9-1-6, 4-7-1-5-82. (1 out of 3).
86. 2-1-8-3-4-3-9, 9-7-2-8-4-7-5. (1 out of 2).
92. 7-2-5-3-4-8-9-6, 4-9-8-5-3-7-6-2. (1 out of 2).

Repeating digits (backwards):

38. 2-8-3, 4-2-7, 9-5-8. (1 out of 3).
54. 6-5-2-8, 4-9-3-7, 8-6-2-9 (1 out of 3).
79. 6-9-4-8-2, 3-1-8-7-9 (1 out of 2).
90. 4-7-1-9-5-2, 5-8-3-2-9-4 (1 out of 2).
93. 4-1-6-2-5-9-3, 3-8-2-6-4-7-5 (1 out of 2).

Comprehension of questions:

11. What must you do when you are tired?  
 What must you do when you are hungry?  
 What must you do when you are cold?  
 (2 out of 3).
23. What should you do:-  
 If it is raining when you start for school?  
 If you are going somewhere and the wheel of your motor car or wagon breaks?  
 If you find that your house is on fire?  
 (2 out of 3).
35. What should you do:-  
 If you have broken something that belongs to somebody else?  
 If you are on your way to school and notice that you may be late?  
 If a playmate hits you without meaning to do so?  
 (2 out of 3).
60. Why should you save some of the money you earn instead of spending all of it?  
 What ought you to do before undertaking (beginning) something difficult?  
 Why should we judge a person more by his actions than by his words? (2 out of 3). See Terman.

Similarities:

42. I am going to name two things which are alike in some way and I want you to tell me in what way they are alike:-  
 dog-horse, wood-coal, apple-peach, iron-silver.  
 (2 out of 4 actual similarity).
62. I am going to name three things that are alike in some way, I want you to tell me how they are alike.  
 snake-cow-bird, book-teacher-newspaper, cotton-wool-leather, knife-blade-piece of wire-cent, rose-potato-tree.  
 (3 out of 5) See Terman.

Material for administering the Test:

Cards used for tests 17, 20, 24, 30, 53, 64 obtainable from Terman's Test Material for the Measurement of Intelligence. (Geo. Harrap & Co., Ltd., London).  
 Five pillboxes weighing 15, 12, 9, 6 and 3 grammes, respectively, used for tests 19, 29, 45, 49 and 71.  
 Healy Fernald Formboard for test 50.  
 Two rectangular cards, each 4 X 6 inches, one cut diagonally in two, for tests 18 and 82.

GOODENOUGH DRAWING TEST"DRAW THE BEST MAN YOU CAN"

(ONE POINT)

1. Head enclosing head line
2. Legs (2) from front view 1 or 2 from side.
3. Arms attached anywhere
- 4a. Body even a line
  - b. Length breadth
  - c. Shoulders bent at neck and shoulders.
- 5a. Arms and legs joined to body at any point.
  - b. Legs to body, arms to shoulders.
- 6a. Neck
  - b. Neck continuous with head and body.
- 7a. Eyes 1 or 2.
  - b. Nose
  - c. Mouth
  - d. Nose and mouth (2 lips) 2 dimensions.
  - e. Nostrils.
- 8a. Hair
  - b. Hair without outline of head.
- 9a. Clothes (any)
  - b. 2 clothes (not transparent)
  - c. Sleeves and trousers,
  - d. 4 clothing.
  - e. costume.
- 10a. Fingers any method.
  - b. Right no.
  - c. Finger detail.
  - d. Opposition thumb.
  - e. Hand.
- 11a. Arm joint elbow.
  - b. Leg joint knee.
- 12a. Proportion head not more than  $\frac{1}{2}$  - not less than  $\frac{1}{10}$  of body.
  - b. Proportion of arms as long as body.
  - c. Proportion of legs not more 2 x body.
  - d. Proportion of feet (length width not more than  $\frac{1}{3}$  not less  $\frac{1}{10}$  leg).

- 12e. 2 Dimensions arms and legs
13. Heel
- 14a. Motor coordination no gaps firm lines.
- b. Motor coordination firm accurate joints.
- c. Motor coordination head outline no irregularities.
- d. Motor coordination trunk outline no irregularities.
- e. Motor coordination arms and legs (2 dimensions)
- f. Motor coordination features in proportion and symmetry.
- 15a. Ears
- b. Ears position and proportion.
- 16a. Eye details brow or lashes.
- b. Eye pupils.
- c. Eye proportion length breadth.
- d. Eye profile and pupil.
- 17a. Chin and forehead and eye and mouth must be present.
- b. Chin marked off from underlip.
- 18a. Profile, head, trunk, feet.
- b True profile.

## Norms:

SCORE	1	2	3	4	5	6	7	8	9	10
M.A.	3,3	3,6	3,9	4	4,3	4,6	4,9	5,0	5,3	5,6
SCORE	11	12	13	14	15	16	17	18	19	20
M.A.	5,9	6,0	6,3	6,6	6,9	7,0	7,3	7,6	7,9	8,0
SCORE	21	22	23	24	25	26	27	28	29	30
M.A.	8,3	8,6	8,9	9,0	9,3	9,6	9,9	10,0	10,3	10,6
SCORE	31	32	33	34	35	36	37	38	39	40
M.A.	10,9	11,0	11,3	11,6	11,9	12,0	12,3	12,6	12,9	13,0

1 point for each correct item.

Basal Age 3.

For each 4 points, add one year (1 point =  $\frac{1}{4}$ yr).