# THE EFFECT OF AGE ON THE INTELLECTUAL PERFORMANCE OF MENTAL DEFECTIVES

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## ABSTRACT OF THESIS

The necessity for the present study was felt after a review of the literature revealed that few of the many studies concerned with the relationship between age and intellectual processes, dealt specifically with the lower intelligence range. Those which were concerned with large groups were mainly found in the literature of the early years of the century. Their findings were at variance with the more hopeful view of which there was some suggestion in the more recent literature. The purpose of this study was to obtain data which might aid in clarifying an ambiguous situation with regard to the intellectual functioning of mentally defective persons over a wide range of the life span.

The subjects used in the experiment were one hundred familial patients resident in the Manitoba School for Mentally Defective Persons. They ranged in age from fifteen to sixty-four years, and were divided equally into four groups having mean ages of approximately twenty, thirty, forty and fifty years at the time of the first test with the Wechsler-Bellevue Intelligence Scale. Five years later the same test was re-administered.

The results were appraised in two ways: first, the changes occurring in intelligence over a five-year period, and second, changes in intellectual functioning over the entire age range.

Significant mean gains in score were found in all four

age groups when they were retested five years later. These gains were found on all sections of the test, and furthermore, were shown in the scaled scores as well as in I.Q. ratings. Actual or real increases in intellectual performance were therefore obtained. The amount of gain on the Full-Scale was found to diminish as the mean age of the group increased by decades. Performance gains diminished over the time span, while larger Verbal gains were shown at the older age levels. It was found that eighty-eight percent of the subjects tested, either increased or equalled their former scaled scores on the retest, while ninety-eight percent either increased or equalled their former I.Q. ratings.

Turning to the cross-sectional aspects of the study, it was found that the scaled scores on the Full-Scale held up well between the ages of twenty and forty-five, but showed a decline thereafter. The scores of the fifties were significantly below those of the forties. The Verbal scaled scores showed no appreciable loss until the fifties. The Performance scores as a whole decline gradually from the twenties to the fifties, the level regressed to at this age was approximately fifty percent of that reached in the twenties. This was the sharpest drop found to occur in any scale.

The apparent discrepancy between the consistent gains obtained on the retest and the slight decline appearing when the scores are plotted over the entire age period, was attributed largely to a difference in the approach used. Longitudinal studies have almost invariably reported that mental

abilities hold up with age, while cross-sectional investigations report losses of varying amount over the age range.

It is believed that if a purely longitudinal study had been carried out, the tendency of the mental defective to show an increase of mental ability over a five-year period, would also have been evident over the entire age period studied. The gains shown are therefore regarded as a valid indication of an increase in mental ability over the years; a phenomenon of a later maturational process.

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# CHAPTER I

## THE PROBLEM AND THE INTRODUCTION

### I. STATEMENT OF THE PROBLEM

Considerable interest in intellectual processes has existed over the centuries, but although this interest was aroused and stimulated by the recognition of deviates from the norm, mental deficiency has been traditionally a neglected field of study. Research literature abounds with reports of investigations concerning various aspects of intelligence, but in the main, the accent is on the normal and superior range of ability.

One main area of interest has been in the effect of age on intellectual processes. Most of this research has been concerned with children, adolescents and young adults. One of the problems is concerned with the age at which the peak of intellectual ability is reached by people who are of normal, above normal, or below normal intelligence. With the recent development of interest in Gerontology, or the science of ageing, research workers have extended their investigations to include the nature of intellectual functioning in adulthood and old age. However, this interest is almost exclusively directed to people of normal or above normal intellectual ability. Very little investigation has been made of later age changes in mental performance of people whose intelligence range is below normal.

The purpose of this study is to investigate the development and decline of the mental defective throughout the life span, using the Wechsler-Bellevue Intelligence Scale. Employing a partly longitudinal and partly cross-sectional approach, the differential rates of the growth and decline of the measured subabilities will be examined.

## II. INTRODUCTION

The necessity for the present study was felt after a review of the literature revealed that a comparatively small proportion of the numerous investigations on the relationship between age and intellectual processes dealt specifically with the problem of the mental defective. This may be the outcome of the assumption that the theory of mental development was equally applicable to all individuals regardless of intellectual level, and that the mental development of the defective required no special explanation. There is, however, some evidence to the contrary. Therefore it was felt that an investigation dealing specifically with the intellectual abilities of the mental defective might aid in clarifying an ambiguous situation.

The postwar years have seen an added impetus and a new orientation given to studies of mental deficiency. Increased interest is due in part to the rise and the rapidly growing strength of parents' organizations. These movements, now organized on national levels, have as their primary aim

the amelioration of the condition of the mental defective in our society. They stress the need for public acceptance of responsibility in such matters as prevention and rehabilitation, and to this end they press for research which will lead to a fuller understanding of the condition of mental deficiency.

Advances in the field of medicine have lengthened not only the life span of normals but also of mental defectives, so that institutions today house many more older patients than in past years. For humanitarian reasons as well as from the viewpoint of economic necessity, it is imperative that there be a better understanding of the intellectual capacities of the mental defective. It is the aim of this study to provide us with more information on this problem, with special emphasis being placed on the effect of age.

The thesis begins with the historical view of mental deficiency and proceeds to a discussion of present day concepts, including classification, quantitative estimates, etiology, and pseudo-feebleminedness.

Changes in intelligence as a function of age are next discussed. Research dealing with the normal population is examined first, followed by some account of investigations of the superior population. The results of some studies which deal specifically with the mentally defective populations are then presented. Following this historical view of the literature, the procedure of this study is described and the

results outlined. The concluding section is concerned with a summary of the results and the conclusions drawn from the investigation.

## III. THE NATURE OF MENTAL DEFICIENCY

### Historical Views

An interest in mental deviations from the normal is as old as the human race, but written records go back only two or three thousand years. The Bible records the depression of Saul, the hallucinations of Nebuchadnezzar and the feebleminedness of Esau, while the works of Hippocrates make frequent reference to mental disorders.

Hippocrates is said to have held that mental aberration had its origin in an improper balance of "fire and water", recognizing three degrees of such imbalance, the criterion for each being the extent of the individual's deviation from normal behavior. He asserted that mental abnormality was due either to disease or injury to the brain, and therefore advocated physical therapy which was especially directed toward the "juices of the body". His belief in a physical basis for mental disorder and emphasis on bodily fluids has developed into the present science of psychosomatic medicine.

Felix Plater's Praxeos Medicae, appearing in the early seventeenth century, devoted special sections to "Mental Imbecility, Mental Consternation and Mental Alienation". The section on "Mental Imbecility" includes state-

ments which accord rather well with current opinion on the subject, for example:

> Imbecility consists of a weakness or perception, judgment and memory....Imbecility is hereditary; a child born of weak-minded parents is especially predisposed thereto....Blows on the head...bring on enfeeblement of the intelligence...idiocy betrays itself even as early as the time of birth...one observes it in the movement of the child, its capacity for speech.

Anima Brutorum, appearing about 1667, states that idiocy and stupidity depend on a lack of judgment and intelligence, "the actual rational mind being not concerned". The author points out that such a condition:

> ...is inherited when an imbecile has an imbecile child, and accidental if a mentally normal person has a stupid child....Many children who are normally developed mentally, become at the age of puberty stupid; but also, retarded persons may show at the age of puberty an unexpected mental independence.

The works of authors of this period are not without reference to evil spirits and demon-possession, but a more material concept of mental disorder is in the process of formation.

Sylvius (Opera Medicae, 1677) describes in detail how disorders of "the brain and nervous organs produce derangement of sensation, thought, pain, imagery, judgment, emotions ...thereby causing deficiency and manifestations of insanity". One specific statement, namely, "Even the condition of many stupid men is to be designated sickness", could be said to be the seventeenth century version of the orientation of mental health programs today.

The concept of the importance of the life-history of the patient in diagnosis was developed by those scientists of the nineteenth century who were investigating mental disorder in general rather than mental deficiency as a specific entity. These researchers were interested in the "course" of a condition as well as in isolated episodes of behavior, consequently there was laid at this time a foundation for an imposing structure of evidence which testifies to the importance of environmental influences on intellectual behavior, no matter what the extent of the native capacity for learning.

By the end of the nineteenth century there had come to be recognised a group of people who fell far behind their fellows in level of intellectual accomplishment and general social competence. A small proportion of these showed physical anomalies such as accompany mongolism or hydrocephaly and a generalization was made that all defectives were medical problems.

With a growing realization that cases showing such obvious physical stigmata were in a small minority, the concept of "arrested development" was postulated (41). Presumably the mental defective had begun as a normal person, but his development had been arrested at some point below that reached by the normal individual. There appears to have been a division of opinion as to whether this arrest was general and included all aspects of development, viz., mental, physical and emotional, or whether a highly specialised trait

called intelligence was involved. In the latter case the feebleminded need not show physical stigmata or social maladjustment. Mental deficiency was a developmental status rather than a disease; its chief manifestation was intellectual retardation.

About 1930, this concept was challenged by Hollingworth (75), who declared that if the mental defective suffered from arrested development so also did his fellow individuals. The growth rate of various "faculties" was found to be a differential one by scientists of this period (84, 110), but at no point were they found to stop suddenly. The mental defective like the normal child was thought to develop mentally till after adolescence but the peak of his development might be reached at a somewhat earlier age, not by arrest but rather by a retardation of growth. The mental defective says Hollingworth is defective from the beginning, his deficiency is apparent in his earliest acts; his inadequacy is general but it is also differential. "His career is not that of an arrow suddenly blocked in flight, but rather that of one launched with feeble compulsion" (75, p. 162).

There is a general agreement today that the main features of mental deficiency are intellectual retardation as measured by school progress and intelligence tests, together with social incompetence. These failures in adjustment to the complexities of modern living are the result of conditions whose nature may be hereditary, congenital, neo-natal or post-

natal, but they all have a similar outcome, namely, incomplete development of the mind (40, 57, 108).

Certifiable mental defect depends on these dual criteria, and since one of these, namely, intellectual retardation, involves a psychometric rating, it is proposed now to summarize briefly the historical background of the intelligence testing movement as it applies to mental deficiency.

Quantitative Estimates of Mental Deficiency

Little systematic study of the varying degrees of mental ability was made until the nineteenth century, or in adequate fashion until the twentieth century. Locke and Rousseau had directed attention to the variation of potentialities in children, and Itard put many of their ideas into use in his attempt to educate the wild boy of Aveyron. His efforts in this instance met with failure, but Seguin, a pupil, carried on his work, establishing a school for the mentally retarded in Paris in 1837. Esquirol in 1838, made the first explicit statement of the difference between mental deficiency and insanity, pointing out that the degrees of feebleмindedness varied along a continuum from normalcy to idiocy. Esquirol was also the forerunner of those scientists who regarded the individual's verbal ability as a dependable index of his general intelligence (5, 10).

The early research of Galton and Cattell was devoted to sensori-motor tasks rather than the investigation of differential ability in verbal skills as a criterion of intelli-

gence, but these tests combined with the statistical measures of Pearson became oriented toward the estimation of the general mental capacity of the individual, the term "mental test" first being used by Cattell in 1890 (5, 10).

The growing recognition of and concern for the mental deviate, together with the problems raised by an increasing need for institutional care emphasized the necessity for tests that would differentiate among the various degrees of deficiency. Certification was made at this time on a basis of demonstrated social incompetence which was difficult to define in legal terms.

Early in the twentieth century, impetus was given to the mental testing movement by Binet (24), who used both sensory and perceptual items in his studies of the non-achievers among the school children of Paris. His first scale, published in 1905, was followed by several revisions, the term "I.Q." first being used in the Stanford Revision of 1916 (151). Binet's "mental age" concept was easily understood and proved popular. The Binet Scale commonly in use today is the Terman and Merrill Revision which was published in 1937 (152).

In recent years a host of other people, prominent among them David Wechsler (164, 165, 166), have devised intelligence scales, seeking to improve their accuracy for diagnosis of the intelligence level of the individual or the

prediction of his potential ability in terms of its relatedness to the norms of the population. Consequently there has existed for many years a criterion of the degree of deficiency in the below normal individual which may be expressed in quantitative terms.

Classification of Mental Deficiency

In the early days of classification, definitions of degree of deficiency were made solely on a basis of the individual's scholastic achievement and general social competence. The Mental Deficiency Act of 1913 in England, defined three grades of deficiency as follows: a) idiots -- who were unable to guard themselves against common dangers, b) imbeciles -- who were incapable of managing themselves or their affairs, and, c) the feebleminded -- who were unable to profit from instruction in ordinary schools.

Later definitions in England (1931), and in America after the intelligence testing movement began, defined gradations in terms of I.Q. and mental age. At this time the terminology of the grouping of mental defectives was somewhat confusing, but contemporary authorities grade the subnormal as follows: a) idiots -- who have a mental age of two or three years and an I.Q. of less than 25, b) imbeciles -- who have a mental age of about seven years, and an I.Q. of 45 to 50, c) morons -- who may have a mental age of twelve, and an I.Q. of up to 70 or 75. From this point on, a dullard group ranges upward to a borderline category of individuals

who will require special placement within the regular school system, or because of behaviour problems may need custodial care, with education within an institution.

It has already been stated that certifiable mental deficiency includes a psychometric rating plus an estimate of social incompetence which would place an individual within one of the above categories (5, 10, 42, 58). There is however some evidence (22, 79, 88, 145) that there is not always a positive correlation between the I.Q. score and the extent of social competence. Some adults with an I.Q. of 60 are found to be well-adjusted, while other individuals with an I.Q. of 85 require custodial care (58). Delay et al (36) report two cases in which intelligence was normal or superior, but in which the general behavior forced a diagnosis of mental deficiency.

Esher (46) points out that the social and emotional stability sometimes found to accompany a mental age of five years is apparently the result of good family training, educational influences, and the sympathetic understanding of associates, friends and employers.

Further evidence that social competency and the range of I.Q. are not necessarily correlated is offered by Fox (53) who examined two groups of elderly subjects, one group being institutionalised and the other maintaining itself in society. The mean intelligence scores of the two groups were within one point of each other. Fox ruled out such variables as

education and socio-economic circumstances in his selection procedures, but it may be that personality factors, emotional and motivational, have contributed to the observed discrepancies between the social capacities of the two groups.

Heiser (73) comments that the conventional categories of idiot, imbecile, and moron within the I.Q. range of zero to 70, "imputes a totally unreasonable omniscience to the intelligence test, a power which has not been claimed by test constructors". Constancy of I.Q. is assumed by such distinctions, and such constancy has failed to be demonstrated in his opinion. Heiser stresses the need for the consideration of such practical problems as the physical, social, and personality development and function as well as the I.Q. score before a clinical diagnosis of mental deficiency is made.

Etiology of Mental Deficiency

This review of the problem of mental deficiency has already dealt with the difficulties involved in arriving at a classification of the subnormal in terms of the psychometric and social competency criteria. It is proposed now to consider classification as established medically by the criterion of etiology.

Again the diagnosis demands a careful scrutiny of such factors as physical defects, family history, history of the individual's development, social history, school progress, ability to be self-supporting, and ability to make moral

judgments (25, 70, 72, 89, 111, 117, 119, 124, 149, 159). Benda and Farrell (16) emphasis that research must seek to delineate groups of mentally below normal individuals in terms of the factors operating in causing pathology. These factors may operate either in the prenatal, neonatal or postnatal periods; some are genetic in nature, while others are congenital, e.g., infections and malnutrition (6, 37, 57, 108, 116).

E.D. Lewis (90) classifies mental defectives as pathological or subcultural, while the terms organic and non-organic, exogenous and endogenous brain-injured and familial or "garden-variety" (151), make the same sort of distinction as to etiology.

The disease or condition producing the pathological type might be hereditary or environmental, but is considered to depend on a single gene in the former case (5, 29, 67, 127). In the past, stress has been laid predominantly on the genetic factor in the case of the subcultural defective, but of late the environmental aspect is assuming greater importance (32, 34, 40, 59, 63, 82, 95, 97, 129). Gibson (87) states that, "while it is generally conceded that subcultural defect may be aggravated by an adverse environment, it is usually regarded as the effect of multiple genes."

The subcultural group includes 70 to 75 percent of all defectives and is thought to represent the lower range of the intelligence curve, while the organic cases are

scattered at random throughout the population and are not necessarily connected with homes of lower socio-economic level (29, 66, 90, 127, 133).

As more is learned about this large group, often called simple aments or undifferentiated types, it is likely that this category will be subdivided into several distinct types with differing etiologies. Benda (15) has found as a result of autopsies, definite neuropathology in the brains of 200 defectives who had been diagnosed as familial cases. Weatherwax and Benoit (163) say there is incontrovertible evidence that patients generally classified as non-organic do not have some organic basis for their lower mentality as well as those who have been diagnosed by criteria of known injury or disease, and who present some stigmata of degeneration. Bensberg and Sloan (20) using the Cattell Culture-free Test and the Stanford-Binet failed to find support for the hypothesis that cultural deprivation is a factor contributing to the familial type of deficiency.

There is, however, a considerable amount of evidence which would appear to refute such findings (32, 34, 59, 60, 82, 97, 105, 111, 112).

At this point it is sufficient to say that there is no complete agreement among authorities as to the etiology of mental defect, but scientists have accepted the assumption that differing etiologies will probably be reflected in differences in intellectual performance on a variety of tests.

Some of the studies carried out in a search for such differences will now be taken up.

Differential Test Performance of Exogenous and Endogenous Groups

Durling and Benda (45) have examined the mental growth curves of mongoloids, comparing them with the performance of familial cases matched for age and intelligence level. The two groups showed differing patterns of mental development. Slowness of growth was more conspicuous in the mongoloids than in the familial cases, but twice as many mongoloids showed a tendency to make gains after the age of 16.

The performance of brain-injured patients has been contrasted with that of endogenous groups by McMurray (98), who employed a card-sorting test; the endogenous group were found to be significantly more rigid in their thinking.

Familial mental defectives are found by Rustia (47) to have specific language difficulties and uncertainty in spatial orientation, as well as confusion of direction. He believes that the fundamental nature of their deficiency is a slowing of maturation, dependent on the slow tempo of myelination of motor and nerve tracts. He finds the thought processes of exogenous cases to follow unexpected lines, while those of the endogenous type concern objects and appear to be relatively static, with some tendency toward abstractions.

Shotwell et al (138) used the Lowenfield Mosaic Test with exogenous and endogenous groups, finding a wide variety

of Mosaics in both groups with some overlapping of distinguishing features. Differences were found in methods of attacking the problems, with less fore planning, coherency, and organization found in the solutions of the exogenous group. Similar results were observed by Bensberg (18) using the Bender-Gestalt, and Dolphin et al (45), who used a picture object formation test. Halpin (67) using the Bender-Gestalt and the Goldstein-Sheerer Stick Test found that familials performed better on tasks requiring visual-motor integrations than do brain-injured children.

A qualitative study of the responses to the Wechsler-Bellevue Similarities subtest was made by Stacey and Markin (147), who found differences among three groups of subjects, namely, defectives, borderline, and dull normal. The more defective subjects were found to give functional rather than descriptive answers, while the dull normals leaned heavily on description and made little attempt at abstractions. There were no significant differences among the groups in abstract responses; the general belief is that the subnormals as a group tend to remain at the level of concrete concepts. Other studies (62, 118, 143) also have found that mental tasks involving abstractions are especially difficult for the mental defective.

Using the Wechsler-Bellevue Intelligence Scale, Allen (3) finds the least affected subtests in cases of brain-injury to be Vocabulary, Information, and Comprehension,

while those most affected are Digit Span, Digit Symbol, Block Design, and Object Assembly.

On the other hand, Goldman et al (61) find Picture Arrangement, Picture Completion, and Block Design to be most markedly affected in organic cases, agreeing with Allen only on Block Design which is not a highly reliable test.

Beck and Lambert (14) using the WISC with three groups of patients, organic, non-organic, and suspected organics, found differential psychometric patterns. The verbal and performance scores varied significantly and inversely with the degree of organic involvement. Only in the non-organic cases was the performance I.Q. above the Verbal I.Q. No characteristic pattern of subtest scores was found for the organic group.

These particular studies are concerned with the possible use of subtest patterns in clinical diagnosis. It is evident that much more research is required before the intelligence test can be used diagnostically with any degree of confidence, but it is an interesting possibility. Broadly speaking it would seem that the brain-injured defective will hold up better in the verbal tests while the familial cases tend to do better on the performance tests.

Although no clear-cut pattern of difference in intellectual performance has yet emerged, it is obvious that results will be vitiated and comparisons continue to be confusing unless adequate attention is given to the etiology of

the groups involved in a research project.

The Concept of Pseudo-feebleminedness

Traditionally there has been a belief that the mental defective is not as susceptible as the normal individual to personality disorders, though the concept of under-functioning on intelligence tests as a correlate of emotional instability is not a new one (22, 26, 72, 95, 105). Actually there is probably a low correlation between range of intelligence and the extent of emotional adjustment (46, 53, 58, 79, 141, 145). The mental defective has the same needs for approval, assurance, and affection as the normally intelligent individual has; emotional deprivation in both cases is known to result in anxiety, conflicts, fear and loneliness, all of which may be reflected in test scores (17, 33, 39, 65, 88, 130).

Dr. Isaac Jolles (80) has gone so far as to state that mental deficiency of the familial or undifferentiated type is a symptom of personality disorder rather than an indication of limited mental ability. His view is thought to be too hopeful by many, but some support is given by Heuer (112) who finds that emotional disturbance together with inferior cultural milieu and substandard living conditions are mainly responsible for the existence of the moron class which includes so large a percentage of all defectives.

Kutash (88) and Sarason (130), using personality tests have found similar emotional stresses in normal and

subnormal individuals. Such stresses they believe, may depress the I.Q. score to a degree indicative of mental deficiency, hence the concept of "pseudo-feeblemindedness" as a disease syndrome symptomatic of personality disorder (109, 112, 130). The inference is that as such, it is treatable and amenable to improvement through psychotherapy. The results of Kutash and Sarason are supported by similar investigations made by Sloan (141), Bergman et al (22), and Heiser (72). Heiser's study cites cases where therapy has been beneficial.

McCandless (97) is in essential agreement with this point of view. He proposes two hypotheses to suggest how the individual's psychological environment may contribute to the development of the familial type of mental defect, reiterating the assumption already made, that an impoverished environment may provide inadequate opportunity for acquiring the skills subsumed under the term intelligence. In addition he postulates that such an environment may stimulate habits which are detrimental to intelligent behavior, e.g., expectation of failure, concrete rather than abstract thinking, and a lack of motivation.

Grace Arthur (6) includes in the category of pseudo-feeblemindedness those individuals with special disabilities which have been confused with poor general ability, e.g., physical handicaps of sight, hearing, or early severe illness, as well as the brain-injured. It will be noted that she cuts across the dichotomy of endogenous and exogenous etiology and

includes cases from both categories, whereas those investigators previously quoted confine the use of the term to the familial group.

Summary

A definition of mental deficiency given by Doll (40) in 1941, which has been generally accepted by authors today is as follows:

> Mental deficiency is a state of social incompetence obtaining at maturity, or likely to obtain at maturity, resulting from developmental arrest of intelligence because of constitutional (hereditary or acquired) origin.

Certifiable mental defect depends on the dual criteria of intellectual retardation and social incompetence. To designate anyone a certifiable mental defective is to make a serious decision, for such a diagnosis implies institutionalization of the patient.

Defectives as a group are found to be as complex in their behavior patterns as normals are, and cannot be diagnosed outside their total current situation. They are found to suffer from the same environmental limitations, physical defects, and emotional maladjustments. Possibly the defective is more greatly handicapped by such factors for he lacks powers of adjustment and the ability to profit by experience, through the very nature of his deficiency.

Research in the field of psychotherapy is of comparatively recent origin and much more investigation will be required before its usefulness can be established. Perry (117)

points out that while mental deficiency is generally regarded as a relatively incurable condition, this kind of thinking is not congruent with the trends in other areas of mental health where alcoholics, psychotics or delinquents are the victims.

There is abundant evidence (37, 73, 80, 88, 95, 108, 112, 116, 129, 130, 132, 134) of a renewed interest in the capacity of the retarded to change and be changed, with emphasis shifting from intelligence as the central problem to the subject of the personality as a whole. The orientation of research today is toward better understanding of mental processes of the mental defective, for reasons which may be theoretical or practical, or essentially humanitarian.

## IV. AGE CHANGES IN INTELLIGENCE

Since the modern era of intelligence testing began in the early years of the twentieth century, a considerable body of data has been accumulated on the effects of age on mental processes. Many investigations have sought to establish the limits of intellectual growth as well as the duration and rate of decline; other studies have been concerned with the facets of intelligence as revealed by an analysis of subtests.

Studies on age changes in general intelligence may report their findings in terms of a single score such as the I.Q., or changes may be described as a rise or a decline in specific intellectual functions, e.g., a Verbal or Performance score. Again the score may be a composite of the two, as in the Wechsler-Bellevue Intelligence Scale.

Two main types of approaches have been used to study the age changes in intellectual functioning, viz., longitudinal and cross-sectional. In the longitudinal approach the same subjects are retested periodically over a large part of their life span. This is the ideal method but it is extremely arduous and time-consuming. Only a handful of studies have employed it. The usual approach is the cross-sectional one where the investigator tests groups of individuals who represent the different age levels of 20, 30, 40, and so on, at the time the study is in progress. This method is much easier to carry out because the investigator can test all of his subjects simultaneously and does not have to wait for them to grow older. Almost all of the studies to be reviewed are of this type. Among the serious weaknesses of this second approach is the problem of getting comparable groups (in terms of education, socio-economic background, occupation) at the different age levels. Only to the extent that large samples of carefully matched subjects can be obtained can any confidence be placed in the findings of cross-sectional investigations. Since each of these methods possess certain inherent weaknesses, a compromise method employing both approaches could be used. This approach has not as yet been used. It will be employed in the present investigation.

In the following section research on age changes in intelligence of the general population will be taken up

first, then studies on the superior intelligence range, and finally a review of studies concerned with the mentally defective population.

## Age Changes in the General Population

### Age of Cessation of Mental Growth

About the time of World War One, the peak of adult mental age was placed at fourteen years but since then estimates of the age of peak intelligence have been placed progressively higher. When Terman and Merrill revised the Stanford-Binet (152) they estimated the peak of intelligence to be reached by the average adult at fifteen years, while the later Wechsler-Bellevue Intelligence Scale (164) placed the peak of intelligence in the early twenties. Conflicting estimates of peak age of intelligence may be due in part to the type of test used, e.g., the Stanford-Binet is largely a verbal test, while the Wechsler-Bellevue contains both verbal and performance items. Some tests are speeded, which penalizes older subjects, some are power tests, others are combinations of speed and power. Some tests reflect schooling more than others do, while such variables as cultural and socio-economic influences may preclude matched sampling. Another source of variation is a function of the type of approach used, i.e., whether the cross-sectional or longitudinal method is used.

Age Changes in General Intelligence

Several extensive studies of age changes in intelligence of the general population have been carried out. One of the most comprehensive is that of Jones and Conrad (81) who administered the Army Alpha Group Intelligence Test to a homogeneous population between the ages of 10 and 60 years. They found the growth curve to rise sharply at first, to be followed by a slower rate of development till a peak is reached somewhere between 18 and 21 years. A gradual decline followed. By the age of 55, the curve had declined to the 14 year level. When an analysis was made for the performance of individuals in the different intelligence ranges, Jones and Conrad found a differential rate of growth for bright and dull adolescents, but no evidence for a different duration of growth or point of decline.

Miles and Miles (101) administered the Otis, a verbal test, to a group of subjects ranging in age from 16 to 60 years found improvement in mean scores until the late teens or early twenties with a sharp drop thereafter.

Wechsler's standardization sample (164) included subjects within an age range of 7 to 65 years. He found that the peak of intellectual ability was attained at the age of 22 years after which it declined.

When comparisons are made among these three studies, employing the general population as subjects, the rate of

decline is found to differ, with the Otis curve dropping more sharply than the Wechsler curve, and the Army Alpha most slowly. These differential results are probably due to differences in the type of subtests used in the batteries, e.g., the Otis is a purely verbal test, while the Wechsler-Bellevue Intelligence Scale includes both verbal and performance items.

In these three studies it was found that the brightest persons in the older groups still performed conspicuously better than the duller subjects in the younger groups.

These differential results are supported by Raven's work (125) with 8000 subjects ranging in age from 6 to 60 years and varying in I.Q. level. He investigated vocabulary scores over the age span as a function of the intelligence range. He found that the abilities of the top five percent continued at a constant level over the age span. The subjects of the average group were slower to reach maturity and were consistently inferior to the top group, while those of inferior ability were still slower in reaching peak performance, were poor at all age levels, and ability declined earlier and more markedly.

An examination of the results of the more recently tested Wechsler sample (166) shows that scores continue to increase over somewhat a longer period, and decline is later than was observed in the case of the original Wechsler

sample. Educational differences between the two populations are known to exist, and the results probably reflect educational changes over the intervening fifteen years.

If the evidence of cross-sectional studies is accepted, we must conclude that mental growth continues till the mid-twenties and is followed by a decline which is more or less rapid, depending upon the type of intellectual process which is being appraised by the test.

Age Changes in the Subabilities

The studies that have been reviewed so far were concerned with age changes in general intelligence. Intelligence, however, is not generally regarded as a unitary function, rather it is thought to be composed of a number of different facets, each of which can be more or less specifically appraised (146, 155, 156, 164). The following section reviews the studies concerned with the different facets or subabilities of intelligence.

The Wechsler Scale (164) has been widely used in studies dealing with the growth and decline of the various aspects of intelligence assumed to be measured by the subtests. Consistent differences in mean scores are observed when the subabilities are examined in varying age groups. The scores of Wechsler's standardization sample show that in general the growth curves for the performance tests reach an earlier peak and show a sharper decline than do the verbal subtests. Performance scores as a composite of

the five subabilities, reach their peak before the age of twenty and begin their decline before 30 at steady but differential rates. Verbal scores on the whole reach their peak somewhat later and hold up longer in the main. Some tendency to drop after age 30 is observed but the scores show increases at ages 40 to 44 in four of the subtests while the fifth, Arithmetic, shows a slight gain at the next age level. Standard deviations are found to be generally larger at the older age levels when the mean score is equal to that of the younger subjects. Vocabulary was not included in the report of mean scores, but Wechsler says that it holds up well with age but does show some loss at the older age level. Information and Comprehension hold up well.

Wechsler has divided the subtests of his scale into two groups which are widely known as the "hold" and "don't hold" tests. The "hold" tests are those believed to show little decrement with ageing, and include Information, Comprehension, Object Assembly, Picture Completion, and Vocabulary. The "don't hold" group consists of Digit Symbol, Block Design, Similarities, Arithmetic and Picture Arrangement. In a reanalysis of Wechsler's data, Hunt finds himself in disagreement with the original dichotomy. He concludes that only Information and Comprehension can be said to hold up well with age. Object Assembly and Picture Completion, two "hold" tests, apparently did not hold up as well as did Arithmetic, one of the "don't hold" series (77).

Wadonick and Solomon (56), examining 50 subjects over the age of 60 in a denominational home for the aged, found the order of performance to be in agreement with Wechsler's findings. These subjects performed best on Comprehension and Information, while they showed the greatest decrement on Picture Arrangement and Digit Symbol subtests. This however was a highly selected sample for many of the subjects had been successful persons of above average intelligence.

In line with earlier findings, Berkowitz (23), studying a group of 1200 males aged 20 to 64, found that Vocabulary and Information showed no decrement with age. Other subtests such as Digit Symbol, Block Design, and Picture Arrangement, on the other hand, showed a progressive decline from the early twenties onward. The remaining subtests, Object Assembly, Comprehension, Digit Span, and Similarities, showed a progressive decline from the twenties into the late fifties, then levelled off with no further decrement.

Gurvitz (64), using the Revised Army Alpha and Beta as well as the Wechsler Bellevue Scale, found that greater decrements with age were shown in the Performance section of the Wechsler, the Alpha, and Beta, than in the Verbal subtests of the Wechsler. These greater decrements were attributed to the speed factor for the Alpha resembles the Wechsler Verbal test but is timed. The decrement in the 45 to 50 year-old group was 22 percent in the Alpha, while the Wechsler Verbal showed only half as much decline. The Army Beta which is a

Performance test showed a decrement of 25 percent, while the Wechsler Performance section (also timed) declined by 28 per cent.

Some support for the theory that decline in old age is due in part at least to loss of speed rather than power, is given by studies which compare the results obtained by different age-groups on the C.A.V.D. (a power test with unlimited time allowance), the Army Alpha, the Otis and the Thorndike Intelligence Examination for high-school graduates. Lorge (91, 92, 93, 94) found a decline with increasing age on all but the C.A.V.D., indicating that the loss was one of speed rather than power.

The consensus of opinion would seem to be that verbal tests on the whole show less decline and at later age levels than do the performance tests (23, 50, 51, 52, 64, 88, 122, 123, 164). The amount of age decrement varies with the nature of the function tested and the assumption underlying the test construction. If Performance tests are speeded they show greater decline (48, 49, 64, 92, 93, 94, 100, 103). Vocabulary and general information show little change with age and in some cases show improvement (23, 49, 50, 77, 81, 103, 136, 150, 156). Support is found for Wechsler's view that a valid test should contain material which examines differential aspects of ability.

## Age Changes in the Superior Population

Some reference was made earlier to the fact that the intellectual performance of the individuals of superior intelligence does not fall off as sharply or as soon as that of the average or lower intelligence levels. Several studies will now be taken up which deal specifically with the superior population.

A study by Sward (150), matched 45 University professors aged 60 to 80 with 45 younger academic men aged 25 to 35. He found some decline in mental abilities and overall I.Q. in the older men but there was considerable overlapping on all the tests, some older men surpassing the younger. The two groups were found to be equal in word-meaning, while the older group was consistently better on a Synonyms and antonyms test.

Longitudinal studies of age changes in intelligence are quite rare. Four such studies will be mentioned. One of these was carried out by Bentz (21) who periodically retested a group of 200 business executives on the A.C.E. Psychological Examination. He states that those subjects under the age of 35 at the time of the first test showed significant gains ten years later, while those aged 40 or over showed a slight loss.

Owens (115) administered the Army Alpha to 127 men who had taken the test 30 years before at College entrance. He found a significant mean gain in scores. Similar results

were obtained by Garrison (56) in a study of a group of men and women, using the Yerkes-Bridges Point Scale.

Employing the Concept Mastery Test over a twelve-year interval, Bayley and Oden (13) found continued increases in scores, even though the subjects ranged in age from 20 to 50 at the time of the first test.

There is thus some evidence that for certain groups at least, intelligence test scores may continue to increase through life (11, 13, 21, 115, 150). It should be pointed out that the subjects used in these studies were largely of superior intelligence, e.g., business executives and college graduates. The Bayley and Oden (13) study was concerned with a follow-up of Terman's gifted subjects.

The studies which are especially concerned with the mental abilities of the superior population stress the verbal aspects of test performance. It can safely be assumed on the evidence provided by studies of large populations in which the superior range is included, that there will be some falling off in tasks which involve speed (64, 81, 96, 100), but purely power tests will show little decrement with age in the superior individual (11, 13, 21, 115, 125, 150). Reference has already been made to Lorge's study which tested the speed factor. When corrections were made for the speed factor on the Army Alpha and the Otis, no essential decline in intelligence was found. The results were comparable to those of the C.A.V.D., the power test which had shown no decrease of

ability with age (91, 92, 93, 94).

Having reviewed the literature on age changes in intelligence in the general and superior population we turn now to the studies which are concerned with the mental defective.

Age Changes in the Mental Defective Population

Some of the difficulties encountered by the scientist who investigates the mental processes of the normal population have already been mentioned, but when the research deals primarily with the mental defective, such difficulties are often magnified, with additional variables contributing to an already complex design.

Sampling for the purpose of cross-sectional studies is complicated by educational and socio-economic influences in any case, but when the subjects are mental defectives, the variety of types making up this population must be taken into account. For example, studies have already been reviewed which show that groups which differ in etiology, (endogenous and exogenous groups, and such categories as the mongoloid), display dissimilar patterns of mental growth and decline as well as qualitative differences in performance on a variety of tasks assumed to measure the differential aspects of intelligence (14, 45, 47, 61, 62, 67, 116, 133, 139, 143).

There is a dearth of research which employs large numbers of mental defectives and the reasons for this are easily identified. In the case of the normal subject a group

test may be employed, whereas an individual test is necessary for the defective; also the large number of subjects required for cross-sectional studies are not readily available. Longitudinal studies are costly and time-consuming, while populations tested originally have in the past shown a tendency to decrease in number due to factors such as early death-rate, or on the other hand, to rehabilitation. Retests after any considerable period of time may be concerned with a smaller and more homogeneous sample than was originally intended, their value thus being reduced.

Research which deals particularly with the mental processes of the below normal group follows the same designs and explores the same areas as the studies which are chiefly concerned with the normal or superior population. Some of this research is now examined.

The Growth and Decline of Mental Abilities

It was assumed by Stern (148) in 1914 that the age of cessation of mental growth changed markedly with the grade of intelligence. His assumption of an early cessation of mental development for the individual of below normal intelligence appeared to be verified by the findings of Doll (41) who as a result of a re-examination of feebleminded patients, placed the peak age of their mental ability at 11 to 13 or 14 years, depending on the grade of intelligence.

Kuhlmann (87) conducting a study in 1921, challenged Doll's conclusion regarding an early arrest of intelligence in the

mental defective. He examined 639 feebleminded subjects over a period of 10 years, finding that the mental abilities of the subnormal group increased with age at a rate proportionate to the degree of intelligence. On the whole he found mental growth continuing to 15 years for low-grade patients, while those of the borderline group showed improvement up to the age of 18. Lower grade patients were found to lose in mental age more frequently than the high-grade, while frequency in loss increased with age, independently of grade of intelligence. Kuhlmann's findings as to the peak age of mental growth resemble those of the large cross-sectional studies where a sample of below normal individuals has been included with normal and superior subjects, but while the latter show that the abilities of the brighter subjects hold up best with age, Kuhlmann found the scores of his brighter subjects declining more rapidly than those of his duller subjects. Kuhlmann was, however, seeking to differentiate between groups of the feebleminded, while the cross-sectional studies on the whole population report on the mean performance of the lower intelligence range.

A study which supports the assumption of early decline in the mental defective is that of Sloan and Harman (144), who studied 2,267 tests and retests of subjects with mean initial I.Q. of 50, and a mean chronological age of 14.8 years at the time of the initial test. The median span of time between test and retest in the whole group was 5.5 years, some inter-

vals being more than 12 years. Decreases in scores on the retest were shown in 61 percent of the cases, while gains were made by 31 percent. Among the patients with a mental age of less than three years the proportion of cases showing a loss was relatively lower. Sloan and Harman sum up their findings in a statement that the mental defective does not maintain a constant I.Q. but tends to decrease his score as he grows older. Changes in I.Q. were not related to the level of intelligence, but the patients on the whole showed an early decline in mental ability.

Kaplan (83) reapplied the Stanford-Binet to 66 morons after an average interval of nearly 15 years. The mean age at the time of the first test was 41.17 years and the mean I.Q. was 57.01. The average decline was only 6.65 M.A. months, which is less than the normal increment for age allowed for in Wechsler's Scale. The initial I.Q. appeared to have no bearing on the test results, and nine persons were found to have increased their scores. Sward (150) has found deterioration to occur less and later the higher the intelligence level, but Kaplan's results would suggest that deterioration in the defective may not be as general or begin as early as some of the studies have indicated.

It is apparent that studies of the general intelligence of the mental defective do little to clarify an ambiguous situation regarding intellectual growth and decline. It is proposed now to examine some research which deals with the subabilities.

Subtest Patterns in the Performance of the Mental Defective

As in the case of normal subjects, stress is now being laid on specific aspects of cognitive functioning in the mental defective. Since ageing undeniably involves organic and physiological changes it would seem to be important to investigate the extent to which such changes are reflected in subtest performance (170). The psychometric pattern of the mental defective is of considerable interest at the present time, for efforts are being made to distinguish between normal ageing processes and those in which pathology is involved, and also to define the patterns of different diagnostic groups (78, 121, 123). Again the Wechsler-Bellevue Scale provides an instrument of measurement, though its effectiveness for use with the mental defective has been questioned. Sloan (140) as well as Boehm and Sarason (27) report studies which show that positive deterioration indices are found in undeteriorated defectives, among whom, low scoring on the "don't hold" tests seems to be a life-long feature. There is also a criticism by Olch (113) that the patterns of schizophrenic deterioration are the same as those postulated for normal ageing processes on half the subtests.

Wechsler states that there are some difficulties in differentiating mental deficiency from simple schizophrenia in a small number of cases, the most critical subtests appearing to be Arithmetic, Similarities and Block Design. He finds that schizophrenics may on occasion get high scores on any or all of these subtests, but the mental defective, almost never.

These three tests, he finds, will differentiate between borderline and definite mental deficiency, for the true defective tends almost invariably to score low on all of them. On Digit Span and Object Assembly, he has found that defectives will not infrequently obtain non-defective and even average scores. Mean scores on defective groups are often higher on Vocabulary than for any other subtest, and this in spite of the fact that mental defectives generally score higher on the Performance than on the Verbal part of the scale. This may not be true in some cases of organic pathology, especially if the patient has formerly had a reasonably high intelligence rating (164).

At the present time the usefulness of the scale in clinical diagnosis depends on the experience and skill of the psychologist, but it has proved effective in measuring the growth and decline of the various aptabilities subsumed under the name "intelligence".

It has already been stated that there is no general agreement as to which of the subtests "hold" with age and which do not, but there is added controversy when the subjects of the test are mental defectives. Babin (121) includes Similarities in the "hold" tests and omits Object Assembly and Picture Completion from Wechsler's original list of "hold" tests. He omits Digit Span and Arithmetic from the "don't hold" group, presumably believing them to hold up better with age in the mental defective. The pattern which finally emerges is a dichotomy which designates all

Verbal subtests as "hold" tests, and Performance subtests as the "don't hold" category.

One of the more comprehensive studies on ageing process in the mental defective is that of Thompson (153) who examined 137 subjects aged 16 to 69, of moron grade (50 to 70 I.Q.). He employed ten performance tests, including three from the Wechsler-Bellevue Scale. No decrease on any of the tests appeared before the age of thirty, when an abrupt decline set in, terminating in a plateau of no change at any age. Vocabulary and Digit Span, two added verbal tests, showed no decline at any age between 16 and 69. There is some doubt whether Digit Span, a memory test, has any correlation with general intelligence in either normal or subnormal populations (164, p. 65), on the other hand, Vocabulary has been accepted traditionally as a reliable criterion of intelligence (5, p. 244).

In addition to these tests, Thompson employed the Picture Arrangement, Block Design and Digit Symbol subtests of the Wechsler-Bellevue Scale, finding in all three a significant decline between the age of 20 and 30. The fall-off in Block Design was found to be significant at the five per cent level of confidence, while the Digit Symbol subtest Series II showed the most significant decline (.001).

Past the age of thirty he found only one other significant decrease. This occurred between the ages of 40 and 50 on the Digit Symbol subtest, Series I. Thompson therefore postulates from this evidence combined with the results on the other items in his study, that there is an early loss of

efficiency in the moron, but the level regressed to is maintained till late in life.

Because the Vocabulary and Digit Span subtests fail to discriminate between age levels, Thompson concludes that the Performance type of test is most appropriate for studying intelligence changes with age in the mental defective. It would seem, however, that because verbal performance as a whole is found to correlate so highly with general intelligence, any adequate investigation of the mental abilities of the individuals below the normal range, should include a wider variety of verbal tasks.

In conclusion, it is interesting to note the differences between the reported results of the early studies of Doll, Stern and Kuhlmann, and these findings of Thompson, 30 years later, in 1951. The early arrest of intelligence and sharp decline postulated in 1921, and even later, by Sloan and Harman in 1947, find no parellel in the more recent study.

Critique of Previous Investigations

The preceding review of the literature dealing with the mental abilities has shown that numerous investigations have sought to determine facts which would lead to a better understanding of the psychological process known as intelligence. The development and decline of intelligence over the life span have been examined by cross-sectional and longitudinal methods with considerable attention being given to

the differential aspects of mental ability. Most of these investigations have been concerned with the normal or superior intelligence range with only a passing mention of the lower end of the curve in the large cross-sectional studies.

Research which deals primarily with the mental processes of the mental defective is comparatively scarce. Some work has been done on the growth and decline of intellectual functions, particularly with reference to performance on subtests. Few studies have employed large numbers of subjects and in others the age range investigated has been limited. Only in recent years has there been any realization that etiologic classifications of the subjects constituted a variable which, if not controlled by selection, might well vitiate the results of an investigation. Several studies have sought to differentiate between categories of defectives by means of an analysis of their responses on a variety of tests, and there is some evidence that differences do exist. Much of the current research is oriented toward gaining an understanding of the part played by the emotional concomitants of mental deficiency, in observed fluctuations in I.Q. Very few studies are definitely concerned with changes in intelligence over a wide range of the life span, which is the object of this investigation.

# CHAPTER II

## THE INVESTIGATION: MATERIAL, SUBJECTS, AND PROCEDURE

### I. THE PROBLEM

The previous discussion revealed that research which actually examines intelligence changes with age in the mental defective group is scarce indeed. It was because of this paucity of data and the growing need for information about the intellectual capacity of the certified mental defective that the present investigation was planned. Its main purpose is to throw additional light on the course of development and decline of intelligence and its various subabilities in the below normal individual, using a partly longitudinal and partly cross-sectional approach.

### II. THE INSTITUTION

In Manitoba the main center for the care and training of mental defectives is the Manitoba School for Mentally Defective Persons, Portage la Prairie, which accommodates approximately 1000 individuals requiring services which range from complete hospitalization to a relaxed type of supervision. It operates a day school which seeks to teach eligible students up to Grades IV or V. Sense training is organized for the lower-grade children and there is a Kindergarten for the youngest patients. A principal supervises the school educational program and there is a training course for high-grade

defective girls which teaches simple household duties, consisting of waiting on tables, cooking, buying food, housecleaning, sewing and laundry work. This training prepares the girls for graduation to the Broadway Home for Girls, Winnipeg, which conducts a rehabilitation program for mentally retarded women and is closely associated with the Manitoba School.

The boys receive training in the tailor shop, in woodwork, on the farm, in the laundry and the garden, carrying out many duties in the School and about the extensive grounds. As they become proficient in certain skills and are considered trustworthy they may go to work for private citizens who are willing to assist in their rehabilitation.

Recreational facilities are provided for all patients who are able to avail themselves of the opportunities. Music, dancing, concerts, circus days and trips to a nearby beach are much enjoyed. Transportation on bus trips is provided by the Parents and Friends organization which shows an active and warm-hearted interest in the School.

The Manitoba School has offered a course in psychiatric and practical nursing since 1938, and since 1957 has become a teaching centre for X-Ray technicians. It has in recent years become more closely associated with the University of Manitoba, Fourth Year Medical students visiting the School monthly for a one-day seminar since 1955, and many other University groups including students in Social Work, Sociology, Mental-Testing and Adult Education, spend an instructive

day at the School.

The policy of the Institution is moving toward the building up of its professional staff so that the Manitoba School may become a teaching center for the Province in the various aspects of mental deficiency.

## III. THE TEST: THE WECHSLER-BELLEVUE INTELLIGENCE SCALE

### The Nature and Purpose of the Test

The Wechsler-Bellevue Intelligence Scale was constructed on the assumption that intelligence can best be measured by power to perform tasks as well as to verbalize, therefore, provision is made by means of subtests to appraise both verbal and performance abilities. Several of the subtests are highly correlated showing that there must be considerable overlap in the abilities being approved, nevertheless the separate scores for verbal and performance sections of the test have been found diagnostically useful in a clinical setting. The Performance I.Q. may be acceptable when a subject is penalized by a language deficit either cultural or physiological, while the verbal rating is a good criterion of intelligence when the subject has a motor disability such as spasticity. The Full-Scale score which is a composite of the subscores, probably measures the subject's relative efficiency in his social situation rather than the somewhat nebulous psychological phenomenon termed intelligence.

Raw scores and weighted scores are determined for each subtest, the weighted scores being based on the norms

for the standardization group at the demonstrated peak age of intelligence. The weighted scores at any age are comparable, while I.Q. scores reflect allowances made for normal ageing processes. In theory such age allowances should keep the individual's I.Q. score constant throughout the life span, unless factors other than normal ageing processes intervene.

The eleven subtests together with the abilities they are said to measure are:

Information: This subtest reflects the subject's education and cultural opportunities but is also diagnostic of potential intellectual ability. It correlates well with the total score, (r = 0.67).

Comprehension: The second of the verbal subtests requires practical information and power to evaluate experiences. It is believed to hold up well with age, (r = 0.66 for ages 20 - 34 and 0.68 at 35 - 49).

Digit Span: Memory Span for digits is a poor test of general intelligence but is diagnostically useful. A falling-off in memory processes is often indicative of organic brain disorder, (r = 0.51).

Arithmetic: Results on the arithmetic subtest are effected by education and occupational pursuits. A low score may be indicative of inability to concentrate, or emotional disturbance, for success on this test depends on mental alertness. It correlates better with the total score as age increases, but falls off more quickly than the other verbal tests, (r = 0.63 at 20 - 34, 0.67 at 35 - 49).

Similarities: This subtest is regarded as an excellent criterion of intelligence. It demands discrimination between superficial and essential likenesses, revealing the subject's modes of thinking, (r = 0.73).

Vocabulary: The size of a subject's vocabulary may reflect educational opportunity to some extent, but it is also an excellent measure of his general intelligence. The vocabulary subscore shows little decline with age, (r = 0.85).

Picture Arrangement: This subtest effectively measures an individual's ability to comprehend and size up a situation. It may be indicative of power to function well in society. Picture Arrangement correlates poorly with the other tests of the scale, (r = 0.51).

Picture Completion: The perceptual and conceptual abilities involved in visual perception of familiar objects are examined by this subtest. It is discriminative at the lower levels of intelligence only. The correlation with the total score is 0.61 at ages 20 to 40.

Block Design: Wechsler regards this subtest as a valuable item for clinical diagnosis and an excellent criterion of general intelligence. It correlates well with the total score and individual test items, (r = 0.73).

Object Assembly: This subtest is said to reveal modes of perceiving, degree of reliance on trial and error, and the subject's reactions to mistakes. It correlates poorly with most of the subtests, (r = 0.41 to 0.51).

Digit Symbol: The speed and accuracy with which a subject learns to associate certain symbols with other symbols serves as a measure of his general intelligence. This test tapers off markedly with age due to the fact that success depends on speed and ability to acquire new learning. It correlates more highly with the total test at ages 35 - 49, ($r$ = 0.66).

Reliability and Validity

Wechsler in his manual reports retest correlations of 0.94 found both in a group of children and in a group of adults aged 20 to 34. Similar investigations with psychotic and neurotic patients by Hamister (69), and Rabin (121), have yielded Full-Scale retest reliabilities almost as high. Retest correlations on subtests have been found to range from 0.61 to 0.88 in normal adults, while among psychiatric patients fluctuations are found. Considerable interest is shown in the reliability of the subtests because of the trend toward clinical application of the Wechsler-Bellevue Scale.

In his discussion of validity, Wechsler places major emphasis upon the fact that the test has worked well in clinical practice, and that it agrees more closely with clinical judgments of mental capacity than do other tests. Teachers' ratings have been found to yield contingency co-efficients of .43 to .52 with the Wechsler-Bellevue Intelligence Scale score in the case of high school subjects. The verbal scale has been found to yield higher correlations with college grades

than the full-scale score, while correlations of grades with the performance score were still lower.

## IV. SUBJECTS

The subjects who were used in the experiment were 100 patients at the Manitoba School for Mentally Defective Persons who had taken the Wechsler-Bellevue Test of Intelligence five years previously. They were divided into groups of 25 subjects each in such a manner that the mean age of each group five years ago approximated 20, 30, 40 and 50 years. It was believed that an allowance of at least a year in residence before the administration of the initial Wechsler-Bellevue Intelligence Scale would result in a more valid set of scores, for by that time the emotional problems arising out of the institutional process itself would have had an opportunity to resolve themselves, and the physical and mental effects of a probably adverse early environment could have been overcome to some extent by medical treatment and emotional support. Only eight cases failed to meet this criterion; they had been tested within a few weeks of entry for observation.

In order to control for initial intellectual capacity, the four groups were so selected that their mean raw scores on the Wechsler Vocabulary test were approximately the same (M 6.05). Performance on a Vocabulary test is generally considered to provide a fairly reliable index of a subject's

original intelligence level since vocabulary level is highly correlated with general intelligence and furthermore shows little or no decline with age. All of the subjects had been diagnosed as familial or undifferentiated cases. Other diagnostic categories of defective were excluded since there is evidence that these groups display differential patterns of performance on intelligence tests.

The amount of education received by the subjects was not a variable likely to confuse the implications of the results. Selection would be almost impossible owing to vagueness of report, but the factor is largely controlled by the very nature of the defect in intelligence. For a very large number of these patients the excellent educational facilities provided by the Manitoba School today, did not exist.

Some of the subjects in the sample were occupied in various projects within the institution, for example, the laundry, tailor shop, crafts or domestic work. These were not necessarily found to show a higher grade of intelligence on the initial I.Q., rather the emotional stability and motivation of the patient together with his physical condition were the determinants of his role.

Table I below summarizes the data on the subjects at the time of the initial test. The range and the mean for age, years of residence in the Manitoba School, I.Q., S.D., and Vocabulary raw scores are shown. It will be noted that the group includes 49 male and 51 female subjects. The Vocabu-

lary raw scores show a slight deviation from the total group mean of 8.05 but the value in terms of scaled scores would be equal (4 points).

TABLE I

DISTRIBUTION OF 100 SUBJECTS BY AGE, SEX, LENGTH OF RESIDENCE, I.Q., AND VOCABULARY SCORE

| Age Group | | Sex | | Years in Residence | | I.Q. on Initial Test | | | Vocabulary Raw Score | |
|---|---|---|---|---|---|---|---|---|---|---|
| Range | N | M | F | Range | M | Range | M | SD | Range | M |
| 15-24 | 20.2 | 11 | 14 | 1-13 | 4.3 | 43-83 | 55.4 | 4.75 | 3-12 | 8.2 |
| 25-34 | 30.2 | 17 | 8 | 0-25 | 10.4 | 45-86 | 60.0 | 5.96 | 2-21 | 7.9 |
| 35-44 | 30.6 | 10 | 15 | 0-38 | 15.2 | 49-87 | 65.5 | 4.61 | 4-15 | 8.8 |
| 45-64 | 51.1 | 11 | 14 | 0-40 | 17.7 | 56-76 | 66.2 | 3.16 | 2-13 | 7.6 |

## V. THE PROCEDURE

The Wechsler-Bellevue tests and retests were administered in accordance with the author's instructions. No departures from regulation testing procedures were permitted; his criteria for valid responses were observed in scoring. Six Verbal tests being used, the totals were prorated according to standard procedure.

The original 100 tests were administered by the same psychometrician; the retests involve two additional psychometricians. A comparison of results obtained shows a consistency in scoring, and in ratio of positive to negative results.

Rapport with the patients was easily established and testing conditions were ideal; the test results are regarded as valid.

# CHAPTER III

## THE RESULTS AND DISCUSSION OF RESULTS

The weighted scores for each subtest for each individual, as well as the totals and means for the Full-Scale, Verbal, and Performance sections of the test, are shown in Appendix "A".

The Full-Scale, Verbal, and Performance I.Q. for each test and retest for 100 subjects are reported in Appendix "B".

## I. THE RESULTS

It is proposed now to present the results of the investigation by means of a division of the report into its longitudinal, and combined longitudinal and cross-sectional aspects. The results in each case are discussed first in terms of the weighted scores for the direct comparison of actual achievement on the retest by the different age groups, and next as I.Q. scores which reflect the allowances made for normal ageing processes. The total scores are broken down into the Verbal and Performance sections in both cases, while the six Verbal and five Performance subabilities are analysed by means of comparisons of test-retest scores of each age group. In order to examine the effects of the ageing process on the intellectual performance of the subjects, some inter-group comparisons over the entire age range of 20 to 56

years will follow the test-retest report. Graphical portrayals and tabular summaries of scores are provided for clarification of the discussion.

## Longitudinal or Test-Retest Results

### Scaled and I.Q. Score Changes on Full Test Over Five Years

Full test scaled scores obtained on the test and retest are shown in Table II. It can be seen that each group made a statistically significant gain when retested after a five-year interval. The range of mean gain is found to be from 4.2 to 7.96 within the groups. The youngest group made the largest gain but there is somewhat less of a consistency in their performance than is found in the case of the other three groups. The correlation of their scores on test and retest is 0.88 as compared with 0.94 for groups two and four, and 0.95 for group three.

TABLE II

TEST-RETEST CHANGES IN TOTAL SCALED SCORES

| Age Group (Mean Age) | | Full-Scale (Mean Scaled Scores) | | | Level of Significance (Test-Retest) | |
|---|---|---|---|---|---|---|
| Test | Retest | Test | Retest | Gain | t | p |
| 20.2 | 25.0 | 36.72 | 44.68 | 7.96 | 6.22 | < .01 |
| 30.2 | 35.4 | 32.92 | 38.88 | 5.96 | 5.96 | < .01 |
| 39.6 | 44.6 | 31.12 | 36.08 | 4.96 | 5.47 | < .01 |
| 51.1 | 56.0 | 23.40 | 27.60 | 4.20 | 5.86 | < .01 |

An examination of the I.Q. scores tabled below shows that each of the groups again makes a statistically significant mean gain on the Full-Scale at the time of the retest. The average gain for all groups is 6.7 I.Q. points. The largest gain was made by the youngest group, while a steady decline with age in the amount of gain is a noticeable feature. The average I.Q. for the oldest group at the retest is however only a fraction of a point less than that of the group whose subjects were one decade younger in mean age (45), and is 15.3 points above the mean score of the youngest subjects at mean age 20.2. The correlations between test and retest performance for the various groups range from 0.87 to 0.94.

TABLE III

TEST-RETEST CHANGES IN FULL-SCALE I.Q.

| Age Group (Mean Age) | | Full-Scale (Mean I.Q. Scores) | | | Level of Significance (Test-Retest) | |
|---|---|---|---|---|---|---|
| Test | Retest | Test | Retest | Gain | t | p |
| 20.2 | 25.0 | 55.40 | 64.48 | 9.08 | 10.29 | < .01 |
| 30.2 | 35.4 | 60.00 | 67.60 | 7.60 | 9.33 | < .01 |
| 39.6 | 44.6 | 65.20 | 70.88 | 5.68 | 7.95 | < .01 |
| 51.1 | 56.0 | 66.28 | 70.72 | 4.44 | 6.37 | < .01 |

Scaled and I.Q. Score Changes on Total Verbal Subtests

Table IV below summarizes the achievement of the subjects on the Verbal subtests. The three older groups show mean gains in scaled scores which are significant beyond the one percent level of confidence, while the young subjects closely approach a "p" value of .02. The correlations between test and retest performance for the various groups range from 0.83 to 0.95.

TABLE IV

TEST-RETEST CHANGES IN VERBAL SCALED SCORES

| Age Group (Mean Age) | | Verbal (Mean Scaled Scores) | | | Level of Significance (Test-Retest) | |
|---|---|---|---|---|---|---|
| Test | Retest | Test | Retest | Gain | t | p |
| 20.2 | 25.0 | 13.92 | 15.72 | 1.80 | 2.48 | > .02 |
| 30.2 | 35.4 | 13.32 | 15.88 | 2.56 | 3.72 | < .01 |
| 39.6 | 44.6 | 14.32 | 16.52 | 2.20 | 3.08 | < .01 |
| 51.1 | 56.0 | 10.12 | 13.08 | 2.96 | 5.10 | < .01 |

Table V below shows that each group also made a statistically significant gain in Verbal I.Q.; only fractional differences in the amount of gain appear, the oldest subjects making a slightly larger mean gain and achieving the highest total rating. The range of the correlations between test and retest for the four groups is from 0.80 to 0.93.

TABLE V

TEST-RETEST CHANGES IN VERBAL I.Q. SCORES

| Age Group (Mean Age) | | Verbal (Mean I.Q. Scores) | | | Level of Significance (Test-Retest) | |
|---|---|---|---|---|---|---|
| Test | Retest | Test | Retest | Gain | t | p |
| 20.2 | 25.0 | 58.20 | 62.28 | 4.08 | 4.59 | < .01 |
| 30.2 | 35.4 | 60.56 | 64.84 | 4.28 | 6.11 | < .01 |
| 39.6 | 44.6 | 65.44 | 69.72 | 4.28 | 7.13 | < .01 |
| 51.1 | 56.0 | 65.80 | 70.24 | 4.44 | 6.69 | < .01 |

Scaled Scores on the Specific Verbal Subabilities

The results which have been presented so far dealt solely with over-all Verbal performance. The Wechsler Scale however is comprised of six verbal subtests, viz., Information, Comprehension, Digit Span, Arithmetic, Similarities, and Vocabulary. Table VI below shows the test-retest performance (scaled scores) of the four groups on these six subtests. All age groups when retested show either a significant gain or no change on all six Verbal subtests. In no case is there a significant loss in performance. Comprehension shows a significant gain at all age levels; Information shows a significant gain at the first age level; Vocabulary shows significant gains at all ages except the oldest, while the gain in Similarities is significant only in the two oldest groups. Digit Span shows significant gains in the second group (35.4 years) and the oldest group (56.0 years). Arithmetic shows no significant gain at any age level.

TABLE VI

MEAN SCALED SCORES FOR THE VERBAL SUBABILITIES

| | Age Group (Mean) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 20.2 | 25.0 | 30.2 | 35.4 | 39.6 | 44.6 | 51.1 | 56.0 |
| Subtest | Test | Retest | Test | Retest | Test | Retest | Test | Retest |
| INFORMATION | 2.72 | 3.44 | 2.88 | 3.28 | 3.12 | 3.40 | 2.76 | 2.96 |
| Difference | 0.72 | | 0.40 | | 0.28 | | 0.20 | |
| t-score | 3.08* | | 1.98 | | 1.86 | | 1.35 | |
| COMPREHENSION | 4.00 | 4.76 | 3.60 | 4.64 | 4.28 | 5.52 | 3.00 | 4.40 |
| Difference | 0.76 | | 0.84 | | 1.24 | | 1.40 | |
| t-score | 2.69** | | 3.75* | | 4.82* | | 5.95* | |
| DIGIT SPAN | 2.76 | 2.36 | 2.20 | 2.76 | 2.24 | 2.52 | 0.64 | 1.28 |
| Difference | 0.40 | | 0.56 | | 0.28 | | 0.64 | |
| t-score | 1.20 | | 2.25*** | | 0.90 | | 2.67** | |
| ARITHMETIC | 0.56 | 1.00 | 0.72 | 0.84 | 0.52 | 0.56 | 0.31 | 0.72 |
| Difference | 0.44 | | 0.12 | | 0.04 | | 0.41 | |
| t-score | 1.29 | | 0.05 | | 0.00 | | 1.51 | |
| SIMILARITIES | 2.36 | 2.56 | 2.36 | 2.84 | 2.54 | 3.16 | 1.64 | 2.08 |
| Difference | 0.20 | | 0.48 | | 0.62 | | 0.44 | |
| t-score | 0.86 | | 1.77 | | 3.07* | | 2.52** | |
| VOCABULARY | 4.16 | 4.52 | 3.76 | 4.40 | 4.20 | 4.72 | 3.80 | 4.08 |
| Difference | 0.36 | | 0.64 | | 0.52 | | 0.28 | |
| t-score | 2.64** | | 2.67** | | 3.13* | | 1.18 | |

* Significant at the .01 level of confidence
** Significant at the .02 level of confidence
*** Significant at the .05 level of confidence

Scaled and I.Q. Score Changes on Total Performance Subtests

Table VII shows that each group makes a statistically significant gain (in terms of scaled scores) on the full Performance section on the retest. It is interesting to note that the increases are, generally speaking, greater than those made on the Verbal subtests mentioned previously.

TABLE VII

TEST-RETEST CHANGES IN PERFORMANCE SCALED SCORES

| Age Group (Mean Age) | | Performance (Mean Scaled Scores) | | | Level of Significance (Test-Retest) | |
|---|---|---|---|---|---|---|
| Test | Retest | Test | Retest | Gain | t | p |
| 20.2 | 25.0 | 22.00 | 28.96 | 6.16 | 5.45 | < .01 |
| 30.2 | 35.4 | 19.60 | 23.00 | 3.40 | 4.22 | < .01 |
| 39.6 | 44.6 | 16.80 | 19.56 | 2.76 | 3.34 | < .01 |
| 51.1 | 56.0 | 13.28 | 14.52 | 1.24 | 2.77 | > .01 |

The data showing changes in Performance I.Q. of the four age groups are shown below in Table VIII. An examination of the Table shows that significant gains were made in mean scores on the retest by all the groups except the last, the highest level being attained by the third group, now 40 to 49 years in age range. The largest mean point gain (11.92 I.Q. points) was made by the youngest group who were at an average age of 25 years at the time of the retest. The gain of 1.72 I.Q. points made by the oldest group is not significant while their actual gain in Performance scaled score points was significant at close to the one percent level. This is due

to the fact that as these subjects now range in age from 56 to 67 years, they receive no additional allowance for ageing above that received on the initial test, for Wechsler gives none above age 49. Their increase is entirely due to better performance as it was in the scaled scores.

TABLE VIII

TEST-RETEST CHANGES IN PERFORMANCE I.Q.

| Age Group (Mean Age) | | Performance (Mean I.Q. Scores) | | | Level of Significance (Test-Retest) | |
|---|---|---|---|---|---|---|
| Test | Retest | Test | Retest | Gain | t | p |
| 20.2 | 25.0 | 60.84 | 72.76 | 11.92 | 7.74 | < .01 |
| 30.2 | 35.4 | 64.88 | 74.20 | 9.32 | 6.75 | < .01 |
| 39.6 | 44.6 | 70.32 | 77.72 | 7.40 | 6.43 | < .01 |
| 51.1 | 56.0 | 72.52 | 74.24 | 1.72 | 0.97 | > .10 |

Scaled Scores on the Specific Performance Subtests

The Performance section of the Wechsler-Bellevue Scale is comprised of five subtests, viz., Picture Arrangement, Picture Completion, Block Design, Object Assembly and Digit Symbol. Table IX below shows that all the groups improved their scores on the Performance subabilities at the time of the retest with the exception of the fourth or oldest group which lost nine points in the Digit Symbol subtest (M 2.04 to 1.6), and with the exception of a single point in the total, maintained their score on the Block Design item (M 3.0 to 2.96). The mean gain has been shown to be largest for the youngest group and is found to vary inversely as the age range increases.

TABLE IX

MEAN SCALED SCORES FOR THE PERFORMANCE SUBABILITIES

| | Age Group (Mean) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 20.2 | 25.0 | 30.2 | 35.4 | 39.6 | 44.6 | 51.1 | 56.0 |
| Subtest | Test | Retest | Test | Retest | Test | Retest | Test | Retest |
| PICTURE ARRANGEMENT | 3.80 | 4.12 | 2.88 | 3.64 | 3.12 | 3.56 | 2.24 | 2.68 |
| Difference | 0.32 | | 0.76 | | 0.44 | | 0.44 | |
| t-score | 1.06 | | 3.55* | | 2.26*** | | 2.13*** | |
| PICTURE COMPLETION | 4.20 | 5.52 | 4.64 | 5.56 | 3.48 | 4.00 | 2.48 | 3.52 |
| Difference | 1.32 | | 0.92 | | 0.52 | | 1.04 | |
| t-score | 5.38* | | 2.32*** | | 1.58 | | 3.92* | |
| BLOCK DESIGN | 3.76 | 5.08 | 4.28 | 4.68 | 3.04 | 3.76 | 3.00 | 2.96 |
| Difference | 1.32 | | 0.40 | | 0.72 | | -0.04 | |
| t-score | 4.13* | | 1.87 | | 3.09* | | 0.23 | |
| OBJECT ASSEMBLY | 6.32 | 7.92 | 4.72 | 5.80 | 3.92 | 4.92 | 3.52 | 3.76 |
| Difference | 1.60 | | 1.08 | | 1.00 | | 0.24 | |
| t-score | 2.90* | | 2.37*** | | 2.66** | | 0.81 | |
| DIGIT SYMBOL | 4.68 | 6.32 | 3.08 | 3.32 | 3.24 | 3.32 | 2.04 | 1.60 |
| Difference | 1.64 | | 0.24 | | 0.08 | | -0.44 | |
| t-score | 4.66* | | 1.14 | | 0.29 | | 2.31*** | |

* Significant at the .01 level of confidence
** Significant at the .02 level of confidence
*** Significant at the .05 level of confidence

Graphical Portrayal of Scaled and I.Q. Scores

Figure 1 below graphically portrays the scaled score test and retest performance of the four age groups. It has already been noted that statistically significant gains were made on the retest by all groups on both Verbal and Performance sections of the Wechsler test. A comparison of the sections show that the subjects score better on Performance tests than on the Verbal items but the difference between the two decreases with the advance of age. While Verbal skills show some increase over most of the life span measured, the Performance totals show a decrease. The significance of such changes will be discussed further when attention is turned to the cross-sectional aspects of this study. In the meantime it may be pointed out that the oldest group at the time of the retest practically equalled the performance of the youngest subjects at age 20.2 in the Verbal total scaled scores, in spite of the fact that they had to make up a considerable deficit in the Digit Span item (Table VI). In contrast to this finding, Figure 1 shows that the Performance scaled scores of the oldest group at mean age 56 are approximately 50 percent of those made by the young subjects at age 25. By age 35.4 the Performance scaled scores approximate those of age 20.2, though they have dropped from the peak reached by the young subjects on their retest at 25 years of age. A glance at the Full-Scale totals portrayed in the same figure shows that while the youngest group achieved the highest rating on the retest, their original score at 20.2 was

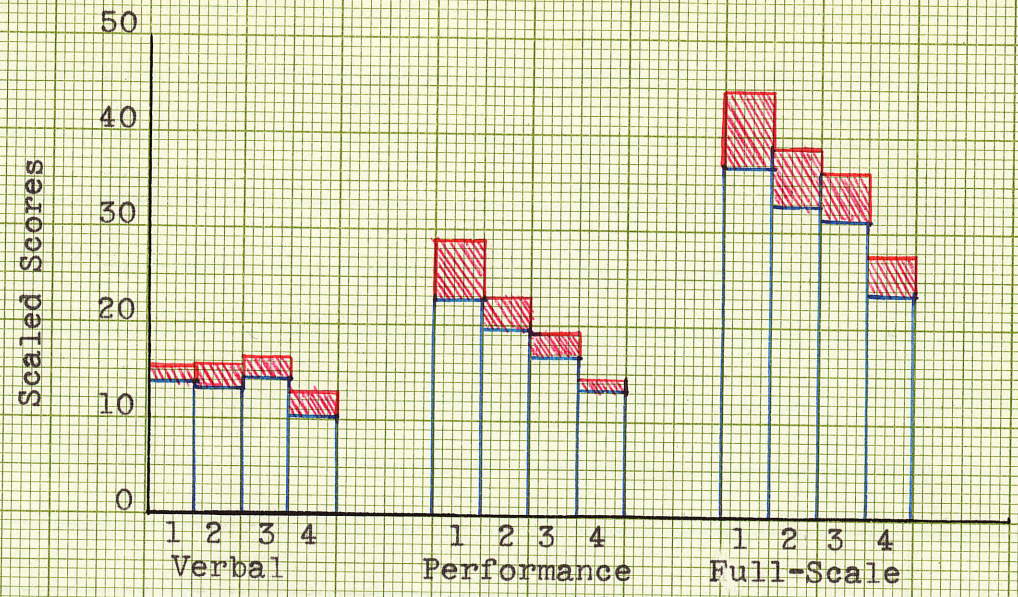



Figure 1 Mean Scaled Score Points on Test and Retest

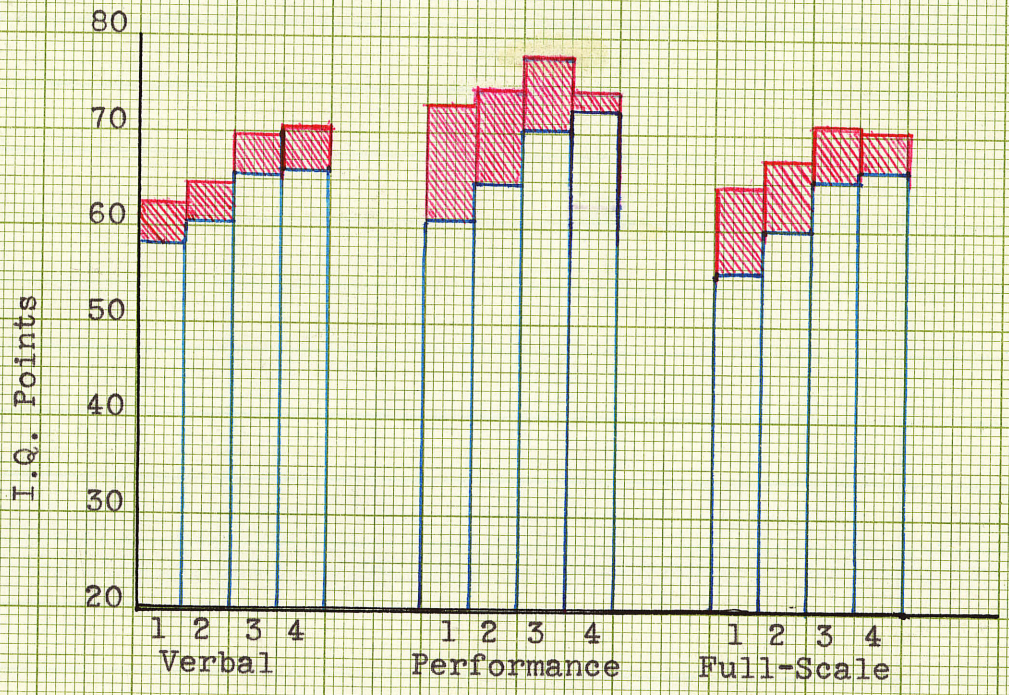



Figure 2 Mean I.Q. Points on Test and Retest

Key: Initial Test / Retest

| Age Group | Initial Test | Retest |
|---|---|---|
| 1 | 20.2 | 25.0 |
| 2 | 30.2 | 35.4 |
| 3 | 39.6 | 44.6 |
| 4 | 51.1 | 56.0 |

bettered by the second age group of 35.4 and was almost equalled by the third group at their retest at 44.6 years of age.

Figure 2 above portrays retest changes in I.Q. in the Full-Scale, Verbal, and Performance tests for the four age groups. It has already been noted that statistically significant gains on the retest were made by all groups on the three sections, with the exception of the oldest group on the Performance section. It is interesting to note that the ageing allowance made by Wechsler to maintain a constancy of I.Q. over the years, succeeds in this instance in giving an increase of I.Q. over the age range covered in this study. A comparison of Figures 1 and 2 shows that while we have some consistency between Verbal scaled scores and Verbal I.Q. ratings whether we view them as test and retest, or over the years, such a finding does not occur in the case of the Performance and the Full test; here we find reversal of the trend to increase scores over the age span, and actual performance shows a decline.

Individual Differences in Performance on the Wechsler-Bellevue

The results which have been reported so far have dealt with the mean performance of the age groups on their initial test and retest. No mention has been made of individual differences in performance. Table X shows the ranges of gain in scaled scores of individuals within the groups, together with the mean range for all groups on the Full-Scale and in the Verbal and Performance subtests. It can be seen

that on the Full-Scale the range of gain for all groups was from -4 to 18 scaled points (Mean 5.77). Furthermore it was about the same for the Performance tests but considerably less for the Verbal tests (-3 to 10). Of the various age groups the youngest made the greatest gains on all tests, while the oldest age group made the least.

TABLE X

RANGE OF INDIVIDUAL GAINS IN SCALED SCORES

| Age | Full-Scale | | Verbal Tests | | Performance Tests | |
|---|---|---|---|---|---|---|
| Mean | Mean | Range | Mean | Range | Mean | Range |
| 25.0 | 7.96 | -1 to 26 | 1.80 | -5 to 13 | 6.16 | -1 to 22 |
| 35.4 | 5.96 | -6 to 17 | 2.56 | -2 to 9 | 3.40 | -5 to 16 |
| 44.6 | 4.96 | -5 to 17 | 2.20 | -3 to 8 | 2.76 | -5 to 15 |
| 56.0 | 4.20 | -4 to 12 | 2.96 | -4 to 10 | 1.24 | -4 to 6 |
| Mean | 5.77 | -4 to 18 | 2.38 | -3 to 10 | 3.39 | -3.75 to 15.75 |

Table XI below shows the range of gain in I.Q. points made by individuals within the groups. As one would expect, the picture is the same as mentioned in the previous paragraph, the only difference being that the scores are now in I.Q. points rather than scaled points. On the Full-Scale the range of gain for all groups is 0 to 16.5 (Mean 6.70); on Performance -2 to 23.25 (Mean 7.59) and on Verbal -3.5 to 13.25 (Mean 4.27). Once more the gains on the Verbal tests are less than on the Performance tests. Also the youngest age group shows the greatest gains, e.g., on the Full-Scale,

the individuals in the youngest group show gains in I.Q. ranging from 3 to 22 points while the oldest age group showed gains of from 0 to 16 points.

TABLE XI

RANGE OF INDIVIDUAL GAINS IN I.Q.

| Age | Full-Scale | | Verbal Tests | | Performance Tests | |
|---|---|---|---|---|---|---|
| Mean | Mean | Range | Mean | Range | Mean | Range |
| 25.0 | 9.08 | 3 to 22 | 4.08 | -6 to 17 | 11.92 | 0 to 33 |
| 25.4 | 7.60 | -1 to 15 | 4.28 | -4 to 12 | 8.32 | -1 to 28 |
| 44.6 | 5.68 | -2 to 15 | 4.28 | -2 to 11 | 7.40 | -4 to 22 |
| 56.0 | 4.44 | 0 to 16 | 4.44 | -2 to 13 | 1.72 | -5 to 10 |
| Mean | 6.70 | 0 to 16.50 | 4.27 | -5.50 to 13.25 | 7.59 | -2.50 to 23.25 |

Table XII shows the percentage of subjects in the different age groups who showed a gain, no change, or a loss in scaled scores at the retest.

TABLE XII

PERCENTAGE OF SUBJECTS SHOWING A GAIN, NO CHANGE, OR A LOSS IN SCALED SCORES AT THE RETEST

| Age | Full-Scale | | | Verbal | | | Performance | | |
|---|---|---|---|---|---|---|---|---|---|
| Mean | Gain | Equal | Loss | Gain | Equal | Loss | Gain | Equal | Loss |
| 25.0 | 84 | 12 | 4 | 48 | 28 | 24 | 88 | 8 | 4 |
| 35.4 | 80 | 8 | 12 | 68 | 16 | 16 | 68 | 8 | 24 |
| 44.6 | 84 | 4 | 12 | 68 | 12 | 20 | 68 | 8 | 24 |
| 56.0 | 64 | 16 | 20 | 68 | 12 | 20 | 52 | 24 | 24 |
| Mean | 78 | 10 | 12 | 63 | 17 | 20 | 69 | 12 | 19 |

It will be noted that in the Full-Scale, 88 percent of all the subjects made gains or equalled their former score; on the Verbal subtests, 80 percent, and on the Performance tests 81 percent. Furthermore a greater percentage of the younger subjects showed a gain or no change in score.

Table XIII also shows the type of change in test performance (gain, no change, or loss) made by the different age groups, but in terms of I.Q. scores rather than scaled scores. Because of the age increment allowed in the I.Q. scores by Wechsler, we find a larger percentage of individuals improving their scores on the retest, as Table XIII shows. For example, on the Full-Scale, 98 percent of all the subjects made a gain or equalled their former score, in contrast to 88 percent (see Table XII) when the scores are expressed in scale units.

TABLE XIII

PERCENTAGE OF SUBJECTS SHOWING A GAIN, NO CHANGE, OR A LOSS IN I.Q. AT THE RETEST

| Age | Full-Scale | | | Verbal | | | Performance | | |
|---|---|---|---|---|---|---|---|---|---|
| Mean | Gain | Equal | Loss | Gain | Equal | Loss | Gain | Equal | Loss |
| 25.0 | 100 | 0 | 0 | 80 | 4 | 16 | 96 | 4 | 0 |
| 35.4 | 96 | 0 | 4 | 84 | 12 | 4 | 96 | 0 | 4 |
| 44.6 | 92 | 4 | 4 | 84 | 8 | 8 | 92 | 0 | 8 |
| 56.0 | 92 | 8 | 0 | 88 | 4 | 8 | 64 | 12 | 24 |
| Mean | 95 | 3 | 2 | 84 | 7 | 9 | 87 | 4 | 9 |

It may be of interest to examine some individual performances on the retest, for group means often tend to obscure

the fact that such differences do exist. Table XIV gives some data about 12 individuals, each of whom makes the greatest gain within his own age group on either Full-Scale, Verbal, or Performance sections of the test at the time of the retest. These individuals are not necessarily those having the highest total score at either test or retest. It will be noted that the subjects who make the greatest gains within their group on the Full-Scale, are those who make a moderate gain on both Verbal and Performance sections of the test. The only individual who has the highest gain in two sections of the test is a 54-year-old male who, with a 49-year-old female made a 10-point Verbal gain, the highest within their group. He also made two points on the Performance section thus achieving the highest Full-Scale gain for the oldest age group, while she lost four points on the Performance section. The highest scorers in each group on the Performance tests are found to lose slightly on the Verbal section. The general trend on the retest has been for individuals to retain their rank order on the retest, for the correlations of test and retest have been shown to be high, ranging from 0.80 to 0.95, the majority bettering 0.90. However enough deviations have occurred (in addition to those tabled below), to show that the size of the original score does not necessarily determine the amount of gain on the retest. The largest Performance gain was made by a 26-year-old male who doubled his own original score of 22 points. The high Performance gains in the older groups were made by individuals

having low Performance scores on their original tests.

TABLE XIV

DATA ON TWELVE INDIVIDUALS MAKING THE GREATEST GAIN ON FULL-SCALE, VERBAL OR PERFORMANCE SECTIONS OF THE TEST AT THE TIME OF THE RETEST

| Gr | Su* | Gain | Pts. | Age | Sex | Years Inst. | Orig. Score V | P | FS | Gain V | P | FS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | FS | 26 | 24 | M | 8 | 7 | 12 | 19 | 9 | 17 | 26 |
| 1 | 21 | V | 13 | 24 | F | 9 | 23 | 52 | 75 | 13 | 1 | 14 |
| | 22 | P | 22 | 26 | M | 9 | 15 | 22 | 37 | -1 | 22 | 21 |
| | 11 | FS | 17 | 39 | F | 20 | 17 | 20 | 37 | 7 | 10 | 17 |
| 2 | 13 | V | 9 | 37 | M | 7 | 14 | 24 | 38 | 8 | 3 | 12 |
| | 3 | F | 18 | 55 | M | 26 | 10 | 2 | 12 | -2 | 18 | 16 |
| | 18 | FS | 17 | 48 | M | 19 | 10 | 5 | 15 | 3 | 14 | 17 |
| 3 | 10 | V | 6 | 43 | F | 16 | 50 | 35 | 65 | 8 | 0 | 8 |
| | 16 | P | 15 | 46 | F | 19 | 6 | 7 | 13 | -1 | 15 | 14 |
| | 6 | FS | 12 | 54 | M | 35 | 18 | 28 | 46 | 10 | 2 | 12 |
| 4 | 4 | V | 10 | 54 | M | 35 | 18 | 28 | 46 | 10 | 2 | 12 |
| | 25 | V | 10 | 49 | F | 5 | 12 | 19 | 21 | 10 | -4 | 6 |
| | 1 | P | 8 | 62 | M | 24 | 11 | 6 | 17 | -1 | 8 | 7 |

* See Appendix "A".

Table XV below shows the percentage of subjects in each age group reaching or exceeding the mean of the Full-Scale, Verbal, and Performance Scaled Scores at the test and retest. The means are calculated to the nearest whole figure for the combined tests and retests, numbering 200. The percentage of subjects scoring at the mean or better shows an increase on the retest in each age group with the exception of the third group on the Performance section when the percentage remains unchanged. The percentage scoring at or

above the mean holds up best with age in the case of the verbal skills, for among the youngest subjects at mean age 20.2 and those of mean age 56 we find 11 in each group who reach or better the mean score for the entire sample. In Performance scores however, only half as many subjects at mean age 56 do as well as the younger subjects at the initial test. Taking the mean percentage for all sections on test, and re-test, it is found that 34 percent of the subjects in the two older groups do better than the 46 percent in the younger groups who failed to reach mean scoring on test or retest in spite of the age advantage.

TABLE XV

PERCENTAGE OF SUBJECTS REACHING OR EXCEEDING THE MEAN* FOR 200 TESTS AND RETESTS (SCALED SCORES)

| Age Group | | Full-Scale | | Verbal | | Performance | |
|---|---|---|---|---|---|---|---|
| Test | Retest | Test | Retest | Test | Retest | Test | Retest |
| 20.2 | 25.0 | 52 | 76 | 44 | 80 | 56 | 80 |
| 30.2 | 35.4 | 40 | 56 | 32 | 44 | 40 | 64 |
| 39.6 | 44.6 | 40 | 44 | 40 | 52 | 40 | 40 |
| 51.1 | 56.0 | 16 | 28 | 20 | 44 | 20 | 28 |

* Full-Scale mean for 200 tests -- 34.
Verbal mean for 200 tests -- 14.
Performance mean for 200 tests - 20.

Combined Longitudinal and Cross-sectional Results

The results that have been discussed so far are largely concerned with the retest performance five years later of four groups of subjects who were of mean ages 20, 30, 40 and 50

years at the time of the initial testing. In the present section the main emphasis will be on the intellectual performance of the subjects over the entire period of 20 to 56 years as a cross-sectional sample of the mentally defective population.

Effect of Age on Full-Scale, Verbal and Performance Scaled Scores

Figure 3 below shows the relationship between age and scores on the Full-Scale, Verbal and Performance tests. It can be seen that the scores on the Full-Scale hold up well between the ages of 20 and 45 years but decline thereafter. The slightly higher scores of the youngest subjects are not significantly different from those at ages 30 to 35, nor are those of the 40's significantly below those of the 30's ($t = 1.50$, $p>.05$; $t = 0.66$, $p>.05$). The scores of the 50 to 55 age group are significantly lower than those of the 40's ($t = 2.48$, $p<.05$). Over the range from 20 to 56 the decrease in score is highly significant ($t = 5.12$, $p<.01$).

The scores on the verbal tests also hold up well between the ages of 20 and 45 years. None of the differences are statistically significant. However, the performance of the 50 to 56 year age group is significantly lower than that of the preceding age groups ($t = 2.53$, $p>.01$).

The scores on the Performance tests seem to show a different trend. They decline gradually from ages 20-25 to ages 50-55. However, when tests of significance are applied to the differences between the groups it is found that there is a significant decline in scores between age groups one and two

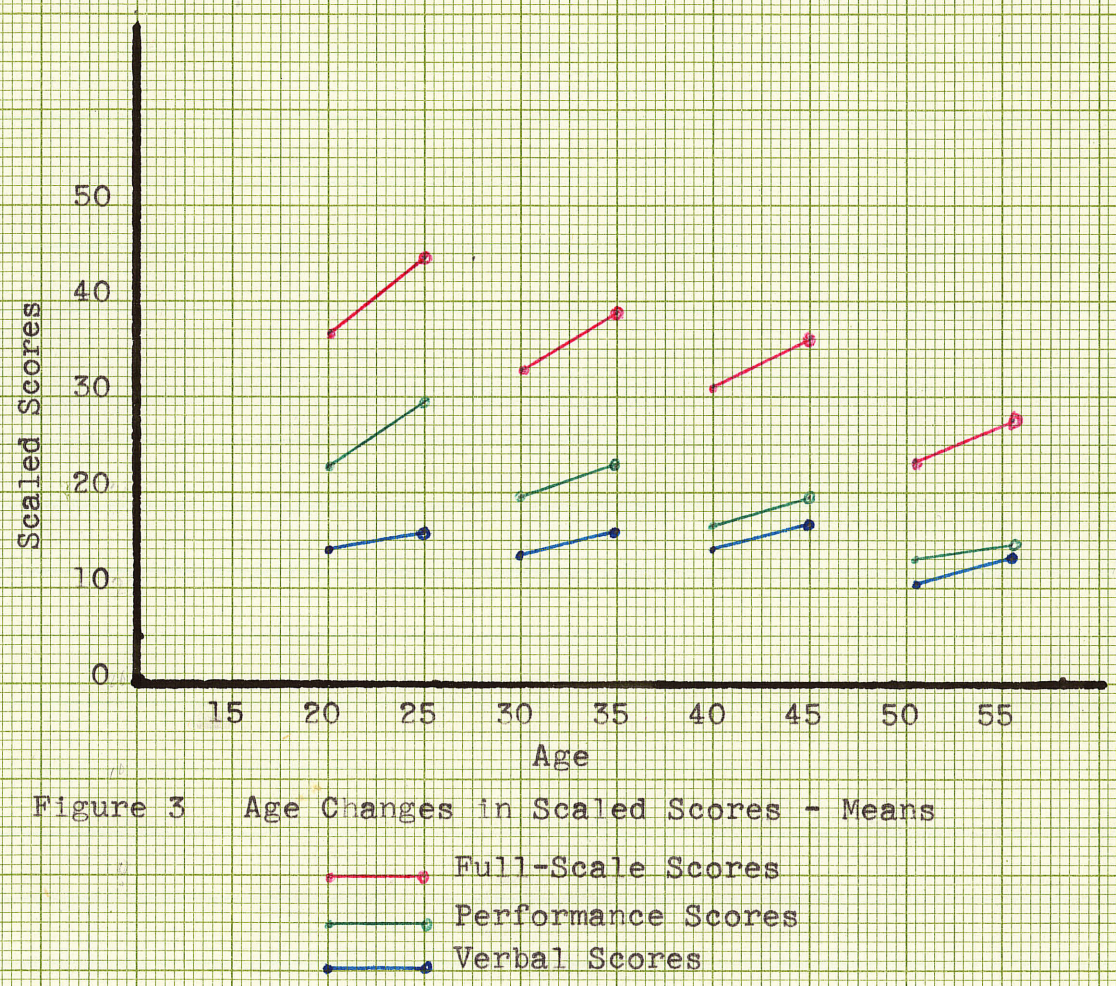



Figure 3 Age Changes in Scaled Scores - Means

Full-Scale Scores
Performance Scores
Verbal Scores

($t = 2.206$, $p < .05$), and groups three and four ($t = 2.23$ $p < .05$), but none between groups two and three. Performance tests decline after the 20-25 year interval, hold up at this lowered level to age 45, and then decline again.

Effect of Age on Performance on the Subabilities

Figures 4 and 5 summarize graphically the relationship between age and performance on the six Verbal subtests, viz., Information, Comprehension, Vocabulary, Similarities, Digit Span and Arithmetic over the age range of 20 to 56 years. Of the Verbal subtests, Vocabulary, Information and Arithmetic show no significant change with age. Comprehension, Similarities and Digit Span show a significant change in the scores of the 50's as compared with those of the 40's ($t = 2.52$, $p > .01$; $t = 2.84$, $p < .01$; $t = 2.69$, $p < .01$, respectively).

Figures 6 and 7 summarize graphically the relationship between age and scores on the five Performance subtests, viz., Digit Symbol, Picture Completion, Picture Arrangement, Block Design and Object Assembly. The problem of age changes in these tests is quite different from that of the Verbal subtests, e.g., the Performance subtests show significant decreases in scores at an earlier age, with the exception of Picture Arrangement.

Figure 6 shows the relationship between age and scores on the Picture Completion and Block Design tests. In both cases there is no significant change in scores between the 20-25 and 30-35 age groups. However on both tests there is a significant change in scores between 30-35 years and 40-45 years

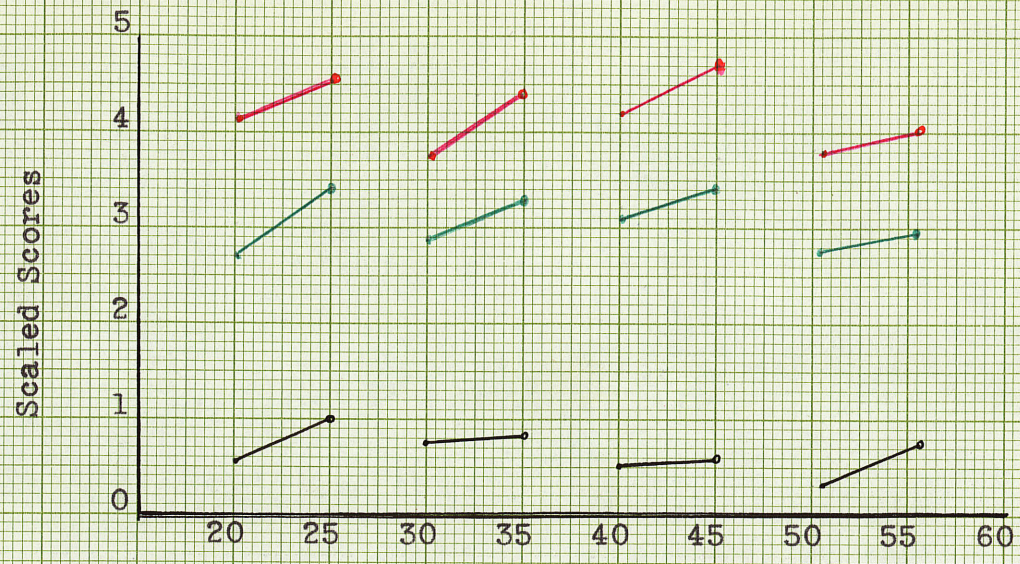



Figure 4 Age Changes in the Verbal Subtests - Means

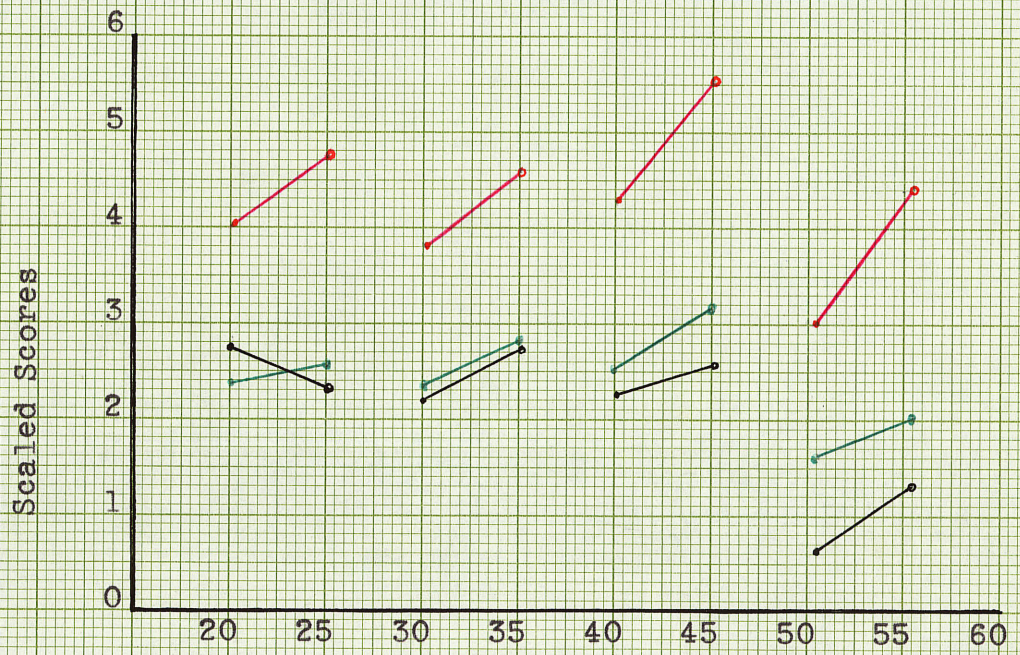
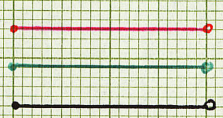




Figure 5 Age Changes in the Verbal Subtests - Means



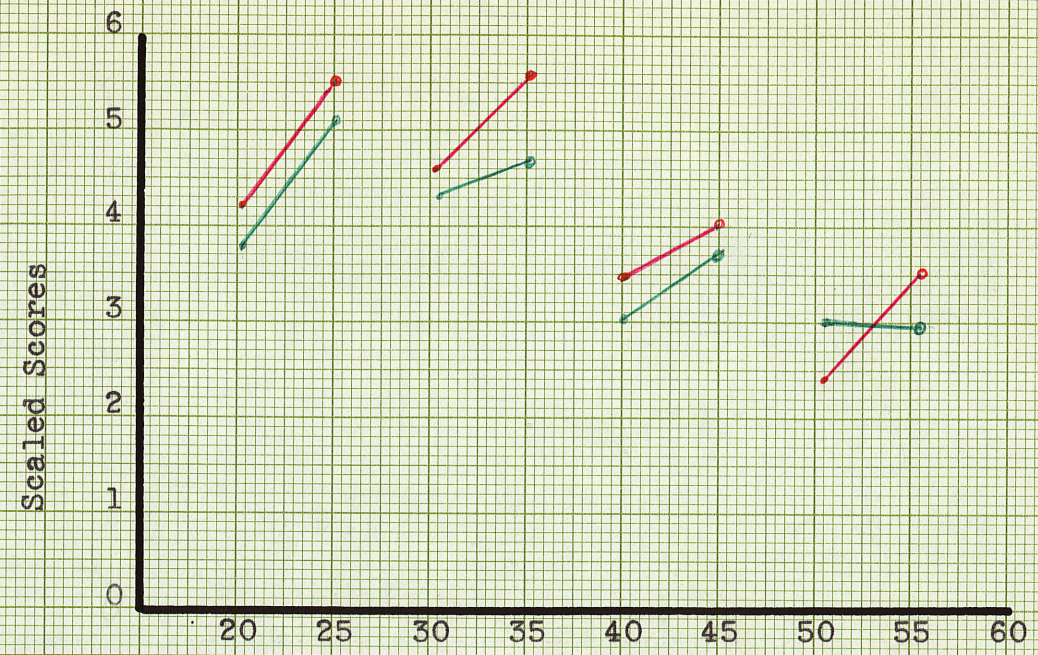



Figure 6 Age Changes in the Performance Subtests - Means

Picture Completion
Block Design

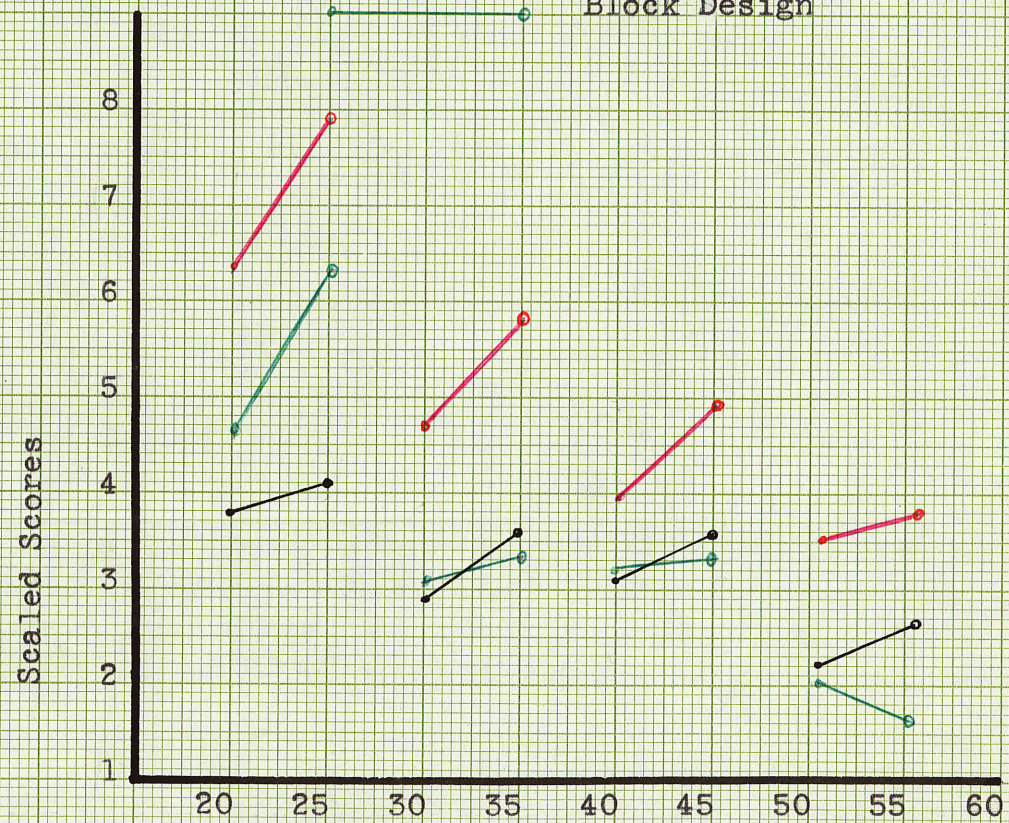



Figure 7 Age Changes in the Performance Subtests - Means

Object Assembly
Digit Symbol
Picture Arrangement

($t = 2.23$, $p < .05$; $t = 2.15$, $p < .05$). Thus it would appear that performance on these tests holds up to age 45 and maintains a plateau thereafter.

Figure 7 shows the effect of age on performance on the remaining three tests. Picture Arrangement holds up well showing a significant decline in scores of the 50's as compared with the 40's ($t = 2.51$, $p > .01$). Digit Symbol shows a significant decline in the scores of the 30's and maintains a plateau till the 50's when a significant decline is shown ($t = 5.50$, $p < .01$; $t = 3.50$, $p < .01$). Performance on the Object Assembly test is different from all other tests, both Verbal and Performance, in that it falls off in the scores of the 30's as compared with the 20's ($t = 2.56$, $p > .01$), showing no further decline over the age period.

## II. DISCUSSION OF RESULTS

The purpose of this study was a two-fold one. The first was to study the change in intellectual performance over a period of five years, of four groups of mentally defective persons who were approximately 20, 30, 40 and 50 years of age at the time of the initial testing. The second objective was to determine to what extent intellectual performance as measured by the Wechsler-Bellevue Intelligence Scale, holds up or does not hold up with age over the entire period from 20 to 56 years. The results of the two approaches will now be taken up and related to the general body of knowledge on intellectual changes with age.

One of the most important results of the present study was the demonstration that a significant gain in intellectual performance could occur over a period of five years, regardless of the age at which the subjects were first tested, e.g., whether they were in their 20's or 50's. This very definite increase in retest performance is found whether the results are reported in I.Q. scores which reflect the age allowance, or whether we deal with scaled scores which provide us with a much more valid picture of actual test achievement as it occurs at the different age levels. Furthermore, these significant gains are shown, not only on the Full-Scale, but also on the Verbal and Performance sections of the Wechsler Test, indicating that the improvement is quite general.

These noticeable gains in the Wechsler-Bellevue I.Q. (Full-Scale) are supported by the findings of two studies carried out by Clarke and Clarke (32, 34) in 1954 and 1958. These investigators, retesting institutionalized mental defectives over different time intervals with the Wechsler Scale, also reported some surprisingly large gains in I.Q. Unfortunately, however, they employed only young subjects (mean age 25 years) in contrast to the present study where both young and old subjects were used. Nevertheless, certain significant comparisons can be made between our youngest subjects and those of the Clarkes.

A total of 34 subjects were used. They were divided into two subgroups. The first group of nine subjects had been

reared in extremely adverse early environmental conditions before coming to the institution. The second group of 24 subjects came from a less adverse background. They were given a psychometric appraisal over two retest intervals, a three-year and a six-year time span, both dating from 1949. As far as range of gain in I.Q. is concerned the young subjects of the present study and the entire sample of the Clarkes' showed an identical range, viz., 3 to 22 I.Q. points. The picture is somewhat different when we deal with mean I.Q. gain and also deal with the two subgroups rather than the whole sample. The subjects from the less adverse environment showed a mean gain of 10.2 I.Q. points over a six year period. Of this total gain, 4.5 was made during the first three years and 5.7 during the last three years. This total gain of 10.2 is very similar to the mean gain of 9.08 I.Q. points made by our youngest subjects. However, the subjects coming from the adverse environment made a much larger mean gain over the six year period, viz., 16.2 points. Of this gain, 11.1 points were made during the first three years after admittance and the remainder, 5.1 points, in the second three-year interval. Since the defectives with the more adverse background had shown a larger gain in the first three years than those with better backgrounds had made over the entire six year period, the Clarkes maintain that the largest I.Q. gains are made by patients who suffer severe environmental deprivation in early childhood. Furthermore, when these gains occur they are made in the early years of institutional life. In this regard, it

should be pointed out that the sample used in the present investigation was not differentiated according to the type of environment existant in the home. A similarity of early environmental influences was assumed on the basis of the etiology of their defect, for they were all diagnosed as familial cases -- a category of defectives known to be associated with homes of low socio-economic level and impoverished cultural conditions (28, 59, 63, 66, 73, 82, 97, 129).

Although the subjects used by the Clarkes were, on the average, quite young (mean 25 years) some older subjects (in the 50's) were also used. These also showed gains in I.Q., but the gains were not as large as with the younger ones. This finding is in keeping with the present results where gains were found at all ages but the amount of gain decreased with age. These results lend support to the Clarkes' statement that moderate gains may be made by the defective over a long period of institutional life. In the present case, however, some of the gains were quite large, e.g., 16 I.Q. points -- after 15 or 20 years of institutional life.

One puzzling factor in the Clarkes' studies, as well as in the present investigation, is that improvement was found to take place when intellectual growth is commonly supposed to have ceased. Mental growth has been found to terminate sooner the lower the I.Q. (41, 97, 144, 145), and eventual decline to begin much earlier in the defective than in normal persons (48, 49, 51, 125, 153). Whether the subjects are mental defectives,

or other populations, life within an institution has been thought to contribute to loss rather than gain in mental ability (5, p. 306; 60, 106, 126, 139, 167). Goldfarb (60), for example, finds the environment of the institution producing a lack of differentiation of personality, deficient inhibition and control, passivity and apathy in the patients. On the other hand it has been found (83) that young morons show a considerable degree of motivation in their approach to a testing situation, while older morons appear to be more highly motivated than normal persons of similar age. These differences of opinion may be a reflection of the type of institution, the orientation of its program, and the facilities for stimulation of the patients, for no doubt such differences do exist. Goldfarb (60), for whom we find plenty of support in the literature (59, 63, 66, 97, 111, 114, 126, 129), feels that a severely impoverished environment in early years may so seriously depress a child's intellectual development that he may remain permanently handicapped in later years. This view, however, is not entirely confirmed by the findings of the Clarkes, who found that early adverse conditions did not necessarily predict an unfavorable outcome for their patients because some of their largest I.Q. gains were found in individuals with this type of a background. They do not deny, however, the possibility that limits to their mental growth may have been set by the degree of severity of their early environment.

In view of some of these opinions it is not suprising

that the Clarkes' retest results (showing gains in the 20's) were regarded as highly controversial when they first appeared (in 1954), for the consensus of opinion up to about 1950 and even later was that the mental defectives reached their peak of mental development early in life, sometime between 11 and 15 years, which was soon followed by a very rapid decline (41, 87, 144, 148). A search of the literature prior to 1950 shows only slight evidence of support for a more hopeful point of view.

The discussion so far has been concerned with relating the present results on I.Q. gain on the Wechsler to those of others (32,34) also employing the Wechsler test. Attention will now be focussed on two studies which have used the Stanford-Binet rather than the Wechsler. Since the reported correlations between the Stanford-Binet and the Wechsler-Bellevue Scale for mentally defective populations, as given by Wechsler (164, p. 134), are very high ($r = 0.93$, at ages 16 to 59), a comparison of the results obtained on the two tests is quite legitimate. The results of these studies, surprisingly, are at variance with those which have just been described. The most comprehensive of the examinations was carried out by Sloan and Harman (144) who performed 2,267 tests and retests on approximately 1500 mental defectives whose mean age was approximately 15 years -- a decade younger than the youngest group in the present study. The test-retests were over varying periods of time with the median interval between tests being 5.5 years, similar to that of the

present study.

When a comparison of the two studies is made, it is found that 95 percent of our entire sample showed a gain in I.Q. with only two percent showing a loss. This contrasts with 31 percent of the Sloan and Harman subjects showing a gain and 61 percent showing a loss. Furthermore this difference is still striking even when the results are expressed in scaled score units. In this case 88 percent of our subjects still gain or equal their former scores on the retest. What makes the discrepancy even more pronounced is the fact that the mean age of our sample is approximately 40 years, while for the Sloan study it is 14.8 years. Our findings are, however, well in line with those of the Clarkes, who find 53 percent of their subjects gaining more than 10 points, and 26 percent gaining more than 15 points over a six year interval. In view of this supporting evidence this discrepancy on these two intelligence tests cannot easily be dismissed.

The second relevent investigation, also employing the Stanford-Binet, was carried out by Kaplan (83) who retested a group of 66 older morons (mean age, 41 years) over a period of 15 years. Over this interval of time, he has reported an average decline of 6.65 mental age months. Only nine of his subjects increased their score.

It is always rather unsatisfactory and far from conclusive, to compare the results of studies which have employed different mental tests, because (as we have emphasized) of

differing basic assumptions about the nature of intelligence and how it is best demonstrated and measured. We have noted that the results reported by the Clarkes (32, 34) agree rather closely with those of the present investigation, but these employed the Wechsler Scale. On the other hand, the studies of Sloan et al. (144) and of Kaplan (83), showing disagreement of varying degree, made use of the Stanford-Binet. We may well question whether the divergent results are not a function of the tests employed, rather than of differences of mental functioning among the groups. Furthermore, sampling differences are undoubtedly also involved.

Several other studies which have also used the Stanford-Binet on a test-retest basis will now be taken up. In general most of these have reported sizeable I.Q. increases. These studies are however, in a special category since they have employed training procedures and gains in I.Q. might therefore be expected.

A study by Dr. Bernadine Schmidt (134) claims a mean gain of 40.7 points on the Binet Scale at the end of a three-year program of special training and counselling with a group of 254 boys and girls between 12 and 14 years of age. This group whose mean I.Q. was 52.1 (range 27 to 69) were designated as children who had been referred to special classes rather than as an institutionalized population. They had, nevertheless, an initial I.Q. which would place them in the low imbecile to moron range of intelligence. At the end of the three year period of special training only 7.2 percent

of the group were classed as feebleminded. A follow-up study showed that gains of lesser extent were still being made. Schmidt's findings have occasioned considerable critical comment (5, p. 403; 74, 86, 109). Hill (74) challenged her findings by conducting a parellel study using the Binet Scale. Finding no such general gains, he arrived at the conclusion that a faulty diagnosis of many of the subjects was the factor mediating such gains. Other criticisms levelled at the study have been in connection with statistical faults, the ambiguous reporting of training procedures and so forth. Anastasi, (5, p. 405) has pointed out, however, that such gains are not unusual when special training has been instituted (85, 86), while the Clarke study (32) has shown large gains in the absence of therapeutic procedures.

The gains made in the Clarke studies are regarded by them as products of maturation processes which had been delayed by early crippling environmental influences. Large gains were also found in the present study in the absence of special therapy. In view of such findings it is extremely likely that a carefully planned educational and therapeutic program might result in even larger gains than those found by the Clarkes or in the present study (1, 5, p. 406; 150, 157).

Another investigation on the effects of special training on I.Q. was carried out by Kephart,(85). He provided intensive instruction over a period ranging from six months to nearly three years for 16 institutionalized boys aged 15 to 18 years at the beginning of the experiment. Their Stanford-

Binet I.Q. rose from 66.3 to 76.4, in contrast to a control group gain of 1.9 points. The results have been regarded as somewhat ambiguous in view of the fact that some of the materials used in the instruction, closely resembled some of the Stanford-Binet items, thus the training could be regarded as coaching (5, p. 405). Vernon (161), testing the coaching factor, used coaching plus practise on complete tests. He reported a mean gain of nine points. Practise alone had little effect on the scores. She found, however that maladjusted children made the greatest gains in score.

These latter studies are of course, in the main, dealing with younger children and perhaps should not be compared with the Stanford-Binet studies which dealt either solely or in part with older populations. There is considerable evidence in the literature of fluctuations in I.Q. found in both borderline and normal groups of children (7, 126, 137, 139, 167, 166). These are in part occasioned by maturational processes and in part by differential educational and cultural factors. A greater constancy in I.Q. in older persons has been assumed in the past (11, 12, 99, 150, 151, 152, 164). To quote only a few of the many studies concerning such fluctuations; Vernon (162) has said that gains in scores over a lifetime may be as large as 40 points; Honzik et al (76) have found gains of 50 points. Cattell (30) has reported that 0.3 percent of his subjects changed 40 points or more according to Stanford-Binet tests and retests, one percent changed 30 points or more. Children who deviate from the average are

found to improve their scores more than normal subjects, and the brilliant more than the subnormal (11, 12, 30, 170, p. 281). Increase in scores is found also to be a function of the time elapsed between test and retest (76, 154, 170, p. 282). From these findings it is clear that I.Q.'s can and do change with age and consequently we should not be surprised when quite large gains are reported in the literature.

The discussion so far of the present results has largely dealt with the performance of the subjects on the Full-Scale of the Wechsler. Now let us turn to the Verbal and Performance sections of the test and make an examination of the differential aspects of their mental ability. We find that all groups make significant gains on both sections of the test, and in terms of both I.Q. and scaled scores. When we examine the comparative contributions of the Verbal and Performance sections of the test to the total achievement, we find that Performance tests in general give the mental defective a better opportunity to increase his score in the earlier decades, while his verbal skills are slower in maturing and he makes larger gains in his later years on the subtests which demonstrate these. The largest gain in Verbal scaled scores was made by the subjects in the 50's (2.96 points), while the subjects in the 20's made the greatest gain in Performance retests (6.16 points). On the other hand, the older subjects made a gain of only 1.24 scaled score points ($p > .01$) on the Performance tests, while the young subjects made a gain of only 1.80 ($p > .02$) on the Verbal sec-

tions of the test. When reported in terms of I.Q., the gains found are of course considerably larger and in every case highly significant ($p < .01$), with the exception of the oldest group who have received no increment for ageing above that allowed for at age 49. In most cases this allowance has already been reflected in the scores at the initial test when the mean age was 51 years. In view of these findings it would seem that intelligence tests which measure performance as well as verbal skills, e.g., the Wechsler, would give a more accurate picture of the total mental ability of the young mental defective than a more purely verbal scale such as the Binet. Difficulties in speech (1, 6, 89, 119) and hearing (25, 70, 107), and a somewhat lessened speed and power of making verbal associations (47, 48, 49, 71, p. 115; 114, 118, 143, 155) are known to penalize the patient on verbal tests. This may in part account for the apparently contradictory nature of the results which have been found in the studies employing the two kinds of intelligence tests on the mentally defective population.

In summarizing the results of the test-retest or longitudinal approach to the problem of ageing in mental defectives it is clear that the most significant finding was that a statistically significant gain in intellectual performance could occur over a period of five years regardless of the age at which the subjects were first tested. This gain was evident in both scale score units and in I.Q. units, and in the Full-Scale of the Wechsler as well as on the Verbal and

Performance sections. Little support was found in the literature for these findings except for the work of the Clarkes (32, 34), who also reported sizeable I.Q. gains in the Weehsler. Unfortunately, however, their study was restricted to young subjects. No other studies, using an older population and retesting them over a period of years on the Wechsler, have been carried out. Several investigations, however, using both young and old subjects have been done, but they employed the Stanford-Binet. The results are at variance with those of the present study. Possible reasons for the discrepancy in results from these two types of tests were pointed out. A number of instances were mentioned where sizeable I.Q. gains were reported (85, 86, 134, 151). However, all these were the result of special training procedures. No special remedial techniques were employed in the present study.

The problem arises, therefore, of accounting for the sizeable I.Q. and scale score gains which were made by all the age groups, including the oldest. This question is particularly important because the consensus of opinion is that mental defectives reach their peak of intellectual ability very early in life (11 to 15 years) with a decline occuring soon after (41, 87, 144, 148). A number of variables will be examined to see to what degree they could account for these consistent gains in all age groups. The first of these is test practice. This would be a possible factor if we were dealing with subjects of average intelligence but it is dif-

ficult to believe that it could be a significant factor in mental defectives, especially after a period of five years. Furthermore, there is evidence in the literature that test practice, unless allied with coaching, does not bring about such gains as are reported (161). Finally, none of the subjects received any additional Wechsler testing at any time during the five year period and only a very few had been given any other type of psychological test. They were not, therefore, test oriented.

The second possible factor in this study is the manner of administering the tests and the attitudes of the psychometrician. As far as test administration is concerned, no departures from regulation testing procedures were permitted and Wechsler's criteria for valid responses were adhered to in all tests. In regard to the attitudes and motivations of the psychometricians, it should be mentioned that none of the testers were aware that a test-retest study was underway. There was, therefore, little possibility that their scoring was otherwise than objective. It should also be mentioned that approximately 20 percent of both tests and retests were administered by the same psychometrician. The remainder of the testing was done by other psychometricians. A careful examination of the results showed that all of the testers were consistent in their results, i.e., they all obtained gains and an occasional loss in score.

The third variable which needs to be examined is that

the gains occured as a result of placing the defectives into an institution whose environment was much more stimulating than the one they came from. It has already been mentioned that the Clarkes obtained a much greater gain in I.Q. in those patients who came from a very adverse home environment than those who came from a less adverse home. Furthermore, they reported that the greatest gains occured during the early years of institutionalization. This variable is not believed to be too important because the subjects were purposely selected in such a manner that their length of residence in the institution was at least one year at the time of initial testing. Only 8 out of the 100 defectives had been hospitalized less than one year. Furthermore, these eight cases were not restricted to one age group but were spread throughout the four age groups. Despite this, some of the gains were undoubtedly due to a transfer to a better environment for a year may not have been sufficiently long to counteract the depressing effects of a prolonged period of exposure to an adverse home environment. However, we are still faced with the problem of accounting for the I.Q. gains which occured in the older age group many of whom have been in the constant institutional environment for periods of 15 to 20 years.

The fourth and perhaps the most important factor which needs to be discussed is the problem of faulty diagnosis. There has been a great deal of concern about this matter. First it may be well to outline some of the thinking on the concept of pseudo-feeblemindedness which in the

minds of many researchers (80, 95, 108, 111, 112, 159) is a condition resembling the mental deficiency of the true "irremediable" category (37, 41), but is not of a totally irreversible nature. It is generally agreed that physical defects of speech (1, 6, 10, 89, 131) and hearing (25, 70, 107), motor deficiencies and neurotic and psychotic states (22, 58, 82) may bring about a condition of mental functioning which well accords with the psychometric and social criteria of true mental deficiency. The concern then is about a false diagnosis which will entail institutionalization of the patient. Some have felt that the term should be applied only to those whose malfunctioning is due to emotional factors (17, 22, 26, 65, 80, 95, 105, 111, 141), others have felt that any child who as a result of psychotherapy finally functions at a normal level was never feebleminded (120), therefore no such condition as pseudo-feeblemindedness exists. The Clarkes (31, 33) feel that the psychometric and social rating of the patient at the time of admittance is a true measure of his efficiency, no matter what the underlying cause of his deficit, preferring the idea that a wrong prognosis of his future mental performance is the crucial factor. They have found large gains to be made merely as a reactivation of environmentally delayed maturation (32, 34). There is, however, a growing body of evidence that therapeutic measures may bring about even larger gains (1, 8, 26, 105, 130, 132, 157, 160). Hence a differentiation between those who may profit by remedial measures and those whose defects are, (at the present

stage of medical and psychiatric knowledge), of an "irreversible" nature, is a matter of growing concern (31, 39, 42, 72, 116, 117, 124, 131, 149).

It is believed that with the advance of medical research, more rigorous neurological and physical examinations will bring to light the nature of the defect now usually referred to as "the additive effect of numerous genes" (15, 29, 57, 127). Exhaustive case histories (6, 37, 59, 72) and projective techniques (63, 68, 130, 159) may aid in differential diagnoses which will help to reduce the number of cases originally diagnosed as feebleminded, thereby determining the course of future therapy (6, 63, 108, 116).

There is no doubt that when the present subjects were admitted they displayed the symptoms of true mental deficiency in terms of psychometric ratings and social inefficiency. Recognizing the fact that physical, environmental and emotional factors may have placed limits on the growth of the mental capacities with which nature has endowed the mental defective (29, 59, 71, 79, 97, 114, 169), it is our belief that their removal to the institution has probably hastened delayed maturational processes by providing more favorable conditions for their development. These conditions stimulating the previously arrested maturational processes, may then be reflected in I.Q. gains even in the older subjects.

The policy of this institution for many years has been to provide the best physical care and to surround the patients with an atmosphere which minimizes the custodial aspects of

institutional life, and accents the possibilities of rehabilitation. Though facilities have in the past been less than could have been desired, the patients have been given the best of medical and nursing care and though limitations of staff and some lack of accommodation prevents the realization of some of the programs planned, the quality of care being rendered the patients is optimal. Especially noticeable and especially therapeutic, one would surmise, is the acceptance of the patients as worthwhile individuals; the apathy and listlessness spoken of by Goldfarb (60) was certainly not shown by the subjects of this investigation.

We concur with the Clarkes' belief that the maturation processes of familial defectives have a slower rate of development than those of normal persons. This view point receives some confirmation in the literature from the study of Eustis (47) who postulates a physiological basis for a slower maturation rate in the mental defective, in a slower myelination of nerve tracts, and also from the numerous studies already quoted, which support the contention that many patients diagnosed as mental defectives of the familial category are in reality, under-functioning as a result of early deprivation and psychogenic disorders. It may be a matter for speculation only, but there is a possibility that but for the intervention of physiological and organic changes due to ageing, the familial patient would in time reach normal performance on an intelligence test. In the case of some of these subjects who show surprising gains late in life,

we may perhaps surmise as Miles (103, 104) did in the case of his normal subjects, that a well-balanced emotional and social adjustment and the will to use such skills as he possesses may counteract some of the physiological changes in neurological mechanisms which bring about a decline.

The preceding discussion has been concerned with the retest performance, five years later, of subjects of different ages. As is already clear, all age groups showed a significant improvement in intellectual performance. It is now proposed to examine the performance of the mental defectives over the entire age period using a combined longitudinal (test-retest) and cross-sectional approach. Since the findings from a different approach will now be dealt with, certain differences in results are to be expected. The nature of these differences and the reasons for them will be taken up later.

It was found that general intelligence as measured by the Full-Scale (scaled scores) shows only a small decline from the twenties to the forties, with a more noticeable one thereafter. Since no other investigator has administered the entire Wechsler Scale to mental defectives over a wide age range, we are unable to make any direct comparison of our results with those of others. However, we can make some comparisons of our results with those of subjects of average intelligence. When this is done it is seen that the curves are essentially the same in shape. Wechsler (164, p. 118)

has shown that performance on his test (scaled scores) reaches a peak somewhere in the mid-twenties, and then slowly and progressively declines with increasing age. The only difference in the shape of the curves is in the older age groups where the performance of our mental defectives decline somewhat faster.

The effect of age on the scores obtained by the subjects was different on the two sections of the Wechsler. On the Verbal tests there was no decline between the 20's and the 40's, with a significant decline occurring only in the 50's. On the other hand, the scores on the Performance Scale showed a somewhat different pattern. They declined gradually from the 20's on, with some levelling off, however, occurring between the 30's and the 40's. The curves are again essentially similar to those of the Wechsler on normals, whose Verbal scores hold up much better with age than their Performance scores. Certain differences appear, however, in the relative performances of the two groups. In the case of normal subjects, Performance scores contribute slightly more to the Full-Scale totals up to the late 20's, after which the Verbal scores contribute much more heavily. However, in the case of our mentally defective population, the Performance scores contribute much more heavily to the Full-Scale totals at the lower levels with the difference gradually diminishing with increasing age. In the older group the contributions of the Verbal and Performance scores are much more equal, 11 points difference in the 20's having decreased to less than two points in the 50's. This differential pattern

of performance has been assumed by several investigators (68, 121, 123) to be typical of the subtest performance of the mental defective.

Attention will now be focussed on the performance of the subjects on the six tests which go to make up the Verbal Scale, and the five tests comprising the Performance Scale. Vocabulary, Information and Arithmetic show no significant decline over the age period studied. The defectives in general scored very low on Arithmetic at all ages, and this poor score is in part responsible for the fact that their total Verbal scores at all ages are below their Performance scores. Comprehension, Similarities and Digit Span, all hold up till the scores of the 50's are compared with those of the 40's when they are found to be significantly lower.

The scores on the Performance subtests also show a differential pattern of decline. Picture Completion and Block Design show a significant decline in scores in the 40's as compared with the 30's, after which no further decline is shown. Picture Arrangement dropped sharply in the 50's as compared with the 20's, showing no significant change thereafter. Digit Symbol shows a different pattern of decline in that a significant loss is shown in the 30's, after which no further decline takes place till the 50's are reached.

A direct comparison of these subtest results with those of other investigators is extremely difficult because of the almost total lack of relevant studies using mental defectives, and especially the type which covers a wide range

of the life span. The most relevant study was carried out by Thompson (153) who administered 12 different tests to a group of 137 defectives ranging in age from 16 to 69 years. A number of these tests were taken from the Wechsler, viz., Picture Arrangement, Digit Symbol, Block Design, Vocabulary and Digit Span. In the case of the two Verbal tests, viz., Vocabulary and Digit Span, he reported no decrement whatever between the ages of 16 and 69 years. These results on the Verbal tests are somewhat at variance with those of the present study, where it was found that Digit Span held up till the scores of the 50's were compared with those of the 40's; in the 50's a sharp drop took place. Vocabulary scores like those of Thompson showed no significant decline over the age range. Thompson's scores on the three Wechsler Performance tests are also at variance with those of the present study. He reports that all three tests showed a significant loss in score at age 30, as compared with age 20, after which the only significant decrease was from 40 to 50 years in Digit Symbol. The Digit Symbol subtest shows the same pattern of decline as that of Thompson's subjects; Picture Arrangement in our study, on the other hand, shows no decrease until the scores of the 50's are reached. Block Design also shows a later falling-off than that found by Thompson, for the initial decrease is found when the scores of the 40's are compared with those of the 30's with no further decline being noted.

This apparent discrepancy in the results is very

likely due to two factors, viz., differences in the nature of the samples used, and a difference in the approach. As far as the sample is concerned, Thompson restricted his subjects to an I.Q. range of 50 to 70. In the present study the range of I.Q. was much wider. Secondly, in our study more testing of older subjects was done than in Thompson's study. Probably the most important factor is a difference in the approach used. Thompson employed a strictly cross-sectional approach, while in the present study a combined longitudinal (test-retest) and cross-sectional approach was used. Considerable evidence is already available (mentioned in historical review) which strongly suggests that different results will be obtained, depending on the approach used. Furthermore there is a general agreement that a study making use of the longitudinal method, even partly, provides more reliable ageing data than one using the cross-sectional approach, for in the previous case the same subjects are tested over a period of years, rather than different age groups at the same time.

Attention will now be directed to a comparison of the performance of the mental defectives and of normal subjects on the subtests of the Wechsler.

As we have shown in the historical section of this thesis, Wechsler in examining the effects of ageing processes, has divided the subtests of his scale into two groups which have become widely known as the "hold" and "don't hold" tests (164, p. 64). Along with the three Verbal tests, viz., In-

formation, Comprehension and Vocabulary, he has placed two Performance tests, viz., Object Assembly and Picture Completion in the "hold" section. Others (77, 23, 96) as a result of examinations of older normals agree that these three Verbal tests hold up with age, but disagree with the inclusion of the two Performance subtests maintaining that they really belong in the 'don't hold" category (77, 121).

This study is in agreement with Wechsler in that the three Verbal tests, viz., Information, Comprehension, and Vocabulary hold up well with age, though Comprehension shows a significant decrease in the 50's. In the case of Object Assembly we find a decrease in the scores of the 30's as compared with those of the 20's but no further decline. Picture Completion shows a decline a decade later than Object Assembly and also shows no further decline. In Picture Completion, Wechsler's oldest subjects are shown (164, p. 222) to have lost three points from a high score of approximately 10 at 20 - 24 years, while the present subjects declined over the age span in much the same ratio (4.86 to 3.0). Object Assembly, the other Performance test said by Wechsler to hold up well with age shows a slightly smaller loss than Picture Completion in Wechsler's subjects, but declines by 50% over the age range in the mental defectives (7.14 to 3.64), the significant loss taking place between the 20's and 30's. Thus we find that the subjects in this study follow very much the same pattern on the Verbal subtests as the normal subjects, with the exception of the Object Assembly subtest which does

not hold-up as well.

Turning to the "don't hold" category we find that Wechsler has included the remaining three Verbal tests, viz., Arithmetic, Digit Span and Similarities with the remaining Performance items, viz., Block Design, Digit Symbol, and Picture Arrangement. In the case of the mental defectives, Arithmetic holds up over the entire age range; Digit Span, Similarities and Picture Arrangement show no change until a decline appears in the scores of the 50's as compared with those of the 40's. Digit Symbol has a distinctive pattern, in that an early loss occurs, with no further change till the 50's, as compared with a steadier but sharp rate of decline in Wechsler's subjects.

Summing up the pattern of "hold" and "don't hold" subtests as found in this study it is seen that the six Verbal subtests and Picture Arrangement show no significant declines till the 50's are reached while three of these, viz., Information, Vocabulary and Arithmetic show no loss even in this decade. Picture Completion and Block Design show a loss in the 40's, while Object Assembly and Digit Symbol show a loss between the 20's and 30's. In the case of Object Assembly this is followed by a plateau of no change while Digit Symbol declines again in the 50's. The findings of this study follow more closely those of Rabin (121) who placed all the Verbal subtests in the "hold" category and the Performance items in the "don't hold" class.

Hunt (77) has also done some work in the "hold" and

"don't hold" tests. He reports that Information and Comprehension hold up well while Block Design and Digit Symbol decline. He considers these four tests to be better indices of normal deterioration than Wechsler's selection. The findings in this study show quite close agreement with those of Hunt where these four tests are concerned with Comprehension holding up well till age 50 and with Information holding up over the entire age period. On the other hand, Digit Symbol shows an early decline, a plateau and a further decline at the oldest age level, while Block Design shows a significant loss after the thirties.

Although originally designed as an intelligence test, there has been for some years a considerable interest in the possibility of the use of the Wechsler as an instrument in clinical diagnosis of psychotic groups, or in differentiating cases of brain-injury from the familial type of mental deficiency. While deterioration is certainly more marked on some tests, and in some groups than others, Rabin (127) and Guertin have said, after reviewing the literature, that there is little or no prospect for the success of a mechanical system of differential diagnosis. By means of profiles of performances on cognitive tests, however, the experienced clinician may gain insights into mental conditions which will aid in diagnosis.

Boehm and Sarason (27) have said that Wechsler's deterioration index will not discriminate between mental deficiency and mental deterioration because of the tendency of

the mental defective to score low throughout his lifetime on tests said by Wechsler to deteriorate with age. These subjects have been found to score very low on Arithmetic at all age levels with no significant differences between age being shown. The same is true of Digit Span, another "don't hold" subtest.

Tests such as Vocabulary, whose level represents as it were, what intelligence has been achieved in the past (4, 9, p. 330) show a greater resistance to age in either normals, psychotics or defectives, than is shown in tests involving speed (23, 36, 49, 100), complex abstractions or conceptualization (118). Some however have warned against accepting Vocabulary scores as indicators or former general intelligence in the case of familial defectives and illiterates (68, 125), while abstractions are in general found to be more difficult for the defective at any age (135, 145, 163).

Using Wechsler's deterioration index, the writer examined several scores in this study at random throughout the age range. Though no conclusive statement can be made on the basis of a limited number of observations, it would seem that the inclusion of the scores of Arithmetic and Digit Span in the ratio of "hold : don't hold" suffices to reveal deterioration quotients in even the youngest subjects, while in the case of individuals who stand out in the groups as having done comparatively well in these tests, little deterioration beyond that of Wechsler's postulated normal ageing process is shown at any age, and in some cases none at all. Using

the index in this way with the scores of the mental defective is assuming that mental deficiency and mental deterioration with age are manifested in the same subtest performance.

It may be well to point out at this time that there is no evidence that the pattern of decline in the various aspects of intelligence as a result of normal ageing processes bears any resemblance to that which may occur as a result of brain pathology in the exogenous mental defective, or to the generally lowered pattern of functioning in the familial cases (4, p. 335). Ageing is found to involve organic and physiological changes which at present it would be difficult to correlate with their psychological aspects (76, 121, 123). In the great majority of familial mental defectives any organic or physiological cause for their lowered mentality has yet to be isolated (15, 33, 90, 127). Miles has said, as a result of the Stanford Later Maturity studies (100, 101, 102, 103, 128), that the ageing process is often delayed because of the positive psychological attitudes of some older individuals, while a considerable body of evidence has accumulated which testifies to the role played by defeatist attitudes, cultural deprivation and emotional disorder in the intellectual deficiency of the familial category of mental defectives, some going so far as to state that all familial deficiency is psychogenic in origin (60, 95, 112). In view of all the as yet "unknowns" and the controversy revealed in the literature regarding patterns of performance on subtests, it is little wonder that the experienced clinician

approaches categorization on a basis of subtest pattern or "scatter", with a considerable degree of caution, and then only on a basis of other clinical findings.

Let us turn now to some general theoretical considerations regarding the intellectual functioning of mental defectives and how their functioning compares with that of normals.

It is our belief that we have in the results of this study some evidence that supports the belief that the familial category of mental defectives represents the lower end of the intelligence range (29, 126, 133). This theory would not deny the contribution of physical defects of sight and hearing, motor deficiencies, and psychogenic factors to a lowered mentality. There is however, no evidence, that were all these deficiencies corrected, a high degree of intelligence would result. There is evidence in the literature that in spite of mental disorder, brain-injury often massive in extent, and less than optimal early environments, a high quality of test performance may be maintained. There is also no denying the fact that the individuals who are innately endowed with a lesser amount of the mysterious force (called variously, "elan vital", the "g-factor", "global capacity", "psychic energy", "a cluster of traits") are more likely to succumb to environmental limitations and cerebral insults, especially those occurring in early life. Moreover, a low mental ability seems to be an aspect of a genetically weaker organism (71, 78, 123).

What has actually been measured in these tests has been the product of the interaction of innate endowment with the opportunities provided for its development. In the case of these patients, cultural and emotional phenomena have in all probability been hostile to this development. Many of them have formed habits and prejudices which have acted as a deterrent to the acquiring of new knowledge. Woodworth (169) has said that intelligence does not grow; knowledge increases through the application of the same capacity in a wider frame of reference. Interests, will power, health and opportunities are factors which determine how little we use our basic capacity or intelligence. Thorndike (155) defines intelligence as a combination of learning and memory; to Spearman (146) intelligence is a grasping of relationships; thus the knowledge we acquire is a product of the relationships grasped and held in memory. To the grasping of relationships we must necessarily add the factor of the speed with which these associations are made. Speed is considered by Sloan (142) to be a general, all-pervasive aspect of intelligence, not to be considered a separate trait; if lacking a generally lowered tone of mental functioning results. A composite of these views would be that intelligence consists in a grasping of relationships, and the building stores of experiences as wide as the environmental field allows. The sum total acquired will depend upon the speed or energy of cerebral functioning by means of which such associations are made. It is around a core of the earliest grasped relationships that knowledge

increases and with it, access to experience in a more extensive frame of reference. Herein lies the difference between the seemingly demonstrated power to grow in ability over the years which is characteristic of superior individuals, and the apparent decline of the defective in comparison with even those of average ability as age increases.

As Hebb (71) contends, the speed with which associations are made will determine how rich the store of knowledge from which we draw in later years will be, opportunities for development being equal. The speed factor has been found to penalize older subjects in intelligence tests; at the same time it has also been shown that the more intelligent are better able to compensate for motor loss in heightened power to perform. An apparent loss in many skills involving speed may often be attributed to lack of use, or a general falling-off in motivation.

In the scores of this study it would seem that we have considerable evidence that the mental defective of the familial category is not a deteriorated human being, but rather one who, because of a lessened amount of the vital factor (no matter by what name it is called) has never fully grown. It would seem that Hollingworth's statement that the defective is like "an arrow launched with feeble propulsion" is amply demonstrated (75, p. 162). He is slower to get started and he reaches no very considerable height, but otherwise his performance on the mental tests differs in no way from that of normal persons. This we have shown by many comparisons

of the curves which result from the scores of the present familial subjects and those of the normal range. It should be noted, however, that certain defects of sight, hearing, speech and motor disability more commonly found among defectives than among normals, may have contributed to a sharper falling in certain tests, especially those which are highly speeded and those in which a repetition of the question, or instructions is forbidden, or penalized. This is particularly the case with Object Assembly and Digit Span where there is some discrepancy between the performance of the defectives and normals.

Considerable emphasis is often placed on the fact that Performance skills contribute more highly to the general intelligence rating of the mental defective than do the Verbal items of the Wechsler. His functional answers to many of the verbal items rob him of partial scores though it is apparent that the patient has attained the concept involved. Several researchers are averse to differentiating between concrete and abstract level of thinking on the grounds that every concept attained, no matter how simple, has shown the elements of both. These patients have formed many concepts in general which are precisely the same as those learned by the young, whether of high, low or average intelligence, the difference again consisting in the speed with which they are acquired. New knowledge necessary for the formation of more complex conceptualizations comes slowly to the defective. He requires concrete and repetitious experiences beyond those

required by the normal young, therefore he is left farther behind in the developmental stages with the passage of time.

Verbal skills are slower in maturing in normal subjects, according to Wechsler's scores, for until approximately age thirty, his subjects also score higher on Performance items. After this age the Verbal skills contribute more heavily to the total score as time advances. The scores for the defectives follow the same pattern but they are in the 50's before they approximate each other, some 20 years later than the normal subjects. In both cases some falling-off in the performance tests is a factor concerned as well as an increase in verbal ability. If we discount the decline in Digit Span at later ages, and consider the upward trend of the more purely verbal skills in the 40's, we have evidence that in spite of the lack of opportunity for wider experiences which would tend to promote maturation, these patients are still acquiring additional learning. Hebb (71) has said that the mental skills demonstrated by performance tasks in general, differ not in kind but degree, hence the earlier acquired performance proficieney. The differentiating factor is the speed with which the implicit type of problem solving behavior can reach the stage of verbalization about problems, unaided by the visual and motor aspects of the typical performance test.

Thus we are led to believe, as we have stated, that the mental ability of the defective if given opportunity, continues to mature as time goes on. In age where speed above

all is extolled, his slowness and confusion in dealing with a complex life situation sets him apart from his fellows. If he is institutionalized, the change in environment often appears to reactivate his mental powers up to the point at least where necessary restrictions may set a limit to the demonstration of new skills.

It was noticeable that in some of our patients who had reached the top of the moron category or beyond, smaller gains were made than in the case of those with very low scores. On the other hand some patients with low scores improved very slightly. A few investigators (19, 54) have examined such variables as age, length of institutionalization, former scores, former academic learning before institutionalization, as well as visual and auditory defects in an effort to find correlations between such factors and test scores. No general agreement has been reached. Satter (133) has found several factors which appear to distinguish between retarded adults who achieve gains and those who do not. These appear to be very closely concerned with such factors as we have shown. He finds differing degrees of the general factor of intelligence, differential perceptive-motor abilities, and what he calls a substitution factor which is displayed in the present case in the Digit Symbol scores. Our scores fell-off sharply in early years in this subtest and again in the 50's, according to the cross-sectional view, though re-test gains were made by all but the older group. In many of these patients it was shown, during the practise period, that

they had grasped the requirement and were able to make the transfer. However, the speed with which they were able to do this penalized them. Even the manual task of holding the pencil was difficult for some because of lack of practice, a defect partly of institutional life and partly of the defect in learning ability in earlier years. It may be that such examinations as those of Satter and others (19, 20, 132, 133) into individual differences in performance of mental defectives may provide clues to a better understanding of the vital factors, and point the way to remedial procedures in the learning field.

The final question that needs to be dealt with is the apparent discrepancy in our results in which intellectual gains were obtained in all age groups on a test-retest basis but some losses occurred when the results were plotted over the entire span of years. It is our belief that this discrepancy is in large measure due to a difference in approach. In the first case the longitudinal method was used where the same subjects were tested over a period of five years. In the second case this method together with a cross-sectional one was used where the subjects were of different ages at the time the study was made. Evidence has already been received in the historical section in which it was pointed out that studies using the longitudinal method have invariably reported that intellectual abilities hold up or improve with age. Similarly, studies employing the cross-sectional method have almost invariably reported a decline in there abilities. Al-

though these investigations employed subjects of average or above average intelligence it is extremely likely that the same situation applies to the mental defective population.

It is generally agreed that the longitudinal approach provides a much more accurate and valid picture of age changes, for the same individuals are being studied at all ages and consequently the sampling problem is not too important. On the other hand, the cross-sectional approach presents some almost insurmountable sampling problems especially when older age groups are involved and attempts are made to equate them to younger subjects. Such factors as differences in education and environmental upbringing, attitudes and motivation toward taking of psychological tests are only a few of the variables that are difficult to equate when different age groups are employed. These sampling problems are especially difficult in the case of institutionalized mental defectives. In this case the older defectives are usually those of lower intellectual capacity (or of poorer social adjustment) who have failed to reach the standard necessary for rehabilitation. In addition, many of the patients in the older age groups owe the fact that they are still alive to recent advances in medical research. This means that they may be essentially weaker in physical and mental health than their fellows. In the light of such facts it is not surprising, therefore, that when our results were plotted cross-sectionally they showed a decline in scores. Furthermore, it is our belief that if a purely longitudinal study was done over the

whole period of 35 or 40 years rather than just a partly longitudinal one, the performance of our mental defectives would not only have held up over the entire span but very likely would have shown a small but progressive increase.

It would seem that there is in these patients a defect which it may be hoped in time can be remedied. As we have said, about the physiological basis little is known. Drugs have been produced which have depressant effects on mental functioning; drugs have already been used in experimentation as activators of mental energy, though not with proven success and not on older subjects. There would appear to be hope that in future the retarded functioning found in the defective may be better understood, and as a result may be increased.

As to future prognosis as it appears today, we quote Dr. R. Gibson* of the Manitoba School whose patients we examined. Striking a hopeful note, he makes the suggestion that, "inasmuch as intelligence is partly determined by environment, and presumably to that extent capable of alteration, we may surely hope that the civilization which has made amazing technical progress in other fields will also learn in time to develop this asset." (57).

The Clarkes (33) sum up the situation as it appears at present by saying that mental defectives "can be changed within limits which are not yet ascertained, nor are the factors influencing and limiting such change really understood." They do however believe that intellectual subnormality among deprived

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people such as the certified feebleminded is not necessarily a permanent, irreversible condition. With such statements we are in full accord for we believe that this study supports such conclusions.

# CHAPTER IV

## SUMMARY AND CONCLUSIONS

The research literature abounds with studies dealing with the effect of age on various intellectual processes, but in the main, they have been concerned with subjects of normal or above normal ability. Ageing in the mental defective population has been an area of considerable neglect. This may be because of an assumption that the theory of intelligence was equally applicable to all individuals, or because such studies as were conducted presented such a hopeless view regarding the prognosis for the mentally deprived population. There was, however, some suggestions in the more recent literature, that such gloomy predictions were unjustified, at least for certain categories of mentally defective individuals. Therefore, it was felt that a rather exhaustive study on age concerning the intellectual abilities of one of these categories, the familial group, might aid in clarifying an ambiguous situation.

The subjects who were used in the experiment were 100 familial patients from the Manitoba School for Mentally Defective Persons. They ranged in age from 15 to 64 years. They were divided equally into four groups having a mean age of 20, 30, 40, and 50 at the time of the first Wechsler test. Five years later, each of these four groups was again given the Wechsler-Bellevue Intelligence Scale.

There is some evidence in the literature that a

longitudinal (test-retest) approach provides a better measurement of the mental abilities as they function over a period of years, than do those of the cross-sectional type where large groups of individuals of different ages are simultaneously examined. The approach to this study, therefore, is a two-fold one, the first, to examine the test-retest performance of the subjects over a time span of five years; the second, to present data in the form of a cross-sectional view of mental functioning over the entire age period studied.

The main findings of the test-retest section of the study were as follows:

1. Significant mean gains in scores were found in all four age groups when they were retest five years later. These gains were found on Full-Scale, Verbal and Performance sections of the test, and furthermore, were shown in the scaled scores as well as in I.Q. ratings. Actual or real increases in intellectual performance were therefore obtained. The amount of gain was found to diminish as the mean age of the group increased by decades. Performance gains diminished across the time span, while larger Verbal gains were shown at older age levels.

2. Of the six Verbal subtests, Arithmetic alone showed no significant gain in any of the age groups. Information increased significantly only in the 20 to 25 age period, while Comprehension and Vocabulary showed significant gains in all age groups, except in the case of the oldest subjects in Vocabulary. Similarities, thought to fall-off with age in

normals, showed significant gains in the two older groups, strangely enough, while Digit Span maintained its reputed tendency to fluctuate by showing a loss at the earliest age level (20 to 25), and significant gains in the 30to35 and 50 to 55 age period.

3. The five Performance subabilities showed a rather widely scattered pattern of gain, though on the whole these gains were larger than those made on the Verbal subabilities. Picture Arrangement, Picture Completion and Object Assembly showed consistent gains in all age groups, Block Design was best in the 20's and 40's, Digit Symbol showed a highly significant gain in the 20's and again, surprisingly, in the 50's.

4. Individual gains were found to be as large as 26 scaled score points on the Full-Scale, and 22 points on the Performance section, as compared with 13 points on the Verbal scale. The highest gain in I.Q. (33 points) was noted in the Performance section of the scale, the Full-Scale high being 22 points. It was noted that individuals scoring large gains on one section tended to show a minimum increase or even a loss on the other, thereby reducing their total gain.

5. It was found that 88 percent of all the subjects tested either gained or equalled their former scaled scores on the retest, while 98 percent either gained or equalled their former scores in I.Q. ratings.

Turning now to the results of the combined Longitudinal

and Cross-sectional approaches, the main findings were as follows:

1. In terms of scaled scores, the Full-Scale scores were found to hold up quite well between the ages of 20 and 45, but showed a decline thereafter, the scores of the 50's being significantly below those of the 40's. The Verbal scaled scores hold up well, though again a significant loss occurs in the 50's as compared with the performance of the 40's. The Performance scaled scores as a whole declined gradually from the 20's to the 50's, the level reached in the 50's being approximately 50 percent of that of the 20's, the sharpest drop found to occur on any scale.

2. Scores on the individual Verbal subtests showed no significant decreases over the life span on three tests, viz., Vocabulary, Information and Arithmetic. The remaining three tests showed a loss only in the 50's. In contrast to the holding up of the Verbal subtests, all of the Performance subtests showed a decline. This decline was a differential one with Object Assembly and Digit Symbol showing the earliest decrement.

3. The apparent discrepancy between the consistent gains obtained on test and retest and the slight decline appearing when the scores are plotted over the entire age period are attributed largely to a difference in approach used. It has already been pointed out that longitudinal studies have almost invariably reported that mental abilities hold up with age, while cross-sectional investigations

report varying amounts of loss over the age range. It is believed that if a purely longitudinal study had been carried out, the tendency of the mental defective to show an increase over a five year period would also have been evident over the entire age period studied.

4. The gains shown are regarded as a valid indication of an increase in mental ability over the years; a phenomenon of a later maturational process. Support for such a belief has been found in the theory of intelligence, and in some more recent studies.

5. These intellectual gains have occurred without the application of any special individual or group-therapy and for the majority of the patients, without special individual educational procedures. They are believed to be due to the removal of the patients to the more favorable environment provided by this institution where the patient is regarded and treated as a worth-while individual.

# APPENDICES

# A P P E N D I X "A"

## ABBREVIATIONS USED IN THE TABLES

| | |
|---|---|
| Su: | Subject |
| A: | Age |
| S: | Sex |
| IN: | Years Institutionalised |
| I: | Information |
| C: | Comprehension |
| DS: | Digit Span |
| A: | Arithmetic |
| Si: | Similarities |
| V: | Vocabulary |
| PA: | Picture Arrangement |
| PC: | Picture Completion |
| BD: | Block Design |
| OA: | Object Assembly |
| Sy: | Digit Symbol |
| V: | Verbal |
| P: | Performance |
| FS: | Full Scale |
| **: | Age at Initial Test |

## SCALED SCORES ON SUBABILITIES

### AGE GROUP 15 to 24 **

| | | | Initial Test | | | | | | | | | | | | | Retest | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Su | A | S | IN | I | C | DS | A | Si | V | PA | PC | ED | OA | Sy | | A | IN | I | C | DS | A | Si | V | PA | PC | ED | OA | Sy |
| 1 | 21 | M | 9 | 3 | 0 | 0 | 0 | 1 | 3 | 3 | 4 | 0 | 2 | 3 | | 26 | 14 | 3 | 3 | 0 | 0 | 1 | 4 | 3 | 6 | 1 | 7 | 0 |
| 2 | 19 | M | 5 | 1 | 5 | 0 | 0 | 1 | 3 | 3 | 3 | 4 | 9 | 4 | | 25 | 11 | 2 | 1 | 2 | 0 | 1 | 3 | 3 | 9 | 5 | 9 | 3 |
| 3 | 24 | M | 11 | 3 | 3 | 0 | 0 | 1 | 4 | 1 | 7 | 1 | 8 | 2 | | 29 | 16 | 3 | 1 | 0 | 0 | 1 | 4 | 3 | 7 | 1 | 8 | 3 |
| 4 | 24 | F | 3 | 2 | 5 | 6 | 0 | 4 | 4 | 1 | 2 | 1 | 2 | 4 | | 29 | 8 | 3 | 5 | 4 | 0 | 2 | 3 | 3 | 2 | 4 | 0 | 4 |
| 5 | 19 | F | 4 | 1 | 7 | 2 | 1 | 1 | 4 | 8 | 4 | 7 | 10 | 9 | | 23 | 8 | 4 | 6 | 0 | 0 | 1 | 4 | 6 | 7 | 7 | 11 | 8 |
| 6 | 17 | F | 4 | 3 | 5 | 4 | 1 | 3 | 5 | 4 | 3 | 3 | 6 | 7 | | 21 | 8 | 3 | 3 | 9 | 0 | 1 | 5 | 10 | 4 | 3 | 8 | 8 |
| 7 | 16 | F | 1 | 4 | 5 | 6 | 1 | 4 | 5 | 4 | 3 | 5 | 8 | 8 | | 21 | 6 | 4 | 4 | 6 | 0 | 4 | 5 | 4 | 7 | 6 | 7 | 10 |
| 8 | 23 | F | 6 | 2 | 3 | 0 | 0 | 1 | 4 | 3 | 9 | 4 | 3 | 2 | | 28 | 11 | 2 | 5 | 0 | 0 | 1 | 4 | 3 | 3 | 3 | 5 | 8 |
| 9 | 15 | F | 2 | 4 | 5 | 3 | 1 | 3 | 3 | 3 | 2 | 5 | 10 | 6 | | 20 | 7 | 4 | 3 | 4 | 1 | 3 | 4 | 4 | 7 | 7 | 14 | 7 |
| 10 | 23 | F | 2 | 3 | 4 | 4 | 0 | 2 | 5 | 3 | 3 | 4 | 3 | 6 | | 28 | 7 | 3 | 4 | 2 | 0 | 3 | 6 | 4 | 3 | 1 | 5 | 6 |
| 11 | 20 | M | 6 | 3 | 3 | 4 | 0 | 1 | 5 | 6 | 6 | 7 | 10 | 6 | | 25 | 11 | 3 | 5 | 2 | 1 | 1 | 5 | 6 | 9 | 12 | 14 | 6 |
| 12 | 21 | F | 5 | 3 | 3 | 0 | 0 | 1 | 4 | 3 | 4 | 1 | 1 | 4 | | 25 | 9 | 3 | 5 | 0 | 0 | 1 | 5 | 0 | 4 | 6 | 7 | 5 |
| 13 | 23 | F | 2 | 3 | 5 | 4 | 0 | 1 | 2 | 4 | 2 | 3 | 4 | 3 | | 28 | 7 | 3 | 5 | 4 | 0 | 1 | 4 | 4 | 2 | 4 | 4 | 5 |
| 14 | 23 | F | 13 | 2 | 1 | 2 | 0 | 2 | 4 | 3 | 4 | 4 | 12 | 5 | | 28 | 18 | 2 | 2 | 0 | 0 | 1 | 4 | 1 | 6 | 5 | 12 | 6 |
| 15 | 19 | M | 3 | 1 | 1 | 0 | 0 | 1 | 5 | 4 | 2 | 3 | 1 | 2 | | 24 | 8 | 3 | 5 | 2 | 0 | 5 | 4 | 4 | 6 | 3 | 10 | 6 |
| 16 | 16 | M | 2 | 3 | 4 | 4 | 3 | 1 | 4 | 3 | 4 | 4 | 11 | 3 | | 21 | 7 | 3 | 4 | 2 | 4 | 2 | 4 | 4 | 7 | 4 | 4 | 6 |
| 17 | 15 | F | 1 | 4 | 4 | 9 | 3 | 1 | 4 | 4 | 4 | 5 | 3 | 7 | | 20 | 6 | 4 | 5 | 3 | 1 | 1 | 5 | 3 | 4 | 4 | 11 | 10 |
| 18 | 20 | M | 3 | 3 | 3 | 0 | 0 | 1 | 4 | 3 | 0 | 5 | 4 | 3 | | 25 | 8 | 3 | 5 | 2 | 0 | 1 | 3 | 3 | 4 | 7 | 6 | 5 |
| 19 | 24 | M | 1 | 1 | 2 | 2 | 0 | 2 | 3 | 3 | 3 | 3 | 5 | 3 | | 29 | 6 | 2 | 5 | 0 | 0 | 2 | 3 | 4 | 6 | 4 | 8 | 4 |
| 20 | 18 | M | 1 | 3 | 9 | 9 | 1 | 7 | 6 | 3 | 10 | 7 | 9 | 7 | | 23 | 6 | 6 | 10 | 4 | 9 | 10 | 6 | 6 | 9 | 7 | 7 | 6 |
| 21 | 19 | F | 4 | 5 | 6 | 6 | 1 | 5 | 5 | 11 | 14 | 8 | 12 | 7 | | 23 | 8 | 9 | 10 | 6 | 3 | 8 | 7 | 7 | 13 | 8 | 12 | 13 |
| 22 | 21 | M | 4 | 4 | 5 | 4 | 0 | 2 | 3 | 6 | 4 | 4 | 4 | 4 | | 26 | 9 | 4 | 5 | 2 | 0 | 1 | 5 | 7 | 8 | 8 | 12 | 9 |
| 23 | 17 | M | 2 | 2 | 4 | 0 | 1 | 1 | 5 | 3 | 3 | 1 | 6 | 4 | | 22 | 7 | 2 | 5 | 0 | 1 | 1 | 4 | 3 | 2 | 4 | 1 | 7 |
| 24 | 23 | F | 7 | 2 | 3 | 0 | 0 | 5 | 4 | 7 | 1 | 1 | 7 | 5 | | 29 | 13 | 4 | 6 | 2 | 1 | 5 | 5 | 5 | 1 | 5 | 6 | 5 |
| 25 | 24 | F | 6 | 3 | 5 | 0 | 1 | 7 | 6 | 3 | 4 | 4 | 8 | 3 | | 27 | 10 | 4 | 7 | 3 | 4 | 6 | 7 | 3 | 2 | 5 | 10 | 6 |

## SCALED SCORES ON SUBABILITIES

### AGE GROUP 25 to 34 **

| | | | Initial Test | | | | | | | | | | | | | Retest | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Su | A | S | IN | I | C | DS | A | Si | V | PA | PC | MD | OA | Sy | | A | IN | I | C | DS | A | Si | V | PA | PC | MD | OA | Sy |
| 1 | 25 | M | 7 | 3 | 4 | 0 | 0 | 3 | 4 | 3 | 0 | 3 | 0 | 0 | | 30 | 12 | 2 | 3 | 0 | 0 | 2 | 4 | 3 | 0 | 3 | 0 | 0 |
| 2 | 26 | M | 21 | 3 | 2 | 0 | 0 | 1 | 4 | 1 | 0 | 1 | 3 | 1 | | 31 | 26 | 3 | 4 | 0 | 0 | 1 | 4 | 3 | 2 | 1 | 4 | 3 |
| 3 | 30 | M | 21 | 2 | 0 | 0 | * | 4 | 4 | 1 | 0 | 1 | 0 | 0 | | 35 | 26 | 3 | 3 | 0 | 0 | 1 | 3 | 3 | 9 | 4 | 3 | 1 |
| 4 | 29 | M | 5 | 3 | 3 | 2 | 1 | 1 | 4 | 3 | 6 | 4 | 2 | 3 | | 35 | 11 | 2 | 3 | 3 | 1 | 1 | 4 | 4 | 6 | 6 | 5 | 5 |
| 5 | 32 | M | 9 | 4 | 10 | 3 | 1 | 6 | 6 | 6 | 9 | 8 | 6 | 7 | | 37 | 14 | 7 | 8 | 3 | 3 | 1 | 8 | 6 | 9 | 10 | 7 | 8 |
| 6 | 26 | M | 12 | 3 | 2 | 0 | 0 | 1 | 3 | 3 | 8 | 4 | 2 | 0 | | 31 | 17 | 3 | 2 | 0 | 1 | 2 | 3 | 1 | 8 | 5 | 7 | 1 |
| 7 | 31 | M | 7 | 3 | 1 | 0 | 0 | 1 | 1 | 3 | 1 | 4 | 5 | 3 | | 35 | 11 | 2 | 2 | 3 | 0 | 1 | 4 | 3 | 4 | 7 | 7 | 5 |
| 8 | 33 | M | 11 | 3 | 3 | 6 | 0 | 1 | 4 | 1 | 4 | 3 | 4 | 3 | | 38 | 16 | 3 | 5 | 6 | 0 | 2 | 4 | 3 | 6 | 4 | 1 | 4 |
| 9 | 34 | M | 25 | 3 | 2 | 0 | 0 | 1 | 4 | 4 | 10 | 5 | 7 | 1 | | 39 | 30 | 4 | 4 | 0 | 0 | 5 | 2 | 4 | 8 | 7 | 7 | 3 |
| 10 | 29 | M | 11 | 3 | 8 | 0 | 0 | 1 | 2 | 6 | 8 | 3 | 9 | 3 | | 34 | 16 | 4 | 7 | 0 | 0 | 4 | 6 | 6 | 7 | 3 | 8 | 2 |
| 11 | 34 | F | 15 | 3 | 1 | 4 | 7 | 1 | 4 | 1 | 4 | 5 | 0 | 10 | | 39 | 20 | 5 | 3 | 7 | 6 | 4 | 4 | 4 | 4 | 3 | 10 | 9 |
| 12 | 25 | M | 6 | 3 | 3 | 0 | 0 | 1 | 1 | 3 | 4 | 4 | 5 | 1 | | 30 | 11 | 2 | 5 | 0 | 0 | 2 | 4 | 3 | 7 | 5 | 11 | 1 |
| 13 | 32 | M | 2 | 3 | 0 | 6 | 0 | 3 | 5 | 4 | 8 | 5 | 4 | 3 | | 37 | 7 | 4 | 4 | 10 | 0 | 4 | 5 | 6 | 8 | 4 | 7 | 2 |
| 14 | 33 | F | 1 | 3 | 8 | 7 | 1 | 2 | 5 | 3 | 6 | 7 | 10 | 6 | | 39 | 7 | 3 | 6 | 6 | 1 | 3 | 7 | 3 | 7 | 6 | 12 | 6 |
| 15 | 28 | F | 4 | 1 | 0 | 1 | 0 | 5 | 3 | 1 | 0 | 3 | 6 | 3 | | 35 | 9 | 1 | 0 | 3 | 0 | 2 | 4 | 3 | 0 | 4 | 6 | 3 |
| 16 | 31 | M | 21 | 3 | 5 | 0 | 0 | 2 | 4 | 6 | 6 | 4 | 9 | 4 | | 35 | 25 | 3 | 5 | 3 | 0 | 2 | 5 | 6 | 6 | 4 | 6 | 4 |
| 17 | 33 | F | 10 | 1 | 3 | 0 | 0 | 1 | 3 | 4 | 4 | 5 | 7 | 3 | | 39 | 16 | 2 | 4 | 2 | 0 | 1 | 4 | 3 | 4 | 3 | 7 | 4 |
| 18 | 31 | M | 14 | 2 | 3 | 0 | 1 | 1 | 3 | 1 | 0 | 1 | 0 | 1 | | 37 | 20 | 2 | 3 | 0 | 1 | 1 | 3 | 1 | 0 | 1 | 0 | 1 |
| 19 | 31 | M | 0 | 3 | 2 | 0 | 0 | 1 | 2 | 3 | 2 | 3 | 1 | 3 | | 36 | 5 | 3 | 4 | 0 | 1 | 1 | 2 | 3 | 6 | 5 | 3 | 4 |
| 20 | 32 | F | 19 | 3 | 3 | 5 | 0 | 2 | 4 | 1 | 1 | 1 | 0 | 3 | | 38 | 25 | 3 | 3 | 3 | 0 | 1 | 3 | 3 | 3 | 1 | 0 | 3 |
| 21 | 31 | M | 1 | 4 | 9 | 9 | 6 | 4 | 5 | 3 | 12 | 10 | 10 | 6 | | 37 | 7 | 5 | 12 | 7 | 6 | 5 | 6 | 6 | 10 | 13 | 11 | 6 |
| 22 | 33 | F | 7 | 6 | 8 | 6 | 0 | 6 | 5 | 4 | 10 | 12 | 12 | 6 | | 37 | 11 | 4 | 11 | 7 | 0 | 3 | 5 | 5 | 12 | 10 | 10 | 2 |
| 23 | 26 | M | 1 | 2 | 6 | 0 | 0 | 1 | 4 | 3 | 6 | 3 | 4 | 0 | | 32 | 7 | 2 | 5 | 0 | 0 | 5 | 4 | 3 | 4 | 1 | 3 | 3 |
| 24 | 33 | F | 12 | 4 | 7 | 7 | 0 | 3 | 3 | 1 | 3 | 4 | 7 | 4 | | 39 | 18 | 3 | 9 | 6 | 1 | 3 | 10 | 3 | 3 | 4 | 4 | 2 |
| 25 | 27 | F | 14 | 1 | 2 | 1 | 0 | 1 | 1 | 1 | 4 | 4 | 5 | 3 | | 32 | 19 | 2 | 1 | 0 | 0 | 1 | 4 | 3 | 6 | 3 | 6 | 1 |

## SCALED SCORES ON SUBABILITIES

### AGE GROUP 35 to 44 **

| | | | Initial Test | | | | | | | | | | | | | Retest | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Su | A | S | IN | I | C | DS | A | Si | V | PA | PC | BD | OA | Sy | | A | IN | I | C | DS | A | Si | V | PA | PC | BD | OA | Sy |
| 1 | 43 | M | 24 | 1 | 1 | 0 | * | 1 | 3 | 3 | 6 | 4 | 0 | 3 | | 48 | 29 | 2 | 4 | 2 | 0 | 3 | 4 | 3 | 4 | 3 | 6 | 2 |
| 2 | 38 | M | 23 | 5 | 6 | 4 | 0 | 2 | 6 | 4 | 6 | 4 | 7 | 5 | | 43 | 28 | 4 | 11 | 2 | 1 | 2 | 6 | 4 | 6 | 4 | 10 | 5 |
| 3 | 42 | F | 5 | 3 | 4 | 0 | 0 | 1 | 4 | 1 | 2 | 3 | 4 | 4 | | 46 | 10 | 3 | 5 | 2 | 0 | 2 | 2 | 1 | 4 | 4 | 4 | 3 |
| 4 | 39 | M | 23 | 4 | 6 | 3 | 0 | 1 | 6 | 3 | 4 | 1 | 12 | 2 | | 44 | 28 | 7 | 9 | 3 | 0 | 2 | 5 | 4 | 6 | 4 | 11 | 5 |
| 5 | 36 | F | 2 | 6 | 7 | 6 | 4 | 6 | 6 | 8 | 9 | 7 | 7 | 6 | | 40 | 7 | 6 | 8 | 6 | 6 | 7 | 7 | 8 | 3 | 7 | 11 | 6 |
| 6 | 38 | M | 29 | 1 | 3 | 9 | 0 | 5 | 4 | 7 | 7 | 8 | 5 | 7 | | 43 | 34 | 3 | 3 | 3 | 0 | 6 | 5 | 7 | 10 | 8 | 10 | 4 |
| 7 | 43 | M | 25 | 3 | 2 | 0 | 0 | 3 | 4 | 1 | 3 | 1 | 1 | 0 | | 48 | 30 | 3 | 6 | 0 | 0 | 2 | 4 | 3 | 3 | 1 | 0 | 0 |
| 8 | 38 | F | 13 | 4 | 6 | 3 | 1 | 2 | 3 | 3 | 2 | 4 | 4 | 5 | | 44 | 18 | 4 | 6 | 3 | 0 | 2 | 6 | 3 | 2 | 4 | 5 | 5 |
| 9 | 41 | F | 6 | 3 | 3 | 0 | 0 | 2 | 4 | 4 | 3 | 1 | 4 | 3 | | 46 | 11 | 3 | 4 | 2 | 0 | 2 | 6 | 3 | 3 | 3 | 4 | 3 |
| 10 | 38 | F | 11 | 6 | 9 | 6 | 1 | 4 | 7 | 7 | 6 | 7 | 8 | 5 | | 43 | 16 | 5 | 11 | 6 | 3 | 8 | 6 | 4 | 4 | 5 | 10 | 10 |
| 11 | 39 | F | 2 | 3 | 5 | 0 | 1 | 3 | 6 | 3 | 2 | 4 | 7 | 5 | | 45 | 7 | 4 | 5 | 4 | 0 | 5 | 6 | 3 | 4 | 5 | 6 | 5 |
| 12 | 43 | F | 22 | 5 | 3 | 0 | 0 | 4 | 5 | 4 | 3 | 4 | 5 | 3 | | 48 | 27 | 3 | 4 | 2 | 0 | 2 | 5 | 3 | 3 | 3 | 4 | 1 |
| 13 | 40 | F | 13 | 2 | 5 | 0 | 0 | 1 | 3 | 3 | 0 | 1 | 3 | 2 | | 44 | 18 | 2 | 3 | 0 | 0 | 1 | 3 | 3 | 1 | 1 | 0 | 1 |
| 14 | 41 | F | 21 | 3 | 3 | 3 | 0 | 2 | 5 | 1 | 0 | 1 | 1 | 3 | | 46 | 26 | 3 | 5 | 2 | 0 | 2 | 6 | 1 | 0 | 3 | 0 | 1 |
| 15 | 38 | F | 7 | 4 | 6 | 11 | 3 | 6 | 6 | 6 | 8 | 5 | 7 | 6 | | 43 | 12 | 4 | 9 | 13 | 3 | 6 | 7 | 8 | 10 | 4 | 8 | 8 |
| 16 | 41 | F | 14 | 2 | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 0 | 2 | | 46 | 19 | 3 | 1 | 0 | 0 | 1 | 1 | 2 | 6 | 5 | 3 | 6 |
| 17 | 38 | F | 3 | 2 | 5 | 0 | 0 | 2 | 3 | 3 | 4 | 1 | 10 | 3 | | 43 | 8 | 2 | 5 | 0 | 0 | 1 | 3 | 3 | 3 | 5 | 7 | 1 |
| 18 | 43 | M | 14 | 3 | 3 | 0 | 1 | 2 | 3 | 1 | 2 | 1 | 0 | 1 | | 48 | 19 | 3 | 6 | 0 | 0 | 2 | 5 | 3 | 6 | 4 | 2 | 4 |
| 19 | 44 | M | 21 | 2 | 3 | 0 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | | 49 | 26 | 2 | 3 | 0 | 0 | 2 | 3 | 3 | 2 | 1 | 0 | 0 |
| 20 | 38 | M | 20 | 2 | 2 | 0 | 1 | 2 | 3 | 3 | 2 | 1 | 0 | 2 | | 43 | 25 | 3 | 5 | 0 | 0 | 1 | 4 | 1 | 2 | 1 | 0 | 1 |
| 21 | 36 | M | 23 | 4 | 4 | 0 | 0 | 2 | 5 | 4 | 6 | 5 | 4 | 5 | | 41 | 28 | 4 | 6 | 2 | 1 | 4 | 5 | 6 | 7 | 7 | 10 | 6 |
| 22 | 36 | F | 14 | 6 | 6 | 4 | 0 | 4 | 6 | 1 | 4 | 1 | 1 | 4 | | 42 | 25 | 6 | 8 | 7 | 0 | 7 | 6 | 3 | 4 | 1 | 0 | 3 |
| 23 | 42 | F | 38 | 2 | 2 | 0 | 0 | 1 | 4 | 1 | 0 | 1 | 0 | 1 | | 47 | 43 | 2 | 3 | 2 | 0 | 1 | 4 | 1 | 0 | 3 | 0 | 0 |
| 24 | 39 | F | 0 | 1 | 2 | 0 | * | 1 | 2 | 1 | 0 | 1 | 0 | 0 | | 44 | 5 | 1 | 3 | 0 | 0 | 2 | 3 | 3 | 1 | 1 | 0 | 0 |
| 25 | 36 | F | 6 | 3 | 6 | 7 | 0 | 1 | 4 | 6 | 4 | 6 | 8 | 3 | | 41 | 11 | 3 | 5 | 4 | 0 | 5 | 4 | 6 | 6 | 7 | 12 | 3 |

## SCALED SCORES ON SUBABILITIES

### AGE GROUP 45 to 64 **

| | Initial Test | | | | | | | | | | | | | | | Retest | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Su | A | S | IN | I | C | DS | A | Si | V | PA | PC | MD | OA | Sy | | A | IN | I | C | DS | A | Si | V | PA | PC | MD | OA | Sy |
| 1 | 57 | M | 19 | 3 | 4 | 0 | 0 | 2 | 4 | 3 | 2 | 1 | 0 | 0 | | 62 | 24 | 2 | 5 | 0 | 0 | 1 | 4 | 3 | 7 | 1 | 3 | 0 |
| 2 | 53 | M | 23 | 3 | 1 | 0 | 0 | 1 | 1 | 4 | 4 | 1 | 0 | 0 | | 58 | 28 | 2 | 3 | 0 | 0 | 2 | 4 | 1 | 3 | 1 | 0 | 0 |
| 3 | 45 | M | 24 | 3 | 5 | 3 | 0 | 3 | 3 | 3 | 1 | 4 | 0 | 4 | | 50 | 29 | 1 | 4 | 4 | 0 | 3 | 4 | 4 | 2 | 4 | 2 | 3 |
| 4 | 49 | M | 30 | 6 | 5 | 0 | 1 | 1 | 6 | 6 | 6 | 6 | 8 | 2 | | 54 | 35 | 10 | 9 | 3 | 4 | 1 | 6 | 4 | 8 | 5 | 11 | 2 |
| 5 | 53 | F | 40 | 1 | 5 | 0 | 0 | 2 | 5 | 1 | 0 | 1 | 0 | 0 | | 57 | 45 | 3 | 2 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 0 |
| 6 | 50 | F | 16 | 5 | 5 | 3 | 1 | 4 | 3 | 3 | 2 | 6 | 10 | 5 | | 56 | 22 | 3 | 5 | 3 | 1 | 4 | 7 | 3 | 5 | 6 | 6 | 5 |
| 7 | 48 | F | 19 | 1 | 1 | 0 | 0 | 1 | 3 | 3 | 2 | 3 | 1 | 0 | | 52 | 25 | 3 | 4 | 0 | 0 | 1 | 4 | 3 | 2 | 3 | 0 | 1 |
| 8 | 49 | F | 11 | 3 | 6 | 0 | 0 | 1 | 5 | 1 | 3 | 2 | 4 | 5 | | 55 | 17 | 3 | 10 | 0 | 0 | 1 | 6 | 3 | 4 | 1 | 4 | 1 |
| 9 | 49 | F | 6 | 3 | 2 | 0 | 0 | 1 | 4 | 1 | 1 | 3 | 4 | 4 | | 54 | 11 | 3 | 3 | 3 | 0 | 1 | 4 | 3 | 3 | 1 | 7 | 2 |
| 10 | 45 | F | 14 | 2 | 4 | 0 | 0 | 1 | 4 | 1 | 2 | 1 | 4 | 1 | | 50 | 19 | 2 | 3 | 0 | 0 | 1 | 4 | 3 | 2 | 1 | 0 | 3 |
| 11 | 46 | F | 6 | 3 | 5 | 4 | 1 | 8 | 6 | 6 | 4 | 6 | 0 | 6 | | 51 | 11 | 4 | 9 | 4 | 6 | 8 | 6 | 6 | 3 | 5 | 4 | 5 |
| 12 | 64 | F | 0 | 3 | 4 | 2 | 0 | 1 | 4 | 3 | 6 | 3 | 7 | 5 | | 67 | 3 | 3 | 5 | 0 | 0 | 1 | 4 | 3 | 7 | 3 | 7 | 5 |
| 13 | 56 | M | 1 | 4 | 0 | 1 | 0 | 1 | 4 | 1 | 0 | 3 | 1 | 1 | | 63 | 6 | 3 | 7 | 0 | 0 | 3 | 4 | 3 | 3 | 1 | 2 | 0 |
| 14 | 57 | M | 20 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | | 62 | 25 | 3 | 1 | 0 | 0 | 1 | 3 | 1 | 1 | 1 | 0 | 0 |
| 15 | 50 | F | 12 | 3 | 5 | 0 | 1 | 1 | 5 | 1 | 4 | 4 | 7 | 0 | | 56 | 18 | 4 | 6 | 0 | 0 | 1 | 4 | 3 | 4 | 4 | 5 | 0 |
| 16 | 53 | F | 27 | 1 | 0 | 0 | 0 | 1 | 3 | 1 | 2 | 1 | 6 | 0 | | 59 | 33 | 3 | 2 | 0 | 0 | 1 | 4 | 3 | 4 | 2 | 4 | 0 |
| 17 | 45 | M | 30 | 2 | 2 | 0 | 0 | 1 | 5 | 3 | 7 | 4 | 7 | 4 | | 49 | 34 | 3 | 5 | 2 | 0 | 1 | 6 | 3 | 4 | 5 | 8 | 2 |
| 18 | 55 | F | 24 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 4 | 5 | 2 | | 59 | 28 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 5 | 9 | 2 |
| 19 | 50 | M | 18 | 2 | 2 | 0 | 1 | 1 | 3 | 3 | 4 | 2 | 8 | 1 | | 55 | 23 | 2 | 2 | 0 | 0 | 2 | 2 | 3 | 7 | 3 | 8 | 2 |
| 20 | 47 | M | 21 | 3 | 1 | 0 | 0 | 2 | 4 | 3 | 6 | 4 | 4 | 2 | | 52 | 26 | 2 | 2 | 0 | 0 | 2 | 4 | 3 | 7 | 3 | 2 | 2 |
| 21 | 56 | F | 30 | 2 | 4 | 0 | 0 | 1 | 4 | 3 | 2 | 4 | 4 | 4 | | 60 | 34 | 3 | 5 | 3 | 0 | 3 | 3 | 3 | 6 | 5 | 4 | 3 |
| 22 | 48 | M | 29 | 2 | 3 | 0 | 0 | 1 | 4 | 1 | 0 | 1 | 0 | 0 | | 53 | 34 | 2 | 3 | 0 | 0 | 4 | 2 | 1 | 0 | 1 | 0 | 0 |
| 23 | 58 | F | 22 | 2 | 4 | 0 | 0 | 1 | 5 | 1 | 0 | 3 | 0 | 1 | | 63 | 27 | 3 | 4 | 2 | 0 | 3 | 6 | 3 | 1 | 4 | 0 | 2 |
| 24 | 48 | M | 0 | 4 | 6 | 0 | 0 | 2 | 6 | 1 | 2 | 1 | 0 | 0 | | 53 | 5 | 3 | 6 | 2 | 0 | 3 | 5 | 3 | 2 | 4 | 1 | 1 |
| 25 | 46 | F | 0 | 4 | 1 | 3 | 3 | 1 | 2 | 1 | 1 | 6 | 8 | 3 | | 49 | 3 | 3 | 5 | 6 | 7 | 1 | 4 | 0 | 3 | 5 | 6 | 1 |

## VERBAL, PERFORMANCE AND FULL TEST SCALED SCORES

| | Age Groups (Mean) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20.2 | | | 25.0 | | | 30.2 | | | 35.4 | | | 39.6 | | | 44.6 | | | 51.1 | | | 56.0 | | |
| Su | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS |
| 1 | 6 | 12 | 18 | 9 | 17 | 26 | 12 | 6 | 18 | 10 | 6 | 16 | 6 | 16 | 22 | 13 | 18 | 31 | 11 | 6 | 17 | 10 | 14 | 24 |
| 2 | 8 | 23 | 31 | 8 | 29 | 37 | 8 | 6 | 14 | 10 | 13 | 23 | 19 | 26 | 45 | 22 | 29 | 51 | 5 | 9 | 14 | 9 | 5 | 14 |
| 3 | 11 | 19 | 30 | 8 | 22 | 30 | 10 | 2 | 12 | 8 | 20 | 28 | 10 | 14 | 24 | 10 | 16 | 26 | 14 | 12 | 26 | 16 | 15 | 31 |
| 4 | 18 | 10 | 28 | 14 | 13 | 27 | 13 | 18 | 31 | 12 | 26 | 38 | 17 | 22 | 39 | 22 | 30 | 52 | 18 | 28 | 46 | 28 | 30 | 58 |
| 5 | 13 | 38 | 51 | 13 | 39 | 52 | 25 | 36 | 61 | 29 | 40 | 69 | 29 | 37 | 66 | 33 | 35 | 68 | 11 | 2 | 13 | 7 | 2 | 9 |
| 6 | 16 | 25 | 41 | 18 | 33 | 51 | 8 | 17 | 25 | 8 | 22 | 30 | 18 | 34 | 52 | 17 | 39 | 56 | 16 | 26 | 42 | 19 | 23 | 42 |
| 7 | 21 | 28 | 49 | 19 | 34 | 53 | 5 | 16 | 21 | 10 | 26 | 36 | 10 | 6 | 16 | 13 | 7 | 20 | 5 | 9 | 14 | 10 | 9 | 19 |
| 8 | 9 | 21 | 30 | 10 | 22 | 32 | 14 | 15 | 29 | 17 | 18 | 34 | 16 | 18 | 34 | 18 | 19 | 37 | 13 | 15 | 28 | 17 | 13 | 30 |
| 9 | 16 | 26 | 42 | 16 | 39 | 55 | 8 | 27 | 35 | 13 | 29 | 42 | 10 | 15 | 25 | 14 | 16 | 30 | 8 | 13 | 21 | 12 | 16 | 28 |
| 10 | 15 | 19 | 34 | 15 | 19 | 34 | 12 | 29 | 41 | 18 | 26 | 44 | 30 | 33 | 63 | 38 | 33 | 71 | 9 | 9 | 18 | 8 | 9 | 17 |
| 11 | 13 | 35 | 48 | 14 | 47 | 61 | 17 | 20 | 37 | 24 | 30 | 54 | 17 | 21 | 38 | 20 | 23 | 43 | 23 | 22 | 45 | 31 | 23 | 54 |
| 12 | 9 | 13 | 22 | 12 | 22 | 34 | 7 | 17 | 24 | 11 | 27 | 38 | 13 | 19 | 32 | 13 | 14 | 27 | 12 | 24 | 36 | 11 | 25 | 36 |
| 13 | 13 | 16 | 29 | 14 | 19 | 33 | 14 | 24 | 38 | 23 | 27 | 50 | 9 | 9 | 18 | 8 | 6 | 14 | 8 | 6 | 14 | 14 | 9 | 23 |
| 14 | 9 | 28 | 37 | 8 | 30 | 38 | 22 | 32 | 54 | 22 | 34 | 56 | 13 | 6 | 19 | 15 | 5 | 20 | 3 | 3 | 6 | 7 | 3 | 10 |
| 15 | 7 | 12 | 19 | 16 | 29 | 45 | 8 | 13 | 21 | 8 | 16 | 24 | 32 | 32 | 64 | 29 | 38 | 67 | 13 | 16 | 29 | 13 | 16 | 29 |
| 16 | 16 | 25 | 41 | 16 | 28 | 44 | 12 | 31 | 43 | 15 | 26 | 41 | 6 | 7 | 13 | 5 | 22 | 27 | 4 | 10 | 14 | 8 | 13 | 21 |
| 17 | 21 | 23 | 44 | 16 | 32 | 48 | 8 | 23 | 31 | 11 | 21 | 32 | 10 | 21 | 31 | 9 | 19 | 28 | 8 | 25 | 33 | 14 | 22 | 36 |
| 18 | 9 | 15 | 24 | 12 | 25 | 37 | 8 | 3 | 11 | 8 | 3 | 11 | 10 | 5 | 15 | 13 | 19 | 32 | 2 | 13 | 15 | 2 | 19 | 21 |
| 19 | 8 | 17 | 25 | 10 | 28 | 38 | 7 | 12 | 19 | 9 | 21 | 30 | 8 | 4 | 12 | 9 | 6 | 15 | 8 | 18 | 26 | 7 | 21 | 28 |
| 20 | 29 | 36 | 65 | 39 | 35 | 74 | 13 | 6 | 19 | 16 | 10 | 26 | 8 | 8 | 16 | 11 | 5 | 16 | 8 | 19 | 27 | 8 | 17 | 25 |
| 21 | 23 | 52 | 75 | 36 | 53 | 89 | 31 | 41 | 72 | 34 | 46 | 80 | 13 | 26 | 39 | 18 | 36 | 54 | 9 | 17 | 26 | 14 | 21 | 35 |
| 22 | 15 | 22 | 37 | 14 | 44 | 58 | 26 | 44 | 70 | 25 | 39 | 64 | 22 | 11 | 33 | 28 | 11 | 39 | 8 | 2 | 10 | 9 | 2 | 11 |
| 23 | 11 | 17 | 28 | 11 | 17 | 28 | 11 | 16 | 27 | 13 | 14 | 27 | 8 | 3 | 11 | 10 | 4 | 14 | 10 | 5 | 15 | 15 | 10 | 25 |
| 24 | 12 | 18 | 30 | 19 | 22 | 41 | 29 | 19 | 48 | 36 | 16 | 52 | 6 | 2 | 8 | 7 | 5 | 12 | 15 | 4 | 19 | 16 | 11 | 27 |
| 25 | 18 | 22 | 40 | 26 | 26 | 52 | 5 | 17 | 22 | 7 | 19 | 26 | 18 | 25 | 43 | 18 | 34 | 52 | 12 | 19 | 31 | 22 | 15 | 37 |

# A P P E N D I X "B"

## VERBAL, PERFORMANCE AND FULL SCALE IQ RATINGS

| | Age Groups (Mean) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20.2 | | | 25.0 | | | 30.2 | | | 35.4 | | | 39.6 | | | 44.6 | | | 51.1 | | | 56.0 | | |
| Su | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS | V | P | FS |
| 1 | 49 | 47 | 43 | 55 | 58 | 53 | 59 | 44 | 48 | 54 | 49 | 50 | 57 | 72 | 61 | 67 | 78 | 69 | 69 | 64 | 65 | 68 | 74 | 69 |
| 2 | 50 | 60 | 49 | 54 | 74 | 61 | 54 | 44 | 45 | 57 | 58 | 55 | 70 | 80 | 73 | 75 | 97 | 79 | 61 | 68 | 61 | 67 | 63 | 63 |
| 3 | 55 | 56 | 52 | 54 | 65 | 56 | 57 | 44 | 47 | 57 | 72 | 62 | 62 | 69 | 62 | 64 | 76 | 66 | 68 | 71 | 66 | 74 | 75 | 73 |
| 4 | 64 | 44 | 50 | 61 | 53 | 54 | 60 | 60 | 57 | 62 | 80 | 68 | 68 | 74 | 69 | 75 | 88 | 80 | 72 | 90 | 78 | 85 | 92 | 88 |
| 5 | 57 | 61 | 64 | 57 | 84 | 67 | 75 | 98 | 80 | 77 | 97 | 89 | 81 | 93 | 87 | 87 | 94 | 90 | 67 | 60 | 60 | 65 | 60 | 60 |
| 6 | 63 | 60 | 57 | 64 | 76 | 67 | 54 | 58 | 52 | 54 | 70 | 59 | 69 | 89 | 78 | 69 | 99 | 82 | 72 | 88 | 78 | 77 | 84 | 80 |
| 7 | 67 | 67 | 63 | 65 | 77 | 68 | 51 | 62 | 53 | 60 | 80 | 67 | 62 | 60 | 57 | 67 | 65 | 62 | 58 | 69 | 59 | 66 | 68 | 64 |
| 8 | 52 | 59 | 52 | 56 | 65 | 57 | 62 | 61 | 59 | 68 | 70 | 66 | 66 | 70 | 66 | 70 | 75 | 70 | 69 | 75 | 69 | 75 | 72 | 73 |
| 9 | 60 | 65 | 58 | 61 | 84 | 69 | 54 | 76 | 63 | 63 | 83 | 71 | 62 | 70 | 63 | 68 | 76 | 68 | 62 | 72 | 63 | 68 | 76 | 79 |
| 10 | 60 | 56 | 55 | 62 | 61 | 58 | 59 | 74 | 66 | 66 | 75 | 69 | 82 | 88 | 85 | 93 | 91 | 92 | 63 | 68 | 61 | 64 | 68 | 62 |
| 11 | 57 | 78 | 64 | 61 | 98 | 77 | 65 | 67 | 64 | 76 | 84 | 79 | 68 | 73 | 68 | 75 | 84 | 76 | 78 | 79 | 78 | 88 | 84 | 85 |
| 12 | 52 | 48 | 46 | 59 | 65 | 58 | 53 | 58 | 52 | 58 | 76 | 65 | 65 | 75 | 67 | 67 | 74 | 67 | 70 | 85 | 77 | 69 | 86 | 77 |
| 13 | 57 | 52 | 51 | 61 | 61 | 58 | 62 | 73 | 65 | 74 | 81 | 76 | 60 | 63 | 58 | 59 | 59 | 56 | 66 | 65 | 63 | 72 | 68 | 69 |
| 14 | 52 | 69 | 57 | 54 | 76 | 61 | 71 | 83 | 75 | 73 | 89 | 80 | 65 | 60 | 59 | 69 | 63 | 62 | 61 | 61 | 58 | 65 | 61 | 61 |
| 15 | 49 | 44 | 40 | 61 | 70 | 62 | 54 | 53 | 50 | 54 | 62 | 56 | 85 | 87 | 85 | 83 | 98 | 89 | 69 | 76 | 70 | 71 | 76 | 72 |
| 16 | 60 | 63 | 57 | 61 | 69 | 62 | 59 | 81 | 68 | 65 | 80 | 70 | 57 | 61 | 55 | 58 | 83 | 67 | 60 | 69 | 61 | 66 | 72 | 67 |
| 17 | 67 | 60 | 59 | 61 | 74 | 64 | 54 | 71 | 60 | 61 | 73 | 64 | 60 | 73 | 64 | 60 | 75 | 65 | 62 | 86 | 70 | 68 | 83 | 72 |
| 18 | 52 | 51 | 47 | 59 | 69 | 61 | 54 | 46 | 47 | 57 | 52 | 51 | 62 | 59 | 57 | 67 | 79 | 70 | 60 | 72 | 64 | 60 | 79 | 67 |
| 19 | 51 | 54 | 48 | 56 | 73 | 61 | 53 | 57 | 52 | 58 | 73 | 63 | 59 | 58 | 55 | 63 | 64 | 59 | 64 | 78 | 68 | 65 | 82 | 72 |
| 20 | 77 | 78 | 75 | 90 | 78 | 83 | 60 | 49 | 52 | 61 | 58 | 57 | 57 | 57 | 54 | 63 | 59 | 57 | 62 | 79 | 67 | 64 | 77 | 68 |
| 21 | 70 | 101 | 83 | 87 | 106 | 96 | 82 | 94 | 87 | 87 | 104 | 96 | 63 | 80 | 69 | 70 | 96 | 81 | 67 | 77 | 70 | 72 | 82 | 76 |
| 22 | 60 | 61 | 57 | 61 | 94 | 75 | 76 | 98 | 86 | 77 | 96 | 85 | 73 | 61 | 65 | 82 | 66 | 71 | 62 | 59 | 56 | 65 | 60 | 59 |
| 23 | 54 | 51 | 47 | 55 | 54 | 50 | 57 | 57 | 54 | 60 | 60 | 57 | 59 | 57 | 54 | 64 | 62 | 59 | 68 | 63 | 64 | 73 | 69 | 70 |
| 24 | 56 | 55 | 52 | 67 | 65 | 63 | 79 | 66 | 71 | 89 | 67 | 78 | 55 | 51 | 49 | 58 | 59 | 55 | 69 | 60 | 62 | 72 | 70 | 69 |
| 25 | 64 | 61 | 59 | 75 | 70 | 71 | 50 | 58 | 50 | 53 | 66 | 57 | 69 | 78 | 71 | 70 | 93 | 80 | 66 | 79 | 69 | 77 | 75 | 73 |

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