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"PHYSICAL AND MENTAL RELATIONSHIPS".

"An Historical Survey of The Attempts To Find A Relationship Between Physical Growth and Intelligence, and Physique and Temperament."

A Thesis Presented for the Degree of

MASTER OF ARTS
IN EDUCATION

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by A.A. DAVISON.

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INTRODUCTION

The relationship of mind and body has long claimed man's attention. Early inquiries into the relationship of these two aspects of development have presumed that physical and mental growth were related functionally, that their growth proceeded together at a similar rate, and that any defect of one would immediately show itself in the other. The relationship occupied the minds of such men as Hippocrates, Plato and Aristotle, and many since have seen the relationship and guessed its nature.

Hippocrates, writing of the Scythians said,

"Neither do they make any laborious exertions ... their shapes are gross and fleshy, with ill-marked joints of a humid temperament - for they can neither strain their bows nor launch their javelin from their shoulders owing to their humidity and atony."

Until comparatively recent times no scientific investigations had been made to find out exactly how much or what the relationship was. Early studies worked with average measures of physical development and rough estimates of what intelligence and temperament were thought to be. To measure a person's intelligence was very difficult, but external measurements of physical development were relatively simple to obtain. It is

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perhaps from this point that the search began for a physical basis for intelligence. Children and adults of all types - the genius, the normal and the dull - were studied in an effort to find what relationship existed between mind and body. If one could predict intelligence from outward signs, what an immense advantage this would be, especially for the school teacher and the school administrator.

It is natural that the first studies should employ such obvious measures as height and weight, but the methods of estimating intelligence varied. These early investigations were before the advent of the "intelligence-scale" developed by Binet about the beginning of the century, so that researchers either estimated what a person's intelligence was from his knowledge of him, or, in the case of children, from his"age-class" location. The evidence from these types of inquiry was conflicting. Some revealed extensive relationships and others none at all. Where group averages and subjective estimates are used it is only to be expected that inaccurate results will be yielded. Nevertheless, with the coming of a more reliable scale for measuring intelligence, and, with the use of statistical techniques, the results obtained were still disappointing, for the

relationship between these two aspects of man appeared negligible.

Attention shifted to more complicated measures of physical development, and investigations into the relation of such measures as age at onset of puberty, age when permanent teeth erupt, age at ossification of bones etc., were used in an attempt to find a physical basis for intelligence.

The studies reviewed in this survey will show that no significant results were obtained.

The relation between body-build and character, or the non-intellectual traits of mind has been the subject of much speculation. Popular belief has expressed these relationships in recognizing that the fat man is often of a happy disposition, while the thin man displays shyness. Attempts to determine character and temperament from outward signs are witnessed in the so-called sciences of phrenology, physiognomy and graphology, but their claims are no longer credited.

This survey will review the attempts to find the relationship between physical and mental development and for this purpose the survey will be divided into three parts. Part one will be limited to the more significant investigations of the relation between physical aspects of development, and intelligence.

Part Two will be confined to some studies of the relation between physique, or body-build, and temperament. Part Three will review some studies undertaken in New Zealand. It will include the results found by the writer, of measuring and testing 240 boys aged 10 years to 14 years to see if the relationship is still revealed to any degree.

PART ONE

PHYSICAL GROWTH AND ITS RELATION TO INTELLIGENCE

1. Height and Weight:

There are historical reasons for a belief in a close correlation between measures of height, weight and intelligence. Among the first of these was Galton's (1) statement that men of genius tend to be above average in height and weight; but since then, endocrinology has tended to emphasise the possible importance of physical size as a correlate of mental ability. Striking similarities in physical and mental growth have pointed towards the fact that these two aspects of growth are interrelated and have hastened the search for a physical basis for intelligence. For example, one could, if a definite and good correlation was found, predict future mental development from present physical status. It must be remembered too, that the early studies along these lines were before the advent of "intelligence measurement tests" and so a physical basis was sought for estimating intelligence. In childhood, physical and mental growth proceed concurrently and at a rapid rate. So too, mental growth curves and physical

(1) Galton F. "Hereditary Genius" (MacMillan & Co. London 1925) p.321.

growth curves were so similar in appearance that it was difficult to resist the suggestion that one was the function of the other.

Two of the earliest studies were those of Porter and Gilbert.

In 1892 Porter(1) supervised the physical measurements of 33,500 boys and girls of St. Louis in the United States of America. He wanted to determine from this mass of data the laws of normal growth, for he considered that on such a firm ground there might be established a system of grading which would take into account the physical capacity of the pupil in the apportionment of school tasks. "Age-grade" location was used as the measure of intelligence. From his data Porter was able to conclude that the brighter the child the taller and heavier he is, whereas the dull child is shorter and lighter than the average. However it must be noted that Porter cautions that because he was working with averages, his data did not allow his conclusions to apply to individuals. It will be seen from later and more accurate studies that this assertion of Porter's that the bright children tend to be taller and heavier than the average is substantiated.

One could perhaps disagree with Porter's estimate of the intelligence of children as judged by "age-grade" location, but the tendency was to promote children on ability and not on social grounds. In New Zealand schools

(1) Porter W.T. "The Physical Basis of Precocity and Dullness" 1895 and given in Paterson D.G. "Physique and Intellect" 1930

at the present time, where many promotions tend to be on a social basis and not on ability, the "age-grade" estimates of intelligence would not correlate highly with intelligence measured by more reliable means.

Gilbert's[1] attempt to determine the relationship between height, weight and intelligence differs from Porter's chiefly in the fact that he does not accept "age-grade" location as a suitable criterion of mental ability. In its place he uses the teacher's estimate of the pupil's general mental ability. Gilbert unfortunately had to rely on the judgement of a single teacher for each child, and today we would not regard this as a reliable measure of intelligence. Teachers tend to overestimate the ability of dull pupils and to underestimate the ability of bright pupils. However, if the judgements of many teachers are taken into account, then the errors tend to be averaged out.

Gilbert's averages for height and weight for children of each age group varied considerably from those of Porter, and together with his inadequate estimate of intelligence, the accumulation of errors led him to conclude that there was no relationship at all between height, weight and intelligence.

The studies of Porter and Gilbert were followed by investigations which were obviously influenced by the methods and measures used by them. All these studies worked

(1) Gilbert J.A. "Researches on the Physical and Mental Development of School Children," Yale Univ. Psych. Laboratory Studies, 1894, 2: 40 - 100.

with averages and varying methods of estimating intelligence. For example, MacDonald(1) in 1897 in his attempts to determine the effect of physical growth on schoolwork, stated that when the body was growing rapidly it was best to cut down on schoolwork. So too, in 1903, Wylie(2) in a study of feeble-minded children concluded that feeble-minded children are subnormal in height and weight. This statement of course is not absolutely true and was demonstrated so by Norsworthy(3) in 1906. Most investigators had associated physical deficiency itself as being a sign or sympton of idiocy. Norsworthy studied children who were mentally deficient and then compared their physiques. She concluded that mental defects among idiots were by no means equalled by the bodily. In fact, in measurements of height and weight the defectives were indistinguishable from ordinary children.

Not until the advent of a more reliable intelligence test and the introduction of statistical measurement into this field do we find researches that can be accepted as true estimates of what they had set out to prove. The Simon-Binet measure of intelligence and the techniques of correlation and partial-correlation have

(1) MacDonald E. "Report of U.S. Commission of Education 1897-98" - quoted by Paterson D.G. "Physique and Intellect". p.38.

(2) Wylie A.R.T. "Investigations Concerning the Height & Weight of Feeble-Minded Children" Jour. of Psych-Asthenics 1903 - quoted by Paterson D.G. "Physique and Intellect". p.52.

(3) Norsworthy N. "Psychology of Mentally Deficient Children", Archiv. of Psych., 1906,1-111 - quoted by Paterson D.G. p.58.

been extensively used and several researches making use of these measures will now be examined.

Abernathy,(1) working with adolescent girls, after much careful investigation was led to state that although there was a slight positive correlation between height, weight and intelligence, it was important to emphasise the fact that physical and mental status were to a great extent independent of one another.

This study was of girls at the University of Chicago Laboratory Schools and Abernathy found the partial correlation between height and mental age, and weight and mental age, for 120 girls to be $+.34 \pm .05$ and $+.39 \pm .05$ respectively. However, when chronological age was controlled experimentally, the correlations turned out to be much lower. For the 14 year old group, the correlations for height and intelligence and weight and intelligence, as measured by the Standford-Binet test were $+.10 \pm .08$ and $+.07 \pm .08$.

Gates,(2) who conducted experiments with kindergarten and grade children about the same time as Abernathy, found results that are very similar to those just quoted. For the age groups he was working with, Gates found the

(1) Abernathy E.M. "Studies of the Correlation of Physical and Mental Growth" Jour. of Educ. Psych. 1925, 16: 458-466 and 539-546.

(2) Gates A.I. "The Nature and Significance of Physical Status and of Mental, Physiological, Social and Emotional Maturity." Jour. of Educ. Psych., 1924, 15: 329-358.

correlations between height and Stanford-Binet mental age, and weight and mental age to be + .06 and + .10.

Two studies of gifted children are reviewed. The following table is taken from "Genetic Studies of Genius" Vol. 1. p. 168 by L.M. Terman and serves to demonstrate that there is a tendency for gifted children to be taller than children of normal or subnormal intelligence, but it is a tendency revealed in averages only. Terman believes that the great majority of gifted children are like normal children in that they are of medium stature.

TABLE ONE (Coefficients of correlation between M.A., height and weight, after Terman.)

CHRONOLOGICAL AGE.	HEIGHT AND MENTAL AGE				WEIGHT AND MENTAL AGE			
	BOYS		GIRLS		BOYS		GIRLS	
	No.of Cases	r.	No.of Cases	r.	No.of Cases	r.	No.of Cases	r.
10	35	$.16 \pm .11$	42	$.15 \pm .10$	35	$.44 \pm .09$	42	$.16 \pm .10$
11	68	$.15 \pm .08$	48	$.34 \pm .09$	67	$.04 \pm .08$	48	$.14 \pm .10$
12	63	$.10 \pm .08$	45	$.08 \pm .10$	61	$-.09 \pm .09$	45	$-.06 \pm .10$
13	50	$.33 \pm .09$	46	$.04 \pm .10$	50	$.31 \pm .09$	46	$-.20 \pm .10$

The evidence offered by Hollingworth in her study of gifted children seems to confirm Terman's findings that there is a slight positive correlation. In her book "Gifted Children" published in 1926, Hollingworth matched each gifted child with a normal and a dull child. She found that the

median height for the gifted children was 52.9 inches, as compared with a median height of 51.2 inches for the children of average intelligence, and of 49.6 inches for the very dull or feeble-minded group. Similar results were found when the median weights for these groups were compared.

Elsewhere[1] Hollingworth had observed that the demonstrated relationship between superiority of mind and superiority of body as causal, could not be inferred. There was nothing in her data to suggest that superior children were bright because they were tall and heavy, nor that they were tall and heavy because they were bright. She could only say that mentally gifted children, as a group, were large and strong at the ages studied, in so far as she had measured them.

An English investigator, Sir Cyril Burt, made investigations between various measures of physical growth and intelligence. The figures given by Burt as the co-efficients of correlation between these two aspects of growth appear somewhat higher than those found by other investigators. Burt's studies are presented in his book "The Backward Child".[2]

In the chapter headed, Physical Conditions, Burt discusses the relationship between physical and mental

(1) Hollingworth L.S. & Taylor G.A. "Studies of Physical Condition & Growth." Twenty-third Yearbook of the National Society for the Study of Educn. 1924, 1: 221-237.

(2) Burt C. "The Backward Child" (Oxford University Press 1925) 135-163.

development. He wrote that in the first two or three years of life all forms of growth seemed closely correlated and at that early stage the infant's rate of physical development afforded a valuable index of his later mental development. Burt goes on to say that the child who is backward in walking, talking or even cutting teeth, is apt to prove backward later on in intellectual progress. Later in the same chapter Burt states that the existence of some connection between physical and mental development all through the years of growth could hardly be questioned. What he was doubtful about was the amount at different stages.

Burt then attempts to find out how much the correlation is, firstly between height and intelligence, and secondly between weight and intelligence.

For London boys with ages ranging from seven to fourteen Burt found the correlation between height and mental age (Binet-Simon Tests) to be over +.88 and for girls of the same age-range the correlation was even higher. He believes that much of the correlation must be due to the common influence of chronological age, for the older the boy the taller he will be in body and more developed in mind. Nevertheless, Burt does not explain away the whole correlation on these grounds for he says that the correlation between chronological age and mental age is by no means perfect. So Burt eliminates chronological age by the technique of partial correlation and

now gives the specific correlation between height and mental age, weight and mental age as +.48 for boys and +.51 for girls. The average correlation between height and mental level for boys of the same age works out at +.44 and for girls +.49.

When Burt considers weight as a measure of physical growth and correlates it with mental age, the coefficients are lower. Calculated for separate age groups they average +.37 for boys and +.35 for girls. Burt found here also, more variation in the different age groups: for example, the correlation for 13 year old girls is +.21. Eliminating the effect of height upon weight Burt finds that the correlations between weight and mental age are now +.21 for boys and +.17 for girls.

Reviewing these results, Burt states that if we have a number of children all of the same age and all of the same height, the more intelligent prove to be somewhat heavier, solider and better nourished, while the dull and backward are a little lighter and more frail. How far this is due to the direct effect of a healthy life and diet upon the manifestations of intelligence, as judged by ordinary tests, how far it is due to the fact that the more intelligent families are both willing and able to give better attention to hygienic conditions, and how far it is

an outcome of a fundamental impulse to grow more rapidly in all directions, he believes it would be difficult to say.

Later in this chapter Burt inclines towards the latter alternative, i.e., he explains some children backward in all-round development as deficient in their impulse to grow.

It will be observed that all the investigations quoted have been of children, there being very few of adults. Nevertheless, those studies which have been made of adults have, as a rule, worked with college students only, and one must realize that any conclusions drawn from these investigations would hold only for college or university students, as they are not a random sample of the adult population.

One such study outlined in "Physique and Intellect" by Paterson is that of Lee, Lowenz and Pearson.(1) These investigators studied "honour" and "pass" men at Cambridge, using scholastic standing as a criterion of intellect. They found the correlation between weight and intellect to be +.05 and concluded that "honour" men could not be differentiated as a physical class, nor could one predict, with even a moderate degree of probability, an individual's degree of intelligence from a knowledge of that individual's physical status.

(1) Lee A., Lowenz M.A., and Pearson K., "On the Correlation of Physical and Mental Characters in Man," Proceedings of the Royal Society, 1903-1904, 106-114.

If one could claim that "honour" men were more or less comparable with men of genius, then it would appear that Galton's statement in 1869 that men of genius tend to be above average in height and weight cannot be substantiated from the evidence presented in this particular study.

A further study of University students again given by Paterson is that of R.C. Sommerville[1] who studied the relation between a large number of physical measurements and intelligence of 100 students measured by the Thorndike three-hour intelligence test, at Columbia University in 1924. The correlation between intelligence and height was found to be +.16; between intelligence and sitting height, +.13; between intelligence and weight +.10, and between intelligence and chest girth +.01. The probable errors for these coefficients of correlation are in the neighbourhood of $\pm$.07. These slight positive correlations would appear to confirm Galton's argument.

The adolescent and first year university groups were studied by F.D. Brooks[2] with much the same results, the general trend of correlations being as follows; 17 correlations betweenheight and intelligence ranged from -.08 to +.26; 17 correlations betweenweight and intelligence ranged from -.10 to +.31.

(1) Sommerville R.C. "Physical, Motor, & Sensory Traits", Archiv. of Psych. 1924 no. 75.

(2) Brooks F.D. "The Organization of Physical & Mental Traits During Adolescence." Jour. of Applied Psych., 1928, 12: 228-242.

The slight positive correlations that these investigations have shown may be partially explained by social status. The relationship might be explained as follows. Higher social classes are able to provide better prenatal and postnatal care for offspring, resulting in healthier and physically superior children. Better hygienic living conditions, greater variety and better balance of diets, and abundant food provided throughout the period of childhood would perpetuate and increase physical advantages gained in infancy. Paterson(1) holds that this superior nurture, if also responsible for the mental superiority of children belonging to the favoured social classes, would constitute the causal factor. He continues his argument further, saying that even if the potency of this superior nurture were confined solely to physical growth, whereas biological heredity were responsible for the mental superiority of upper class children, the hypothesis would still be effective, although social status could no longer be looked upon as a single causative factor. In this latter case he believes nature (biological heredity) and nurture would combine to produce association, but not functional relationship between physique and intellect.

A crucial test of this theory, Paterson considers would be provided by a demonstration that the slight positive correlation between physique and intellect which

(1) op. cit. p.71.

has generally been found, disappears when social status is held constant. Such a test exists and he quotes from Sorokin,(1) a sociologist, who summarized a large number of research studies showing that bodily differences do exist between the populations of higher social strata and of lower social strata. Along with this evidence Sorokin cites additional data confirming the generalization that there is definite relation, on the basis of averages, between social standing, intelligence, and physical size.

Paterson concludes his review by saying that in the present state of our knowledge, it would seem that social status cannot be invoked as a causal factor producing the physical-mental correlations. All the data reported seem to be in harmony in disclosing the existence of a slight, though definitely positive correlation between physical development as indicated by height and weight and mental development, such correlations being present irrespective of the social status factor. He believes this generalization seems to hold for feeble-minded, dull, normal and gifted children alike.

Burt attempts an explanation of the relationship between a child's physical development and his intelligence. He is of the opinion that a child's general development is to be regarded as forming in the main a unitary phenomenon. It displays a twofold aspect - physical and mental; and either aspect may be measured separately by one or other

(1) Sorokin P. "Social Mobility" 1927. p.222.

of the various modes available. Any of the measurable results may be disturbed by external conditions yet they are all to a large extent, the coordinate manifestations of the one and the same initial momentum, the same common impetus to grow. Burt concludes,

"Inherent backwardness in physical and mental development is in the main a two-sided expression of the one and the same underlying factor - a congenital deficiency in what may be called the original developmental impetus of the child."(1)

It is perhaps reasonable to assume that Burt would explain the above average child by a "congenital abundance" of the original developmental impetus.

A further view on the relationship between height, weight and intelligence, is expressed by C. Fleming(2) who draws on the evidence offered by Abernathy and on that offered from the data of the Harvard Growth Study.(3) Fleming considers that physical and mental development may be neither directly associated as concomitants nor negatively related as compensatory. She thinks that they may be independent - separate in hereditary origin and influenced by different stimuli.

(1) op. cit. p.161.

(2) Fleming C. "Adolescence, Its Social Psychology" London 1948 p.98.

(3) Dearborne W.T. Rothney J.N.M. "Predicting the Child's Development". 1941.

The Harvard Growth Study and other investigations have found little relation between periods of acceleration in mental and physical growth; and intellectual growth on the average has been shown both to proceed more steadily than physical growth and to continue after physical growth has ceased. Physical growth spurts do not appear to be accompanied by a decrease in the rate of mental development. They are not paralleled by marked increments in mental ability - but they appear to take place more or less independently of changes in performance either in school subjects or in tests of what is commonly called intelligence.

H.E. Jones, an authority on physical-mental relationships, remarks on the relationship as follows:-

"(a) A common biological factor or group of factors may favour superior development of the total organism; absence of these factors he thinks would have a generally handicapping effect.

"(b) Disease effects, or the effects of birth injury, malnutrition etc., may be expressed both in the brain and other organs with parallel disturbances in later development.

"(c) Any condition producing an arrest or distortion in growth of intelligence or of the central integrative functions may thereby indirectly handicap the normal development of other functions and other structures.

"(d) Social advantages or handicaps may simultaneously

influence physical development (through nutrition or regimen) and mental development (through education).

"(e) Physical-mental relationships may not be primarily due to a correlation of superior or inferior status, but to a correlation of rates of growth; in this latter case, relationships would be expected to diminish in degree at the end of the growth period."(1)

It would appear that these points put forward by Jones are either covered or partially covered by the explanations offered by Burt and Fleming. When later studies of physical-mental relationships are reviewed, it will be seen that probably any one explanation is insufficient to explain a complex situation, though the explanation offered by Fleming is valid in light of recent evidence.

To summarize the findings of this first section we may possibly conclude that children of superior intelligence tend to be superior in height and weight, whereas those of inferior mental ability tend to be inferior in height and weight. This tendency appears to exist in adults though to a lesser degree than in children. The slight correlations that do exist between measures of height, weight and intelligence make it impossible to predict with any degree of certainty, a person's intelligence when given his height or weight. Furthermore, these

(1) Jones H.E. "Rev. of Educ. Res." Vol. 9, no. 1. Feb. 1939.

relationships have only been demonstrated for large groups, and we are not justified in predicting an individual's development from figures relating to groups.

Paterson admirably sums up the position in these words:-

"It is obvious that such slight correlation as seems to exist between intellect, height and weight precludes the possibility of using height, or weight as a basis for predicting probable intelligence in any given individual case. Although a slight relationship is revealed in terms of averages for the mass, the situation with reference to the individual amounts to a condition of almost complete independence. In other words, individuals representing the extreme limits of variability in physical size (barring, of course, pathological conditions such as cretinism) may be expected to exhibit any degree of intelligence from high to low."(1)

(1) op. cit. p.75.

2. Anatomical Age and Intelligence:

The concept of "anatomical age" as a measure of physical development has been widely used since the turn of the century. Researches have shown that there are well-defined stages in the transformation of cartilaginous tissue into bone tissue, the stages succeeding one another in the same order. The best index of such stages of skeletal development is to be found in the ossification of the eight carpal bones in the wrist, one of which (os magnum) ossifies towards the end of the first year of life, others ossifying at various ages until the last one (pisiform bone) during the eleventh year of life. So too, additional evidence of these stages of ossification is afforded by the stage of ossification of the epiphyses of the ulna and the radius in the forearm.

Various studies have attempted to correlate anatomical age and mental age, but the correlations, like those of the studies of section one, are very small.

Freeman and Carter[1] present correlations between ossification ratio and mental age for 220 boys and 220 girls distributed uniformly over an age range from 7 to 17 inclusive. The correlation between ossification ratio and mental

(1) Freeman F.N., and Carter I.M., "A New Measure of the Development of the Carpal Bones and its Relationship to Physical and Mental Development." Jour. of Educ. Psych., 1924, 15: 257-270.

age for boys was +.73 and for girls +.75. However the correlations between these two measures when chronological age is held constant are +.08 for boys and +.09 for girls. These correlations are so slight that they have little predictive value.

About the time Freeman and Carter were making their studies, Gates[1] published results of investigations he had been making between various measures of physical development and mental development. Working with 115 children from the Horace Mann School, he measured the physical and mental status of 4th grade and kindergarten pupils. The measures of physical status included ossification ratio (ratio of ossification of wrist bones to total wrist bone area), height, weight, chest girth, lung capacity, strength of grip and index of nutrition. Gates used the Stanford-Binet scale as a measure of mental ability. The correlations that Gates found are presented in Table Two and the correlation of relevance to this section, namely between ossification ratio and mental age, is seen to be +.11. The table is presented in full as the results refer to other sections of this study and show the small relationships that exist between physical and mental status.

(1) op. cit. pp. 329-358.

TABLE TWO (Coefficients of correlations between Physical Traits and Various Maturity Indices) after Gates.

PHYSICAL TRAITS	THE VARIOUS MATURITY INDICES						
	Binet M.A.	Mental Maturity	Social Maturity	Educn. Maturity	Educn. Achievement	Emotional Mat.	Physical Vigour
Ossification Ratio	.11	.15	.24	.15	.16	.20	.15
Height	.06	.11	.11	.07	.01	.15	.18
Weight	.10	.13	.09	.17	.07	.17	.25
Chest Girth	.09	.09	.15	.14	.03	.17	.19
Lung Capacity	.09	.09	.12	.06	.00	.11	.22
Grip	.06	.07	.08	.15	.15	.05	.31
Nutritional Status	.13	.15	.18	.17	.15	.15	.37

Abernathy[1] in the study of 317 girls in the University of Chicago Laboratory Schools, investigated the relationship between their anatomical ages as estimated by the ossification ratio and their mental ages as estimated by the Stanford-Binet Scale. Again the correlations are very low. The partial correlation between ossification ratio and mental age (chronological age constant) for 120 girls, aged 6 to 12 inclusive, was $+.02 \pm .06$. For the remaining age groups the correlation was computed for each age separately

(1) op. cit. pp.485-486 and 539-546.

with the following results:-

Age 13, r = -.14 ±.10. Age 16, r = -.02 ±.10.
Age 14, r= -.14 ±.08. Age 17, r = +.04 ±.11.
Age 15, r = -.17 ±.12.

Crissey,(1) using the data available from the Harvard Growth Study, found that the maximum correlation for girls was at the 8 year old level, when the correlation was +.18, and for boys, the maximum correlation of +.116, was at the 14 year old level. Crissey found as Abernathy did, that the correlations between ossification ratio and mental age for adolescent girls were negative.

The conclusion from the researches cited in this section is that there is a very slight positive correlation between anatomical age, as estimated by ossification ratio, and mental age. This conclusion does not appear to hold true for adolescent girls for at this period the correlations are usually negative. The knowledge of the stage ossification of a person's carpal bones provides scarcely any indication of their mental status, nor does the fact that a child's wrist bones ossify early necessarily mean that the child is likewise accelerated in mental development. It appears that anatomical development (ossification of carpal bones) proceeds independently of mental development.

(1) Crissey W.J.E. in Dearborne W.T. & Rothney J.N.M. "Predicting the Child's Development". 1941. pp. 100-109.

3. Dentition and Intelligence:

A further indication of anatomical age is offered by the stage of eruption of teeth. The number of erupted teeth the child has, or has had, is correlated with mental age and several researches find low correlations.

Burt(1) found that for London school children of the same chronological age, the correlation between dental age and mental age averages +.26 for boys and +.21 for girls.

Abernathy(2) computed the coefficient of correlation between dentition and Stanford-Binet mental age for 120 elementary school girls under 13 years of age and found the partial correlation to be slightly negative ($-.12 \pm .06$).

Paterson(3) quotes researches in this field from the contributions of Psyche Cattell(4) writing in the Harvard Monographs in Education. By both comparative studies between bright and dull groups, and by direct correlation for various homogeneous groups, her findings are negative. The growth curves showing the median number of permanent teeth at each age from 5 to 15 for boys and girls classified into 4 levels of intelligence (superior, unselected, dull - normal,

(1) op. cit. p.147.

(2) op. cit. pp.485-486 and 539-546.

(3) op. cit. p.153.

(4) Cattell P. "Harvard Monog. in Educ." no. 9. p.1-91.

feeble-minded), are so similar that Cattell concludes that dental development and mental development are practically unrelated. The major results from the correlational method are shown in Table Three. Sex and age are experimentally controlled and it will be seen that all the correlations are low, but positive. Cattell suggests that when age differences within the one year range are held constant, all the coefficients of correlation between numbers of teeth and mental age are reduced by about .05.

TABLE THREE: (Coefficients of correlations between Mental Age and Dentition) after P. Cattell.

No. of Cases	Age Range	Sex	r.	P.E.
55	6 yrs. 3 mos. to 7 yrs. 3 mos.	Boys	.12	.09
47	6 yrs. 3 mos. to 7 yrs. 3 mos.	Girls	.12	.09
100	8 yrs. 0 mos. to 8 yrs. 11 mos.	Boys	.05	.07
100	8 yrs. 0 mos. to 8 yrs. 11 mos.	Girls	.05	.07
100	10 yrs. 0 mos. to 10 yrs. 11 mos.	Boys	.11	.07
100	10 yrs. 0 mos. to 10 yrs. 11 mos.	Girls	.09	.07
500	5 yrs. 6 mos. to 11 yrs. 5 mos.	Boys	.11	

The conclusion from this section can be summed up as follows. There appears to be a very slight correlation between dentition and mental age though in the majority of cases the two seem unrelated.

4. The Age of Onset of Puberty and Intelligence:

The age of onset of puberty can be taken as an index of maturity. In the case of girls the indication of puberty is taken as the appearance of the first menstrual period. For boys no reliable method of estimating the onset of puberty appears to exist. The growth of axillary hair, pubic hair and other secondary sex characteristics are usually taken as indications that the changes characteristic of puberty are taking place. Fleming(1) quotes various sources which show that the many indications of secondary sex characteristics in boys are not reliable. So too, with girls, the exact date of the onset of the first menstrual period, if not accurately recorded, has to be supplied from memory.

The relationship between the age of onset of puberty and intelligence has been studied by most of the investigators already quoted in respect to other fields. Here too, the coefficients of correlation are low.

Burt(2) found that the correlation between the age of onset of puberty and mental age was +.27 for boys and +.32 for girls. These correlations are higher than others reported and as previously noted, all of Burt's correlations appear on the high side.

Abernathy, (3) again using adolescent girls

(1) op. cit. p.14.

(2) op. cit. p.152.

(3) op. cit. pp.485-486 and 539-546.

from the Chicago Laboratory Schools found the correlations between onset of puberty and mental age measured by the Stanford-Binet scale. The age of onset of puberty was determined by age of onset of menstruation, and 4 age groups from 14 to 17 inclusive were studied. In the 14 year old group Abernathy found the correlation for 45 girls to be $+.02 \pm .10$. For the 15, 16 and 17 year old age groups in which the numbers were 27, 44 and 33 respectively, she found the correlations to be $+.03 \pm .13$, $-.09 \pm .10$, and $-.33 \pm .10$. From these coefficients of correlation there would appear to be no relationship between the age of onset of puberty and mental age.

This conclusion is substantiated by a later study undertaken by Viteles.(1) It shows too, that the slight relationship that may exist is even less with late adolescent girls. Viteles studied 236 first-year students in a Normal School for women. These women ranged in age from 15 years and 11 months to 24 years and in each case sex maturity had been attained. The Pearson coefficient of correlation between age of pubescence and intelligence rating (Brown University Psychological Examination) at the time of the study was $+.01 \pm .043$. A further correlation between age of pubescence and scholastic achievement in Normal School yielded a coefficient of $-.04 \pm .043$. If

(1) Viteles M.S., "The Influence of Age of Pubescence Upon the Physical and Mental Status of Normal School Students," Jour. of Educ. Psych., 1929, 20: 360-368.

scholastic achievement can be taken as any indication of intelligence, then this latter coefficient of correlation would support the view put forward earlier that there is very little relationship between age of onset of puberty and mental age.

The rare instances of puberty praecox would support this conclusion too. In cases of puberty praecox the child's physical development is greatly accelerated so that the secondary sex characteristics appear at abnormally early ages. Studies carried out by Stone and Doe-Kulman(1) and studies reported by Gesell(2) show that corresponding mental development has not paralleled the precocious physical development. Gesell cites the case of a girl aged 3 years 7 months when menstruation began, and who in all subsequent mental examinations carried out over a number of years proved to be average or slightly below average. In the cases studied by these investigators it is quite evident that sudden acceleration in physical and physiological development failed to be accompanied by any corresponding spurt in mental development.

It is now known that the growth hormone secreted by the pituitary gland develops the sex hormones at the appropriate stage of maturation for each individual. These sex hormones in turn react on the growth hormone to slow it

(1) Stone C., and Doe-Kulman L., "Notes on the Mental Development of Children Exhibiting Puberty Praecox" 27th Yearbook of the N.S.S.E. Part 1. 1928. pp.388-397.

(2) Gesell A. "Precocious Puberty & Mental Maturity" 27th Yearbook of the N.S.S.E. Part 1. 1928 pp.398-409.

down so that an early onset of pubescence would appear to slow up growth. Thus early maturers tend to be short and stocky while late maturers tend to be taller and thinner. Studies of mental growth have shown that mental development continues through the twenties so that if these two points are taken together, the conclusion that physical and mental growth proceed independently of each other is supported.

It was formerly believed that physical and mental growth were relatively constant, but this view has been outmoded by recent researches, especially that of the Harvard Growth Study. If growth of physique and intellect were constant one could predict future status from present knowledge of a child's development. McGlinchey carried out investigations which show the variability of physical and mental growth. Her conclusions may be summarized as follows.

"The physical growth of girls was studied through the medium of standard scores. The 266 cases were divided into selected groups of 3 sorts (i) superior height (ii) average height and (iii) inferior height. From a portrayal of group averages the relative status of these group divisions appeared to be the same at maturity as at the beginning of development. However, when these groups were analyzed, individual positions were seen to be fluctuating. Individual members, particularly of the extreme groups,

tended to leave the boundaries of their group division and approach the mean. There appeared to be a levelling up process at work. Those who left the tall group tended to move down toward the average; those near the average tended to remain in their original position, while those who left the short groups tended to move toward the average."(1)

She found that a study of individual cases revealed a marked diversity in growth records. No two cases had exactly the same developmental history as portrayed in their deviation in relation to the mean of the group.

Her[(2)] conclusions with regard to the constancy of relative position in the mental growth of girls are as follows.

In general, girls tended to remain throughout the period of their mental growth to the age of 16 in the same classification as they were at 8 years. Girls who scored very highly on mental tests at an early age were apt to make lower scores and moved down toward the mean at maturity. Girls who scored very low in mental tests at an early age had about an even chance to score higher at maturity. Average scorers were apt to remain at the average at maturity. At approximately the age of puberty, McGlinchey states that girls appeared to show much less variation in mental age than they did before and after that time. In

(1) McGlinchey Grace, in Dearbourne W.F. and Rothney, J.W.M. "Predicting the Child's Development" 1941 pp.168-169.

(2) op. cit. p.186.

the two years following puberty, the variation increased until it was almost twice as much as it was at puberty.

The conclusions from this section are very similar to those reported earlier - there appears to be little relationship between the age of onset of puberty and intelligence.

5. The Relation Between Physical Defects and Intelligence:

Many investigators have sought to find the relationship between physical defects and intelligence. Paterson[1] remarks that the thought behind these researches usually supposes that even though the trend of evidence does not reveal ultimate interrelation of physical and mental development, surely it might be supposed, physiological malfunctioning should promptly reflect itself in reduced mental efficiency. It would seem almost axiomatic, he concludes, that physiological impairment has a deleterious effect upon the intellect.

Burt[2] lists what he considers to be the only physical defects that effect intelligence. Before birth, he believes that congenital syphilis may affect the intelligence of the child. So too, any cause that may produce miscarriage or abortion, for example, poisoned, defective or disturbed circulation of the blood might conceivably affect the cerebral development of the foetus when not sufficient to cause death. Serious disease during pregnancy or obscurer disorders of the mother's health such as unrecognized disturbances of endocrine secretions, may also affect the foetus.

(1) op. cit. p.170.

(2) Burt C. "The Subnormal Mind" O.U.P. 1935. pp. 72-76.

At birth, Burt found that prolonged labour and difficult delivery may affect intellectual development through injury, but he adds that such injuries are slightly more prevalent in the first born. He suggests that the brain is very well protected and only very rarely are injuries such that they cause the arrestment of mental growth.

After birth, Burt lists only 2 major factors that may affect mental development. Cerebral inflammation such as meningitis may definitely affect mental development. However with respect to diseases of this nature, the age of onset seems to be more important than the severity of the attack. The most important defect of physiological development that occurs in early life would seem to be an inadequacy or overabundance in certain endocrine secretions. The derangement of the thyroid gland and of the pituitary gland produce physical defects that in some cases affect mental development. Burt is careful to state that any of the defects mentioned, rarely by itself causes impairment of mental development and multiple causation appears to be the rule in these cases.

Keeping in mind the fact that Burt stressed that rarely does a brain injury impair mental development, it is reasonable to suppose, if this is true, that physical defects such as diseased tonsils, or defective teeth and the host of other ailments mankind is prone to, will not

affect mental development.

At one time it was considered that malnutrition seriously affected mental development, but from the previous findings reported in this survey, it will be seen that malnutrition could have very little effect on intelligence, for malnutrition is reflected in height and weight and these measures had but slight relationships with intelligence. This outmoded view is expressed by Terman(1) who wrote in 1913 that the effect of malnutrition on mental development is probably very great, though difficult to measure accurately. Again this view was exemplified in the health programs and physical exercises which were justified in terms of mental improvement over and above the demonstrable gains in physical condition.

Referring back to Table Two it will be seen that the coefficient of correlation between nutritional status and mental age as given by Gates, is almost zero, and is so low that one could probably conclude that there is little relationship between nutritional status and mental age. Paterson(2) quotes from experiments(3) conducted in New York City which admirably sum up the position. It states that aside from extreme cases of malnutrition, of prolonged hunger, or starvation, which like other pathological states would cause disintegration, it cannot be said that mal-

(1) Terman L.M. "The Hygiene of the School Child" 1914 p.28.
(2) op. cit. p.173.
(3) Hunt J.L., Johnson B.J., Lincoln E.M. "Health Education and the Nutrition Class". 1921. pp.1-281.

nutrition irrespective of other factors, produces, or runs hand in hand with mental defectiveness. In many types of mental processes the reactions of the undernourished child are equal or superior to the average of his age group. The traits in which he may prove less capable seem to be resistance to fatigue under response to uninterrupted or complex stimuli, and exaggerated emotional responses under normal stimulation.

Much has been written concerning physical defects and intelligence. The examination of recruits for the armies of the last two world wars, and of school children, produced so many people with defects that there was the tendency to stress that such defects are associated with, and are often responsible for, mental retardation. Some investigators set out to prove that such defects were of vital importance in the problem of school retardation and as a result inquiries into the relationship between defects such as diseased tonsils, infected teeth, enlarged adenoids, simple goitre, intestinal toxaemia, and intelligence were conducted. The almost negative results of all such investigations will be demonstrated with but a few researches.

Terman(1) reported in 1919 that the gain in I.Q. for 27 children retested after an operation for tonsils or adenoids was negligible. The gain they made was slightly less than that made for a random sample of children. From these

(1) Terman L.M. "The Intelligence of School Children" 1919. pp.151-152.

results Terman suggested that adenoids and diseased tonsils may give a child an exaggerated appearance of dullness.

Paterson[1] reports an exact and comprehensive study by Rogers[2] in 1922. Rogers studied a group of 530 children and divided them into two groups; those that needed medical attention through defective tonsils and those whose tonsils were normal or so slightly defective as to not need treatment. The I.Q. distribution of the two groups is shown in Table Four. It appears from this table that the presence of diseased tonsils in the infected tonsil group in no way impairs their status in I.Q. It will also be seen that the median I.Q. is almost identical for the two groups.

(1) op. cit. p.183.

(2) Rogers M.C. "Adenoids and Diseased Tonsils. Their Effect on General Intelligence". Archiv. of Psych. no. 50. 1922 pp.1-70.

TABLE FOUR: (Distribution of I.Q. for two groups of children. One group with diseased tonsils, one group without) after Rogers.

	DISEASED TONSIL GROUP		NORMAL TONSIL GROUP	
I.Q.	No. of Cases	Per cent of Cases	No. of Cases	Per cent of Cases
140-149	1	.4	0	0
130-139	2	.8	0	0
120-129	6	2.5	9	3.0
110-119	17	7.2	24	8.1
100-109	55	23.3	67	22.8
90-99	80	33.9	107	36.4
80-89	45	19.0	52	17.7
70-79	21	8.9	29	9.8
60-69	7	2.9	4	1.4
50-59	1	.4	2	.7
40-49	2	.8	0	0
TOTAL	237	99.1	294	99.9
MEDIAN	95.3		95.6	

Rogers then gives details on a test whereby 28 children were tested before and after removal of diseased tonsils. He used a control group of 28 children with diseased tonsils who were not operated on. The children in the operated group and in the control group were re-

tested six months later. The average gain in I.Q. for the operated group was 2.25 points as compared with the control group gain of 3.28 points of I.Q. These two groups were tested again after ten and seventeen months and the average gain in I.Q. for the control group was 6.2 points. It would seem from these results that no substantial improvement in I.Q. results from the removal of diseased tonsils. Rogers concludes his experiments by saying that since there was no recuperation in intelligence resulting from operation for adenoids and tonsils, it is reasonable to expect that there had been no retardation from which to recuperate.

The effect of dental treatment on mental efficiency was studied by Kohnky,[1] who, by using a control group sought to find if any improvement resulted in I.Q. through dental attention. The experimental group received elaborate treatment and care, including co-operation from dentists, parents and school nurses; the control group were given no attention. Nine months later the children were retested - both physically and mentally - and the results show that there is very little difference between the two groups.

When we come to study diseases that directly involve the central nervous system, it is found that mental retardation may be a consequence of an attack in early life.

(1) Kohnky E. "Preliminary Study of the Effect of Dental Treatment upon the Physical and Mental Efficiency of School Children." Jour. of Educ. Psych., 1913, 4: 471-578.

One such disease that has been demonstrated to produce mental retardation (i.e. to halt or delay mental development) is encephalitis lethargica.

Paterson[1] was able to report on several inquiries of such a disease and its effect on mental development. He states that the work of Dawson and Conn[2] shows that impairment of development is definite. These two investigators found that the mean I.Q. of 46 encephalitic cases tested from a few days to five years after onset, was 84.6, in comparison with a mean I.Q. of 90.5 for 974 non-encephalitic hospital children. Another important statistical result is seen in analysing the effect of the lapse of time between attack and subsequent testing. The mean I.Q. of those tested within twelve months of onset was 89.5, whereas the mean I.Q. of those tested after an interval of twelve months or more, was 79.8. Given a sufficient lapse of time and the effects of the disease shows itself in impaired mental development. It would appear that the mental after-effects consist in an arrest of normal rate of development rather than in actual mental deterioration. Dawson and Conn conclude that when an attack of encephalitis lethargica stops mental development, the degree of mental impairment it produces will depend on the age of the patient at the time of onset of his illness. Older children show

(1) op. cit. p.201.

(2) Dawson, S., and Conn J.C.M. "Effect of Encephalitis Lethargica on the Intelligence of Children." Archiv. Diseases of Childhood, 1926, 1: 357-368.

less deterioration because their development is arrested at a higher level. The child often retains his mental age, and so may appear dull, stupid, and unable to profit from instruction at school, but he is not reduced to imbecility.

Finally, in this section Paterson(1) reports on an investigation by Fox(2) who reported on cases of glandular dysfunction found among 1867 heterogeneous cases passing through the medical clinic of the St. Vincent Hospital in New York since 1923. Of these cases, 182 ranging in age between 3 and 16 were recorded as being due to some type of endocrine disorder and in each of these cases glandular therapy was prescribed. The distribution of these cases in regard to diagnosis is shown in Table Five, together with the average I.Q., the lowest I.Q., and the highest I.Q. for each type of glandular dysfunction. It will be seen that the column giving average I.Q. for each type of glandular disorder fails to reveal any definite relation between the type of disorder and intelligence. Furthermore, Fox gives additional data regarding I.Q.'s obtained by re-examinations following glandular therapy for periods of four months to two years. Even though the numbers retested are few, it will be seen that little or no increase in I.Q. is demonstrated as an aftermath of appropriate glandular therapy.

(1) op. cit. p.190.

(2) Fox E." An Investigation of the Effect of Glandular Therapy on the Intelligence Quotient". Mental Hygiene 1928, 12: 90-102.

TABLE FIVE: (Distribution of Various Types of Glandular Cases with Data on I.Q.'s) after Fox.

	NO. OF CASES		AVERAGE	LOWEST	HIGHEST
DIAGNOSTIC GROUP	BOYS	GIRLS	I.Q.	I.Q.	I.Q.
Hypothyroid	83	18	75	33	115
Hyperthyroid	1	2	81	59	94
Hypo-Pituitary	16	7	74	30	110
Hyper-Pituitary	2	0	57	52	61
Thyro-Pituitary	2	1	77	71	90
Pluriglandular	8	42	71	30	108

TABLE SIX: (Effect of Glandular Therapy on I.Q.) after Fox.

DIAGNOSTIC GROUP	NO. OF CASES	AVERAGE INDIVIDUAL GAIN IN I.Q. POINTS
Thyroid	12	+ 1
Pluriglandular	7	+ 4
Hypo-Pituitary	3	- 2
Total Cases	22	+ 1.5

From the investigations reported in this section it would appear, that except for diseases and injuries that directly involve the central nervous system itself, it is impossible to explain the tremendous range of

individual differences in intellect on the hypothesis that unfavourable physical condition, or specific physical defects, are operative as a major causal factor. Nature has so safeguarded the central nervous system as to render normal mental development secure, or almost immune to such influences as malnutrition, diseased tonsils, enlarged adenoids, defective teeth and simple goitre. In the case of glandular dysfunctionings, if they are recognized early enough, appropriate glandular therapy may produce increased physical and mental efficiency, though in older cases no significant gains in mental efficiency have been demonstrated.

6. Morphological Index, Height-Weight Ratio and Intelligence:

This final section of Part One sets out briefly some interesting points put forward by S. Naccarati(1) and some attempts to verify them. The late Dr. Naccarati was an Italian who conducted most of his experiments at Columbia University, New York.

Naccarati explained away all previous conflicting results by claiming that intelligence is "a most complex trait" and therefore no simple, single physical trait could be expected to correlate closely with intelligence. He stated that it was obvious that none of the anthropologic traits alone could solve the problem of correlation with intelligence. As he considered intelligence a most complex trait, therefore, any physical trait in order to be a correlative of intelligence must be a compound one, namely, it must be made up of many elementary traits.

Naccarati classified people into three types, firstly, excessively developed trunk as compared with limbs, i.e. fat people (macrosplanchnics); secondly, small trunk so that development of limbs is excessive over it, i.e. thin people; (microsplanchnics); and thirdly, individuals whose limbs and trunk are in harmonious

(1) Naccarati S. "Morphologic Aspect of Intelligence" Archiv. of Psychology. No. 45. Aug. 1921.

development, (normosplanchnics). The investigator had observed that bright children during the period of growth tended toward microsplanchny, in contrast to less bright, or dull children, and he attempted to show that this theory was correct by demonstrating that microsplanchny is associated with brightness, while macrosplanchny is associated with dullness. In order to obtain a workable measurement for his types, he determined the ratio of length of limbs (one upper and one lower) to volume of the trunk. Naccarati called this ratio the morphological index, and proceeded to correlate these indices with intelligence test scores for various groups of college students. However, for most of his work he used a simpler index - namely ratio of height to weight - saying that this ratio correlated + .70 with his morphological index, and thus was almost as good as the more complicated measure.

In a series of papers written by himself and some in co-operation with Lewy-Guinzburg and Garrett, Naccarati gives 13 coefficients of correlation between Ht.-Wt. ratio and Intelligence, one of these correlations being between the more elaborate morphological index and intelligence. The coefficients of correlation range from + .11 $\pm$ .09 to + .44 $\pm$ .08, with an average of + .256, a value that would reveal a slightly more definite relationship than other physical measurements we have studied. However the few cases used would appear to make the correlations unreliable.

TABLE SEVEN: (Correlation Coefficients of Ht.-Wt. Ratio, Morphological Index and Intelligence) after Naccarati.

YEAR	SEX	NO. OF CASES	CRITERION OF MENTAL ABILITY	RATIO OF HT.-WT.	RATIO OF LIMBS-TRUNK
1921	?	75	Thorndike Test	$.16 \pm .08$	$.35 \pm .07$
1921	?	221	Thorndike Test	$.23 \pm .04$	
1921	?	80	Thorndike Test	$.27 \pm .07$	
1921	?	100	Thorndike Test	$.33 \pm .06$	
1922	F.	50	Army Alpha	$.44 \pm .06$	
1922	M.&F.	94	Otis	$.15 \pm .07$	
1922	M.	252	Thorndike Test	$.13 \pm .04$	
1923	M.	57	Army Alpha	$.31 \pm .08$	
1923	M.	57	4 Tests of Controlled Assoc.	$.44 \pm .08$	
1923	M&F.	150	"	$.24 \pm .05$	
1923	M.	50	"	$.17 \pm .09$	
1923	F.	50	"	$.11 \pm .09$	

Paterson[1] reports on several attempts that have been made to verify Naccarati's theories, and some of these and their results will be outlined here.

Johnson,[2] working in New York City, demonstrated the existence of only a slight correlation between Ht.-Wt. index and intelligence for children whose ages ranged from

(1) op. cit. p. 164.

(2) Johnson B.J. "Mental Growth of Children in Relation to the Rate of Growth in Bodily Development". New York 1925. pp. 1-160.

2 to 13 years. For 191 children the coefficient of correlation between Stanford-Binet mental age and the Ht.-Wt. index was found to be + .68 ± .02. By using the partial correlation technique to control chronological age, the correlation turned out to be negligible, namely + .04 ± .05.

An elaborate investigation involving large numbers of subjects was carried out by Heidbreder.(1) She found that the correlations between Ht.-Wt. ratio and the Final score on the Minnesota College Assembly Test for 500 Freshmen Men to be + .03 ± .03; for 500 Freshmen Women the correlation was + .04 ± .03.

Sheldon (2) using Naccarati's elaborate technique (morphologic index) measured 434 Freshmen men at the University of Chicago, and found the range of correlations between these morphological indices and intelligence (measured by American Council on Education 1924 Psych. Exam. for College Freshmen), to be between - .02 and + .12.

These consistently low correlations, and those found by other researches, make it appear that the hopes Naccarati had for his theory of Morphologic Index or Ht.-Wt. Index, and intelligence were not fulfilled. In fact it would appear that just as in the other fields of research we have studied and found negligible results, so too, in this

(1) Heidbreder, Edna, "Intelligence and Ht.-Wt. Ratio". Jour. of Appl. Psych. 1926, 10: 52-62.

(2) Sheldon W.H. "Morphologic Types and Mental Ability" Jour. of Personnel Research, 1927, 5: 447-451.

particular direction, the results are far from convincing.

Dearborne and Rothney[1] in a study made from the data provided by the Harvard Growth Study, stress the unsuitability of the Ht.-Wt. ratio as an index of physical growth. They show that because weight is affected by, and varies with many other influences which may not affect height, e.g., nutritional and hereditary factors, two people may be alike in weight, age and intelligence, and yet differ in height so that the Ht.-Wt. ratio would differ. In light of this evidence, the relationship that Naccarati claims to exist between Morphologic, or Ht.-Wt. index and intelligence would appear to be disputable.

(1) op. cit. p.292.

7. Summary of Part One:

Part One of this survey reviewed some of the more important attempts to find the relationship between measures of physical growth and intelligence. The earliest of these investigations began when little was known of what intelligence was, or how to measure it. It is perhaps with the idea of finding a physical basis of intelligence, so that from a knowledge of the one, the other could be predicted, that these studies were carried out.

The first measures used were the obvious ones of height and weight, but when these two measures of physical growth yielded no striking results, attention was directed to other measurements such as anatomical age, glandular functioning, physical defects, morphologic index and height-weight ratio. From all of these fields the findings presented lead us to believe that there is a very slight relationship between aspects of physical growth and intelligence. In childhood, when physical and mental growth are advancing rapidily, there is bound to be some parallel in the curves of physical and mental growth, so that a relationship between the two seems to exist. In the few studies made of adults it was found that the relationship of these aspects of growth was almost negligible.

The findings of the Harvard Growth Study that mental and physical growth proceed independently of each other, would lead us to believe, that, in the light of

present knowledge, no important relationships between measures of physical growth and intelligence can be demonstrated.

The tendency would appear to be for children of superior intelligence to inherit a superior organism, as desirable qualities tend to go together. Moreover, the bright child often has parents who are able to provide better socio-economic conditions so that the potential inherited by the child is affected favourably by these two different stimuli. Therefore we can perhaps state that for mankind as a whole, and especially for children, the taller and heavier tend to be brighter than the average, while those whose anatomical age, age of onset of puberty, and age of eruption of permanent teeth are advanced ahead of the average of their fellows, are not likewise advanced intellectually.

PART TWO

THE RELATION BETWEEN PHYSIQUE AND TEMPERAMENT.

This field of physique and temperament is of age-old interest to man. We are all familiar with the concepts of the fat, jolly type so admirably portrayed by Falstaff, and the thin, "introverted" type like Cassius. Man has for centuries thought of temperament and body-build along those lines, and yet it is only comparatively recently that any scientific studies to determine the truth of these old adages, have been made. Aristotle wrote,

"The faculties of the mind are always influential even in the most intense life of bodily movement... one assesses the character of a man by watching his movements, the shape of his limbs and the whole effect of his body."(1)

Many so-called scientific systems have been built up that attempt "character analysis" from outward physical signs. Some such "systems" are physiognomy, phrenology, and graphology. However the two outstanding attempts to link body-type to temperament type, have been made by Kretschmer and by Sheldon. These two studies will be examined in detail later in this survey, but first a few

(1) Aristotle - quoted by de Gonst H. in "Physiognomy" delivered at the 1939 Lingiad.

of the earlier investigations will be reviewed.

It is significant to note that the investigators in Part Two encountered difficulties in measuring or estimating body-types and temperament, in the same way as investigators in Part One had been faced with the problem of measuring accurately physical and intellectual characteristics. Some criticisms of these attempts at measurement will be given as each study is outlined, but it is sufficient to say at this point that non-intellectual aspects of mental development cannot be measured as accurately as the intellectual aspects. To measure height and weight is a comparatively simple matter, but when we come to estimate body-types, we find that many factors such as skin colour, coarseness of skin texture, nose-shape etc., have to be taken into account, or so some investigators would have us believe.

With these points in mind we can review some attempts to relate physique and temperament.

1. Physiognomic Traits and Temperament:

Physiognomy is the so-called science or art of judging character from the features of the face. Elaborate outlines are given for interpreting the significance of height of forehead, size and shape of head, mouth, nose, eyes, voice quality, texture of skin, bodily build, posture, hardness or softness of muscles, gait, handshake, gestures, clothing etc. From this list of characteristics from which to interpret character, one can see immediately that the "system" is very complex and workable only in the hands of a skilled operator.

Blackford has a system of character analysis which uses nine physical variables, one of these variables being the "law of colour" whereby one's pigmentation of skin and hair is estimated, and from this the appropriate strength of trait is rated that is associated with blond or brunette colourings. Blackford says of these two main types of colouration that,

"Always and everywhere, the normal blond has positive, dynamic, driving, aggressive, domineering, impatient, active, quick, hopeful, speculative, changeable, and variety-loving characteristics; while the normal brunette has negative, static, conservative, imitative, submissive, cautious, painstaking, plodding, slow, deliberate, serious, thoughtful, specializing characteristics."(1)

(1) Blackford K.H. and Newcomb A. "The Job, the Man, the Boss." New York, 1919, p.141.

Presumably most blonds and brunettes today would be considered by Blackford to be abnormal because it can be shown that no blond or brunette has all these traits nor are they peculiar to any one colour-type. Judging the amount of colouration in any one person would presumably be a difficult problem, yet Blackford assures us that it is simple and straightforward. She says that in applying this law of colour to people of the white race, the method is simple. The less pigmentation in any individual, the more marked the characteristics of the blond in his physical and mental nature; the greater the degree of pigmentation, the more marked the characteristics of the brunette.

It is reasonable to suppose that pigmentation varies in a continuous scale from lack of colouration to the maximum of pigmentation. Just what the standard is from which one should judge the amount of colour in any one person, Blackford does not say, and therefore there is bound to be variation in people's estimates. So too, it is difficult to judge degrees of blondness and of brunette colourings, for not only do we find admixtures of other colours, such as redness, that affect the two colours Blackford chooses, but under different climatic conditions, hair colour will vary slightly, e.g., the brunette's hair will be bleached by strong sunlight. Again, if, as Blackford suggests, this law applies to people of the white race

"always and overywhere", would these character traits apply in toto to the Italian people who are generally dark in hair colour. One could apply many of the blond characteristics to the Italians.

Paterson and Ludgate[1] attempted a quantitative research to test these positive assertions of Blackford. A rating sheet was prepared with the 26 traits listed in random order. Each of 94 judges was asked to select from among his acquaintances two pronounced blonds and two pronounced brunettes, and to rate them with respect to presence or absence of each trait or characteristic. In this way, ratings of 187 blonds and 187 brunettes were obtained. From the data given in Table Eight it will be seen that the percentage of blonds passing in the brunette traits is approximately as large as the percentage of brunettes passing in blond traits. The results from this attempt to verify Blackford's system would appear to lend it no support.

(1) Paterson D.G., and Ludgate K.E. "blond and Brunette Traits: A Quantitative Study." Jour. of Personnel Research. 1922, 1: 122-127.

TABLE EIGHT: (Percentage of Blonds and Brunettes Rated (+) in each of Blackford's so-called Blond and Brunette Traits) after Paterson and Ludgate.

	%AGE RATED (+)			%AGE RATED (+)	
BLOND TRAITS	187 BLONDS	187 BRUN-ETTES	BRUNETTE TRAITS	187 BLONDS	187 BRUN-ETTES
Positive	81	84	Negative	16	17
Dynamic	63	64	Static	28	31
Driving	49	50	Conservative	51	61
Aggressive	62	56	Imitative	39	40
Domineering	36	36	Submissive	25	26
Impatient	56	51	Cautious	54	60
Active	88	82	Painstaking	56	61
Quick	70	68	Patient	43	52
Hopeful	85	85	Plodding	27	31
Speculative	53	51	Slow	20	24
Changeful	53	43	Deliberative	47	57
Variety-Loving	66	62	Serious	58	72
			Thoughtful	67	70
Average	64	61	Specializing	52	45
			Average	42	45

The most elaborate attempt to verify the claims of physiognomic systems was undertaken by Cleeton and Knight[1]. In order to test the proposal that judgement,

(1) Cleeton G.U., and Knight F.B. "Validity of Character Judgements based on External Criteria". Jour. of Applied Psych. 1924, 8: 215-229.

intelligence, frankness, will-power, ability to make friends, leadership, originality and impulsiveness are revealed by various physical characteristics, a total of 122 physical measurements were made on each of 30 subjects. Pooled ratings on each of these character traits were correlated with each of the physical measurements, and the result was that 201 correlations between physical traits and character traits were zero.

Thus these two attempts to verify the claims of physiognomy and its ally, phrenology, show that to judge character from physical characteristics cannot be demonstrated quantitatively.

2. Morphologic Types and Temperament:

Naccarati carried his theories of morphology and intelligence to the stage where he attempted to find the relationship between morphologic types and temperament types. Working with 100 Italian, male psycho-neurotics, the principal conclusions he stated are these.

"(a) The percentage of microsplanchnics and macrosplanchnics is higher among psycho-neurotics than among an equal number of normal individuals of the same age.

"(b) Neurasthenics yield relatively more microsplanchnics, and

"(c) Emotional psycho-neurotics yield more macrosplanchnics."(1)

In other words, psycho-neurotic people tend towards fatness or thinness as compared with normal people; thin people tend towards neurasthenia; and fat people tend to be emotional psycho-neurotics. However the tentative nature of these conclusions is definitely recognized by the author. The method of averages was used throughout his investigations, and until the technique of correlation is used reliable results will not be forthcoming.

(1) Naccarati S. "The Relation of Morphology to Temperament," Jour. of Abn. and Soc. Psych., 1924-25, 19: 254-263.

The precise amount of relationship of morphologic index and temperament as revealed by the technique of correlation was undertaken by Garrett, this time working in co-operation with Kellogg.(1) Measuring emotional stability by the Woodworth Personal Data Sheet and Social Intelligence by the George Washington Social Intelligence Test, the correlations found are presented in Table Nine.

TABLE NINE: (Coefficients of correlations between M.I., Ht/Wt Index and Emotional Stability and Social Intelligence) after Garrett and Kellogg.

TESTS	N.	r
M.I. and Woodworth P.D. Sheet	151	.05 ± .06
Ht/Wt. and Woodworth P.D. Sheet	150	.09 ± .05
M.I. and Social Intell.	123	-.06 ± .06
Ht/Wt. and Social Intell.	122	.05 ± .06

If the two scales, the Woodworth Personal Data Sheet and the George Washington Social Intelligence, measure to any exact degree what they set out to measure, then the coefficients of correlation they yield between morphological index, temperament and intelligence are very slight. In fact the claims originally made by Naccarati

(1) Garrett H.E., and Kellogg, W.N. "The Relation of Physical Constitution to General Intelligence, Social Intelligence, and Emotional Stability." Jour. of Expt. Psych. 1928, 11: 113-129.

and Garrett cannot be substantiated by these findings.

Similar results were found by Sheldon.[1] Working at Chicago University, Sheldon secured trait ratings of 155 Freshmen men. The traits selected for study were, sociability (good nature, likeableness, popularity), perseverance (determination, tenacity of purpose), leadership, domination of a group (influencing their thinking and actions), aggressiveness (pushing oneself forward, self-assertiveness), and emotional excitability (expressing oneself violently, raising the voice, losing temper, getting angry, flushed and wrought up easily). The morphological measurements were secured by following the details of Naccarati's procedure. From the coefficients of correlation between morphologic index, morphologic measurements and the various traits listed, and set out in Table Ten, it is seen that there is little relationship between the physical characteristics and temperament traits. There may be a very slight relationship between bigness, sociability, leadership, and aggressiveness.

(1) Sheldon W.H. "Social Traits and Morphologic Types". Jour. of Personnel Research. 1927, 6: 47-55.

TABLE TEN: (Coefficients of Correlation between Morphologic Measurements and Personality Trait Ratings.) Adapted from Sheldon.

	Emotional Excitability	Aggressiveness	Leadership	Sociability	Perseverance
Morphologic Index	.00	-.08	-.14	-.22	.01
Length of Lower Extremities	.06	.14	.00	-.07	-.01
Length of Upper Extremities	.07	.03	.02	.00	-.02
Height	.09	.13	.05	.00	-.07
Weight	.08	.07	.02	.13	.03

3. Constitution and Psychotic Temperament:

The idea of physical types has a history beginning with the now famous twofold classification of Hippocrates; i.e. his "habitus apoplecticus" and his "habitus phthisicus". We have already met in this survey the threefold classification of Naccarati, but Table Eleven shows that this threefold classification has a long history.

TABLE ELEVEN: (Classification of Body-Types) after Wertheimer and Hesketh - Plus Sheldon's 3 Primary Components of Morphology.

AUTHOR	1.	2.	3.
Hippocrates	Habitus Apoplecticus		Habitus Phthisicus
Walker(1852)	Nutritive Beauty	Locomotive Beauty	Mental Beauty
Carus(1853)	Phlegmatic (Region of Digestive Organs Prominent)	Athletic(Bones and Muscles strongly developed).	Asthenic (Narrow Chest, Long Body, Poor Muscles and Skeleton.
Viola and later Naccarati(1920)	Macrosplanchic	Normosplanchnic	Microsplanchnic
Sigaud	Digestive Type	Muscular Type	Respiratory Type Cerebral Type
Davenport (1923)	Fleshy Biotype	Medium Biotype	Slender Biotype
Kretschmer (1925)	Pyknic Type	Athletic Type	Asthenic (1925) Leptosome (1945)
Sheldon(1940)	Endomorphic Type	Mesomorphic Type	Ectomorphic Type

The most noteworthy attempt to link body-types with types of temperamental disorder is that of Kretschmer, who in 1925 published the result of his researches in the book "Physique and Character". He brought out a revised edition in 1945. It is intended in this section to give an outline of Kretschmer's work in some detail because the evidence appears to confirm his assertions.

Kretschmer introduces his work by observing that in the mind of the man in the street, the devil is usually lean, while the fat devil has a strain of good natured stupidity. The intriguer has a hunch back; where there is brightness and jollity we see the fat knight Falstaff. Explaining these generalizations, Kretschmer says that it may be that phenomena which phantasy of the people has crystallised into the tradition of the centuries, are objective documents of folk-psychology - jottings from the observations of mankind, worthy, perhaps, of a glance even from the eyes of an experimenter.

Kretschmer hastens to assure us that his investigations do not proceed from such general reflections, but from the special problem of psychiatry, and only eventually, by a certain inner necessity, ever making wider circles, do they stretch out over the boundaries of that study into general psychology and the realm of biology. He believes it advisable in presenting the results of his inquiry, to choose the order in which they appeared. On the psycholog-

ical side he states that we have the advantage of already possessing in the two great psycho-pathological types of manic-depressive, or circular insanity, and schizophrenia, which have been distinguished. Kretschmer adopts a broad and elastic classification of patients. Under manic-depressive psychoses he includes those exhibiting in varying degrees, either flight of ideas, psychomotor hyperactivity, emotional exaltation or difficulty of thinking. Similarly, along with dementia praecox cases illustrating the typical shut in personality, he includes in his schizophrene group occasional cases of paraphrenia, psychopaths and degenerates. He continues that as soon as we have worked out the corresponding physiological types by the aid of these psycho-pathological types, we shall see at once that these bodily types not only correspond to the two psycho-pathological types, but they have far more extensive relations to widespread normal psychological types of temperament, which on their side again, have close psychological and hereditary connections with the psycho-pathological types with which we started.

From this summary it can be seen that Kretschmer took recognized types of psycho-pathological temperamental disorder, and then classified them into body types. The method of estimating body types is most elaborate and extensive.

Kretschmer has two forms of his "constitution

scheme" as he calls it - one an extended version and the other an abbreviated form of it. In the scheme he underlines the characteristic which he considers most appropriate for each individual, and when no clear impression can be obtained, the word "medium" is always underlined. The following is a brief summary of his scheme which will serve to show the detail incorporated in it.

i. Face and Skull:

(a) Face: large medium small
long medium short
delicately boned coarsely boned
shining dull
fresh pale
well marked blood vessels, etc. etc.

(b) Eyes: large medium small
colouring
orbital frame, high, low, etc. etc.

Similarly for (c) Nose (d) Mouth (e) Lips
(f) Cheekbones (g) Chin (h) Larynx (i) Teeth
(j) Gums (k) Ears (l) Forehead (m) Profile.

ii. Physique:

(a) Poise. limp, stiff, bent, etc.

(b) Joints (c) Fat Upholstery (d) Musculature, etc.

iii. Surface of the Body:

(a) Skin (b) Bloodvessels (c) Arteries (d) Pulse
(e) Hair, etc.

iv. Glands and Intestines:

v. Measurement: (Ht. Wt. etc.).

vi. Temporal:

(a) Commencement of puberty, (b) Commencement of fattening, etc.

vii. Summing up of Physical States:

viii. Type of Personality:

ix. Heredity:

Kretschmer points out that his scheme is an elaborate one and says that a severe training is required in order to obtain a rough feeling for the average and the variations from it. He favours verbal description because it has certain advantages over such methods as photography. Skin colour, texture, and hair colour cannot be photographed well, but he agrees that optical impressions and accurate measurements must supplement each other. The visual impression comes first in the scheme because Kretschmer says that the tape measure sees nothing.

Before describing the various types of physique, Kretschmer hastens to add that the following remarks have to be made from a statistical point of view with regard not only to his tables, but also, in principle, to all the rest of his numerical values.

1. "That, almost without exception, they have been obtained from individuals springing from the Schwabian people; that is to say, they are comparable only among themselves, and without further work they cannot be compared with numer-

ical values obtained from patients belonging to other races.

2. That the smaller of his sub-groups (particularly the athletic), divided between men and women, includes only a few individuals - a few dozen or less - so that the average figure so obtained is to be regarded only as a provisionary halting place - as an approximation - but not as a statistical constant. It would be impossible to procure during any reasonable period of time, such statistical values for every single measure of the body, and besides, in any case it is superfluous because,

3. even within a single people we can give only approximate figures, since, when dealing with body forms, we have not to do with clearly marked unities, but with ill-defined types, where, with regard to certain borderline cases, it depends on the investigator himself whether or not he includes them on the list of one single type or not."(1)

With these obvious precautions, he nevertheless believes that the average figures afford extraordinarily valuable, objective support for the working out of the fundamental characteristics of the types.

Continuing the description of his technique, Kretschmer says that when he has worked through a larger series of patients with these methods - that is, a combination of exact diagrammatic description, measurement, and registration by drawing and photography - then he is left

(1) op. cit. p.13.

with solid data, which satisfy all the demands of physical science for his purpose, namely, an exact clinical diagnosis of physique, as a broadly physiological basis for a psychiatric theory of constitution.

For the purposes of the investigation, 260 men and women were used and in the 1945 edition of his book, Kretschmer states that he has since had a further 100 cases which confirmed the results obtained from earlier cases. The distribution of cases is shown in Table Twelve.

TABLE TWELVE: (Distribution of 260 Psycho-Pathological cases) after Kretschmer.

CIRCULAR		SCHIZOPHRENE	
Men	43	Men	125
Women	42	Women	50
Total	85	Total	175

Kretschmer then proceeds to describe in detail the three main types of physique he differentiated. The descriptions are often bewildering and interspersed with numerous references to specific cases, and they are concerned, to a considerable extent, with distinctions not only between the three main classes, but also between each of these and intermediate classifications.

The types he found are not ideal types built up from pre-established values, but are obtained from the

average of a large number of morphological similarities. Three ever-recurring principal types of physique emerged which he called asthenic (leptosome in the 1945 edition), athletic and pyknic. They are to be found among men and women, but on account of the fact that the female body is less strikingly morphologically differentiated, Kretschmer believes the most outstanding forms are less often found among women.

Asthenic Type:

"In the clearest cases, the asthenic type is a lean, narrowly-built man, who looks taller than he is, with a skin poor in the secretion of blood, with narrow shoulders from which hang lean arms with thin muscles, and delicately-boned hands; a long, narrow, flat chest on which the ribs can be counted... a thin stomach, devoid of fat and lower limbs just like the upper ones in character."(1)

The asthenic woman, as so far as the types show themselves, are in general appearance, like asthenic men.

Athletic Type:

"The male athletic type is recognized by the strong development of the skeleton, the musculature and the skin. He is a middle-sized to tall man, with particularly wide, projecting shoulders, a superb chest, a firm stomach and a trunk which tapers in its lower region, so that the pelvis and the magnificent legs sometimes seem

(1) op. cit. p.22.

almost graceful compared with the size of the upper limbs."(1)

Pyknic Type:

"The rough impression in well-developed cases is very distinctive: middle height, rounded figure, a soft, broad face on a short massive neck sitting between the shoulders; the magnificent fat paunch protrudes from the deep-vaulted chest which broadens out towards the lower part of the body. The Pyknics tend emphatically to a covering of fat, though the lower limbs may always remain thin."(2)

Women of this type have almost the same characteristics except that the distribution of fat may be slightly different.

Those types which Kretschmer cannot classify under any of these three headings he designates as "Dysplastics". The following table shows the distribution of the various physical types according to the two basic psycho-pathological disorders.

(1) op. cit. p.25.

(2) op. cit. p.30.

TABLE THIRTEEN (Physical and Psychical Dispositions) after Kretschmer.

	CIRCULAR	SCHIZOPHRENE
Asthenic	4	81
Athletic	3	31
Asthenic-Athletic Mixed	2	11
Pyknic	58	2
Pyknic Mixture	14	3
Dysplastic	-	34
Deformed & Uncataloguable	4	13
TOTALS:	85	175

After describing these three body-types and presenting the above table, Kretschmer straightaway presents his results. They are,

"1. There is a clear biologieal affinity between the psychic disposition of the manic depressives (or circulars) and the pyknic body types.

"2. There is a clear biological affinity between the psychic disposition of the schizophrenes and the bodily disposition characteristics of the asthenics, athletics and certain dysplastics.

"3. And vice versa, there is only a weak affinity between

schizophrenes and pyknics on the one hand, and between circulars and asthenics, athletics and dysplastics on the other."(1)

Later, Kretschmer generalizes beyond the limited confines of psycho-pathology in developing a theory of physique and character which embraces the normal personalities found in everyday life. He seizes upon the now generally accepted conclusion that there is no hard and fast dividing line between the normal and the abnormal, the latter merely exhibiting normal mental mechanisms to an exaggerated degree. This enables him to trace the transition from circular insanity to the merely cycloid temperament in which the subject exhibits the mild degrees of excitement and depression and finally to the cyclothymic personality, normal and well adjusted to the demands of everyday life. In a like manner he passes from the pathological schizophrene to the schizoid who reflects the same fundamental psychological symptoms as the schizophrene in milder degree, and thence to the schizothyme, normal and well adjusted to the demands of everyday life. The application of his theory to normal, healthy personalities, known intimately by him (and in the 1945 edition this circle is widened), results in attributing the following physical characteristics to persons of schizothymic temperament. Long noses, angular profiles, abnormally

(1) op. cit. p.37.

high middle faces, long egg-shaped narrow facial contours, and figures which are either thin and slender, or wiry and lanky, or have marked muscular and bony relief.

Persons exhibiting the cyclothymic temperament possess the well known pyknic figures, or five-cornered contours, and the harmonious construction of the profile, with short necks, rounded limbs and the pyknic tendency to fatness.

These physical descriptions should be kept in mind when reading Kretschmer's "temperaments" given in Table Fourteen. The "temperaments" present an amazing combination of technical and everyday terms.

TABLE FOURTEEN: (The Temperaments) after Kretschmer.

	CYCLOTHYMES	SCHIZOTHYMES
Psychaesthesia and Mood	* Diathetic Proportion between raised (gay) and depressed (sad)	Psychaesthetic Proportion between sensitive and cold.
Psychic Tempo	Wavy temperamental curve: between mobile and comfortable.	Jerky temperamental curve: between unstable and tenacious alternation mode of thought and feeling.
Psychomobility	Adequate to stimulus rounded, natural, smooth.	Often inadequate to stimulus: restrained, inhibited, stiff.
Phys. Affinities	Pyknic	Asthenic, Athletic and their mixtures.

SPECIAL DISPOSITIONS:

Poets	Realists Humourists	Pathetics Romantics Formalists
Leaders	Tough whole-hoggers Jolly organizers Understanding Conciliators	Pure Idealists Despots and Fanatics Cold Calculators.

From this summary of Kretschmer's work it will be seen that he has developed from pathological types of temperamental disorder, the outlines of a human character-

ology based on two contrasting temperaments and virtually two contrasting physical types. The acceptance of his findings must be questioned in the light of the relatively few cases used and they must be viewed from the point of view that the distinguishing of his temperamental and physical types was largely a matter (as he says), according to the whims of the investigator. Nevertheless it is perhaps possible to state that the Pyknic or fat types tend towards circular temperamental disorders, and that the Asthenic and Athletic types tend towards schizophrenia.

The difficulties of classifying peoples into various types was revealed in an experiment by Wertheimer and Hesketh[1] who set out to test Kretschmer's theories. Sixty five male patients were chosen without any consideration of physique or mental diagnosis. For the most part, the analyses are restricted to 11 manic-depressives and 23 schizophrenes, for no question as to correctness of diagnosis seemed to exist for these cases.

In studying the physical classification of these patients two methods were used. Kretschmer's criteria yielded physical type groupings (observational method) and a new morphological index (modified from Naccarati) was devised. Having classified each of the 65 patients into the Kretschmer physical groupings by the method of observation and having secured a morphological index for each

(1) Wertheimer F.I., and Hesketh F.E. "The Significance of the Physical Constitution in Mental Diseases." Medicine, 1926,5 : 375-463. Quoted by Paterson D.G. "Physique and Intellect". p.231.

patient, they proceeded to compare the two methods in operation. A striking correlation between them was revealed. There was no overlapping of Asthenic or Pyknic types. The intermediate positions on the scale were occupied by Pyknoid, Athletic and Asthenic - Athletic mixed types. All in all, a continuous distribution of morphological indices was revealed. Thus, the data afforded a clear demonstration that Kretschmer's physical types were not types at all from a biometric point of view. Rather, there appeared to be a continuous gradation from low indices to high indices with a majority of the cases clustering around the middle values. Pyknic type and Asthenic type turned out to be merely extremes on a single, continuous scale of measurement in accordance with modern biometric expectations. It is obvious that Kretschmer was more or less aware that his classifications did not exist as "types" but as extremes on a continuous scale. So too, with his temperament types, because he made use of the knowledge that there is no hard and fast dividing line between the normal and abnormal.

The relationship these two investigators found between body type (Kretschmer's method) and temperamental type is summarised in Table Fifteen. It is apparent that there is a connection between manic-depressive psychosis and the Pyknoid bodybuild. The schizophrene cases are distributed more widely over the whole range of body types and are not definitely confined to the extreme Asthenic types.

TABLE FIFTEEN: (%age Distribution of Manic Depressives and Schizaphrenes According to Body Types). after Wertheimer and Hesketh.

BODY TYPE	CLEAR MANIC-DEPRESSIVES		CLEAR SCHIZOPHRENES	
	All Ages	Aged 29 +	All Ages	Aged 29+
	N = 11	N = 6	N = 23	N = 12
Pyknic	45.5	66.6	4.3	8.3
Pyknoid	36.4	33.3	13.0	25.0
Athletic	9.0	0.	26.1	16.7
Asthenic-Athletic	0.	0.	34.8	25.0
Asthenic	0.	0.	17.4	16.7
Unclear	9.0	0.	4.3	8.3
TOTAL	99.9	99.9	99.9	100.0

The fact that the numbers used in this particular study - especially in the manic-depressive classification - are so very few, make it impossible to accept the results without reservation. This study does not claim that the same relationships exist for normal people as Kretschmer does and the patients used represent extreme deviations from the normal. Altogether, the theory of differences in body build between two contrasting types of temperament seems to have been established for pathological cases only.

4. Physical Types and Temperament Types:

The most recent studies in this field have been conducted by Sheldon at Harvard University, and formerly of Chicago University. Some of the early researches of Sheldon have been cited in connection with morphological index and intelligence, but now he has developed theories in the field of temperament and physique.

Unlike Kretschmer, Sheldon does not work with already diagnosed cases of temperamental disorders, but with normal college students. His search was for the basic factors in determining the relation between physique and temperament.

Sheldon has published two books which attempt to set forth his theories. The first book published in 1940, is called "The Varieties of Human Physique", and in it he elaborates in great detail his methods of

"identifying and measuring the elemental or primary components of human variation."(1)

His second book, "The Varieties of Temperament" * was written before the work on physique, but was not published until 1944. This book he describes as

"presenting a system for treating the problem of individual differences in terms of what appear to be basic components

(1) Sheldon W.H. "The Varieties of Temperament," p.6.

NOTE: An excellent summary of both books and the results of his findings are given by Sheldon in the first part of his book "The Varieties of Temperament". Future quotations are from this book.

of temperament. These components are in turn tied back to and interpreted in terms of basic components of morphology."(1)

The results of the relation between physique and temperament are presented in his second book. In this work Sheldon says that constitutional psychology seeks a basic taxonomy of human beings. It asks for a frame of reference against which individuality may be set off, classified and scaled - a frame of reference simple enough to be comprehensible, yet full enough to account for most varieties of human differences. Since the complexity of human beings makes it advisable to subdivide the problem in such a way that separate attacks can be made at different levels, he has attempted to devise a taxonomy of structure and a taxonomy of function.

The taxonomy of structure was developed in his book "The Varieties of Human Physique". This he regards as the statics of constitutional psychology. The taxonomy of function he limits to temperament and by temperament he means, roughly, the level of personality, just above physiological function and below acquired attitudes and beliefs. It is the level where basic patterns of motivation manifest themselves. The study of the taxonomy of function he regards as the dynamics of constitutional psychology for he says,

(1) Sheldon W.H. "The Varieties of Temperament". p.3.

"When structure takes on function, when man gets up and moves around, expressing his desires and motivations and interacting with his fellows, then he becomes a dynamic organism... viewed in this fashion physique and temperament are clearly two aspects of the same thing and we are not surprised if we are led to expect that the dynamics of an individual should be related to the static picture he presents. It is an old notion that structure must somehow determine function."(1)

Having failed to arrive at a useful taxonomy of structure through anthropometric techniques alone, Sheldon resorted to photography and devised a procedure in which the individual was photographed in a standardized posture from the frontal, lateral and dorsal positions on a single film. When 4,000 photographs of non-negro males were ordered in one place and arranged experimentally in series, it was found that a certain orderliness of nature could be made out by the unaided eye - there were no types but obvious dimensions of variation. By further trial and error arrangement and by measurement techniques from the photographs, three basic components were found, and Sheldon was unable to find a fourth structural variant that was not obviously the result of a mixture of the three. These three basic components he named endomorphy (round, broad and dominant tissue derived from the embryonic endoderm),

(1) op. cit. p.4.

mesomorphy (muscular and dominant tissue derived from the mesoderm), and ectomorphy (lean, angular and dominant tissue from the ectoderm).

Numerically, if each component is rated on a seven-point scale, with 1 for the lowest degree and 7 for the highest, an extreme endomorph can be expressed as 711, an extreme mesomorph as 171, and extreme ectomorph as 117, while persons with fairly equal admixture of the components would be somewhere about 444. The rating can also be shown graphically by means of an equilateral triangle with extreme scores at the apices. There are theoretically 343 numerical ratings, but in practice only 76 combinations occur in large samples, and of these, only 19 are at all common. This combination of three components gives a person's somatotype and is worked out from 17 diametric measurements from photographs of the person in the standard positions. Sheldon has devised a machine whereby the measurements are entered and the required somatotype produced.

Of these components Sheldon says that, "as they occur in nature they are single continuous variables. The designation of the somatotype merely serves the purpose of bracketing a physique within certain defined boundaries. When the somatotype is determined, analysis of the physique is only begun, but the somatotype provides the basis for a

morphological taxonomy that is both comprehensive and statistically manipulatable. The bugaboo of types disappears in a continuous distribution in which every physique has its place, and the establishment of norms becomes a routine."(1)

In adding further to a person's somatotype, Sheldon inquires into such secondary variables as skin texture, aesthetic harmony of structure, racial characteristics, pigmentation and many other similar factors. Two further ratings are added to a person's numerical rating. These are evidence of dysplasia (variation of body type from body sector to body sector, e.g. mesomorph torso and ectomorph legs), and "g" index of gynandromorphy (degree of femininity in males, masculinity in females). Thus each individual can be briefly described by a set of three numerals, an indication of dysplastic factors, and a high or low "g" index. Sheldon claims to have trained in quite a short time, somatotypers who work subjectively by observation, and whose findings correlate very highly with those obtained by objective methods.

In his taxonomy of function Sheldon again found it necessary to determine the first-order components present in temperament. The method that he found that finally yielded results was a variation on the technique of factor analysis applied to quantitative ratings on a group of

(1) op. cit. p.7.

traits. He discovered that he was able to standardize the description of 60 traits - twenty in each of three correlated clusters - which collectively made up a scale for measuring what appeared to be three primary components of temperament. Within each of the clusters the traits are positively correlated, while all the intercorrelations between traits not of the same cluster are negative.

Sheldon designates these three correlated groups of traits; viscerotonia, somatotonia, and cerebrotonia. A brief description of these primary components of temperament may be summarized as follows:

1. Viscerotonia:

"In its extreme manifestation this component is characterized in general relaxation, love of comfort, sociability, conviviality, gluttony for food, for people and for affection. The motivational organization is dominated by the gut; the personality seems to centre around the viscera. The digestive tract is king and its welfare appears to define the primary purpose of life."(1)

2. Somatotonia:

"This type is characterized by a predominance of muscular activity and of vigorous bodily assertiveness. The motivational organization seems dominated by the soma. These people have vigour and push."(2)

(1) op. cit. p.10.

(2) op. cit. p.10.

3. Cerebrotonia:

"The last component of temperament exhibits a predominance of the element of restraint, inhibition and desire for concealment. Cerebrotonic people shrink away from sociability as from too strong a light."(1)

Having found that there were only three basic components for temperament, Sheldon proceeded to rate a person's temperamental make up by assigning a rating to each of the components on a seven-point scale in a similar manner to the method used in his taxonomy of structure. Thus we would find the numerical index of an extreme example of viscerotonia to be 711, for a somatotonic type 171, and a cerebrotonic type to be 117.

In a study extending through a period of five years, Sheldon was able to analyse 200 young men, both morphologically and temperamentally, measuring in addition to the primary components, a number of apparently secondary "temporal characteristics". Sheldon found correlations of about + .80 between the two levels of personality (morphological and temperamental) and he concludes that these correlations indicate that temperament may be much more closely related to the physical constitution than has been usually supposed.

Nevertheless Sheldon cautions that the correla-

(1) op. cit. p.10.

tion between the two levels is by no means perfect, and from the point of view of individual analysis, it seems to be the disagreements, or inconsistencies between the physical and the temperamental pattern, that throw most light on behaviour.

Sheldon considers that roughly there are at least four general factors at work in the development of personality.

(a) The total strength of endowment in each of the three primary components.

(b) The quality of such endowment.

(c) The mixture of components, or their order of relative strength, and

(d) The incompatibilities between morphology and manifest temperament.

From this very brief outline of Sheldon's work it would appear that he has demonstrated a relationship between the two levels of personality as he defined them. The most questionable aspect of Sheldon's theories appears to be that concerning his "dynamic" side of personality, or temperament. Any trait that has to be rated subjectively cannot always produce consistent results and so there is the possibility of different ratings being produced by different operators. For example, a temperamental rating of 343 given by one estimate may be 232, or 454 by other estimates. These variations in estimates will produce

differences in the amount of correlation with the "static" aspect of personality.

A factorial examination of Sheldon's temperament types was undertaken by Adcock(1) and he suggests that independent investigation of the correlations should be made on the basis of ratings by a sufficient number of raters not familiar with Sheldon's scheme. It would appear that Sheldon had in mind the threefold classification before he commenced work on body types and desired a threefold classification to fit in with the three temperament types.

Adcock sums up his examination by saying that since Sheldon's components correlate moderately highly they cannot be regarded as independent factors. He adds that independent investigation of the correlations Sheldon gives, does in actual fact indicate two factors for each component, but gives four factors instead of three suggested by the mathematical approach.

Sheldon's subjects were all male college students so that his findings would apply only to this restricted sample. Much more work has to be done with people of all types, ages and sex before Sheldon's findings can be applied to people as a whole. However Sheldon is the first to realize the limitations of his study and considers them only as a contribution towards further development.

(1) Adcock C.J. "A Factorial Examination of Sheldon's Types" Reprinted from Jour. of Personality, Vol. 16 No. 3 March, 1948.

At the present time Sheldon is working out a taxonomy of structure for women with the intention of relating it to his taxonomy of function.

5. Summary of Part Two:

Part Two has outlined the attempts of investigators to link physique and temperament. If we are prepared to accept the methods of estimating physique and temperament the various investigators use, then we can tentatively hold that in the two major researches (Kretschmer and Sheldon), they have proved what they set out to prove. There does appear to be some relationship between various kinds of temperamental disorder and body types, though we are not justified in applying these limited findings to mankind as a whole as Kretschmer does. Similarly with the work of Sheldon, because we were able to question his restricted sampling, his method of estimating temperament, and his preconception - as Adcock suggests - that temperament would link with three body types, then this much must limit us in the acceptance of his findings.

With far more extensive surveys, with more efficient and accurate methods, it may be that a correlation or a relationship between temperament type and body type will be demonstrated.

PART THREE

SOME NEW ZEALAND INVESTIGATIONS:

This final part of the survey will review briefly some of the work in the field of physical and mental relationships attempted in New Zealand.

In 1924 a large-scale survey was undertaken by the Health Department and Education Department[1], in which twenty thousand primary school children were measured physically and mentally.

The children were divided into three groups - superior, average and inferior intelligence. In the report, just what the demarkation point was between the three levels of intelligence, the authors (Ada Paterson, Director Division of School Hygiene, and E. Marsden, late Assistant Director of Education) do not state. The intelligence score was derived from general tests, including and largely dependent on tests in reading, comprehension and arithmetic reasoning. The average height and weight of the superior group at ages 11-14 was found to be uniformly greater than those of average and still more markedly so for those of inferior intelligence. The figures found by Paterson and Marsden are given in Tables Sixteen and Seventeen.

(1) Appendices to the Journal of the House of Representatives H-31, 1927: 54-63.

In dealing with the measures of height and weight the investigators used the arithmetical average for they found that the average, median and mode did not vary more than 0.15 inches for height, and the average was in excess of the median for weight by 1½ lbs.

The total result of the survey showed that the average height and weight of children of good mental attainment was greater than those of inferior ability.

Reviewing their findings in more detail, Paterson and Marsden state that when mental attainment was considered in relation to the occupation of the father, it was found that children of the professional classes show superiority, the superiority being most marked for the children of doctors and journalists. This superiority they explain by better socio-economic conditions.

The authors found what appeared to be inconsistent results for country children. These children were on the average taller and heavier than town children, and yet as far as their "academic" tests determined, they were intellectually inferior. This apparently contradicted the findings that increased height and weight, on the average, go with increased mental development. Nevertheless, when the authors considered either the town or country group by itself, their conclusion held good. The real interpretation they thought might possibly be that individuals above average in academic attainment, but of smaller

physique, who were therefore not naturally endowed as manual labourers, tend to migrate towards the city. Town life, they believed contributed towards the result. However, in the survey, the proportion of country children was considerably less than town children and so the sample was not truly representative of New Zealand school children.

TABLE SIXTEEN: (Heights in Inches According to Intelligence) after Paterson and Marsden.

NEAREST AGE (A)	INTELLIGENCE		
	INFERIOR (B)	AVERAGE	SUPERIOR
11	54.4	55.3	56.0
12	56.2	56.6	57.0
13	57.0	58.4	59.2
14	59.8	60.1	60.5

NOTE: The degree of intelligence inferiority of children as based on I.Q. and referred to in column (B) is not quite the same for column (A).

TABLE SEVENTEEN: (Weights in pounds According to Intelligence) after Paterson and Marsden.

AGE (A)	INTELLIGENCE		
	INFERIOR (B)	AVERAGE	SUPERIOR
10 yrs. 6 mos. to 11 yrs. 5 mos.	70.9	72.1	75.0
11 yrs. 6 mos. to 12 yrs. 5 mos.	78.1	79.0	80.2
12 yrs. 6 mos. to 13 yrs. 5 mos.	86.2	88.0	89.6
13 yrs. 6 mos. to 14 yrs. 5 mos.	94.0	94.7	97.5

Parkyn(1) quotes the investigations of Sceats at Waitaki Boys Junior High School, during 1941 and 1942. During those years, the twenty-three boys who had Otis I.Q.'s of 120 and over were on the average, one inch over the norms for height given in the 1935 Tables of Ht-Wt. prepared by the New Zealand School Medical Service. The boys ranged in age from ten years eight months to fourteen years two months, most of the boys being twelve or thirteen year olds. In weight they were four pounds above average, using Wetzel's Developmental Age Norms as an index of physical development.

As the number of cases is small, and no one school can be regarded as representative of all New Zealand, Parkyn(1) believes that it is not possible to generalize from

(1) Parkyn G.W. "Children of High Intelligence" (N.Z.C.E.R. Wellington, 1948) .p.45.

(2) op. cit. p.46.

the results. Nevertheless it is possible to see that the tendency for children of superior mental ability to be superior in height and weight, is borne out.

An investigation was carried out by the writer in February and March 1950, with 240 boys of the Intermediate Department, Rongotai College, Wellington.

Otis I.Q. scores were available from the results of tests given to all boys in February. Along with intelligence tests, each boy had a test of arithmetic reasoning, and reading comprehension. The teachers who administered the tests have had considerable experience with the Otis test and the scores can be taken as reasonably accurate. Physically, the boys were measured in school shorts, without shoes (Paterson and Marsden weighed their children in school clothes, without shoes) and the physical measurements were obtained accurately.*

In order to provide a suitable comparison with the method Paterson and Marsden used, namely dividing children into three mental types - superior, average and inferior - and comparing heights and weights of these groups, the same methods were carried out in this investigation. The dividing lines of mental ability were as follows;

* NOTE: Messrs. W.T. Avery & Co. kindly lent the writer a new type of balance-scale which recorded weights to half ounces, and at the same time the height of the boy could be read off from a special height scale attached to the weighing machine. In the weighing of the boys, weights were taken to the nearest pound and heights to the nearest quarter inch.

superior, above 115; average, 85 to 115; and inferior, 85 and below. The majority of cases were in the average or superior group, there being only 9 cases in the inferior group. In an "attached" boys' intermediate school it is most unlikely that a normal distribution of I.Q.'s will be found, but nevertheless the sample provided by the boys of the school studied, demonstrated that the tendency found by Paterson and Marsden, existed. As the number of cases used was fairly large and as the arithmetic average was used throughout, it is reasonable to assume that any inaccuracies arising from the Otis Intermediate Intelligence Test, or from the heights and weights given will be minimised. Further difficulties were encountered in using boys of an "attached" intermediate school. There were very few boys in the 14 year old group, most boys of this age being in the third and fourth forms. The boys aged 14 and still in the intermediate school made up just over half the numbers of the inferior group for the whole intermediate school. The results of the investigation are given in Tables Eighteen and Nineteen.

TABLE EIGHTEEN: (Height in Inches and Intelligence)

AGE	INTELLIGENCE		
	INFERIOR	AVERAGE	SUPERIOR
10	No Cases	54.0	55.5
11	No Cases	57.0	58.0
12	57.5	58.0	60.0
13	60.0	60.0	61.0
14	61.5	No Cases	No Cases

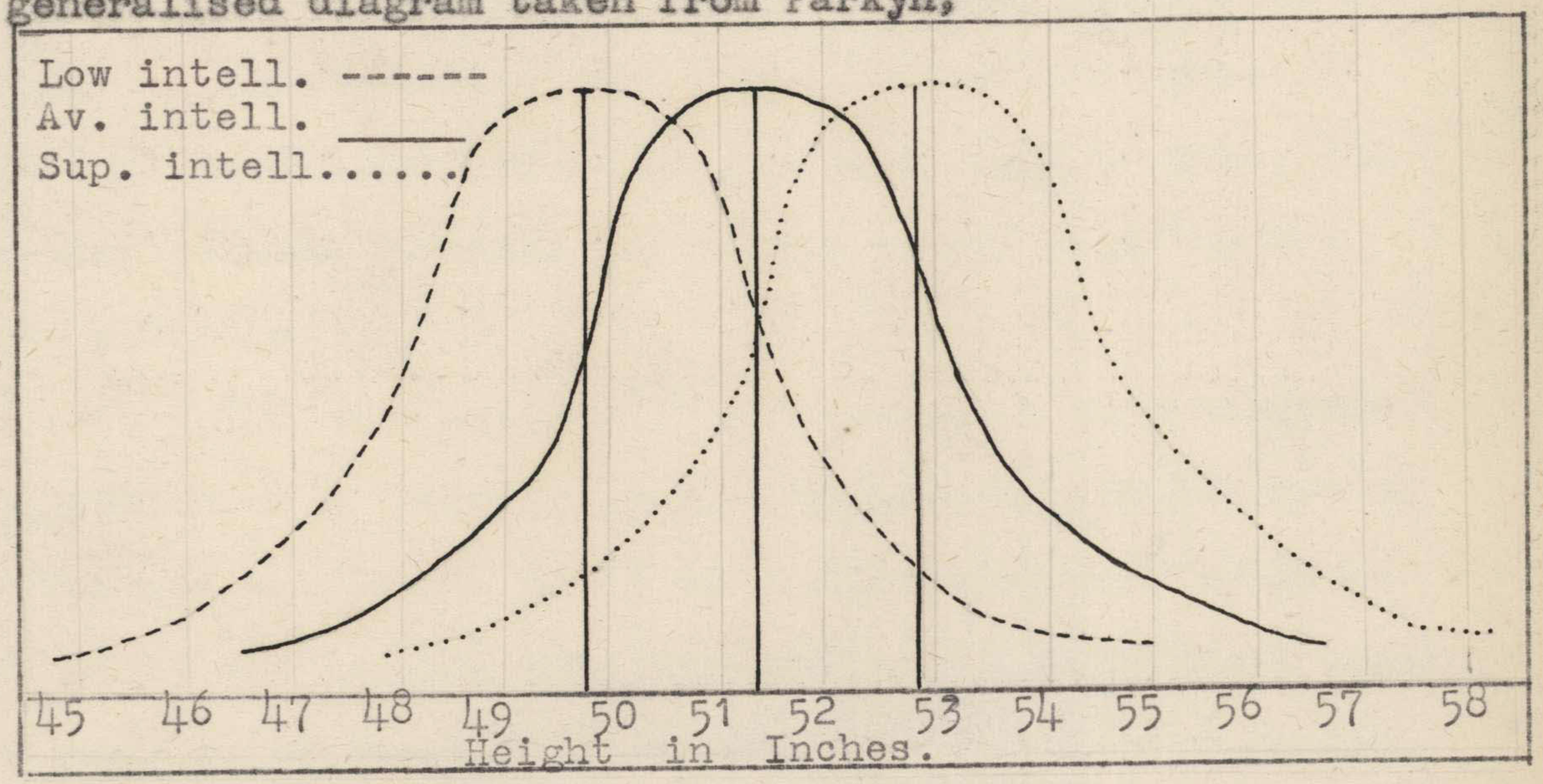
TABLE NINETEEN: (Weight in pounds and Intelligence)

AGE	INTELLIGENCE		
	INFERIOR	AVERAGE	SUPERIOR
10 yrs. 6 mos. to 11 yrs. 5 mos.	No Cases	79.0	80.0
11 yrs. 6 mos. to 12 yrs. 5 mos.	78.0	81.0	84.0
12 yrs. 6 mos. to 13 yrs. 5 mos.	90.0	91.0	92.0
13 yrs. 6 mos. to 14 yrs. 5 mos.	95.0	96.0	No Cases

These tables show the relationship between height, weight and intelligence to be such that the child of superior intelligence tends to be heavier and taller than the child of average or inferior intelligence. It is of interest to note that the figures given in Tables Eighteen and Nineteen for each age group are slightly higher than

those given for the same age groups by Paterson and Marsden. At first sight one might be tempted to conclude that the average child of today is slightly taller and heavier than the average child in 1924. It may be that the present-day child is heavier and taller than the child of 1924, but the superiority revealed in the figures of Tables Eighteen and Nineteen is largely due to the fact that they refer only to boys, whereas the figures given by Paterson and Marsden refer to boys and girls, and hence one would expect the average to be slightly less than for boys alone.

Whenever one deals with any measures of human development there must always be considerable overlapping between various groups. This is demonstrated in the generalised diagram taken from Parkyn,(1)



(1) op. cit. p.16.

and exhibits effectively the findings of this survey that those of superior mental ability tend to be above average in height and weight, while those of average mental ability tend to be superior in height and weight to those of inferior mental ability.

C O N C L U S I O N

SUGGESTIONS FOR FURTHER RESEARCH.

It is perhaps fitting that this survey should conclude by making reference to some factors and researches that may lead to a better understanding of the relationship between physical and mental growth.

Dearborne and Rothney[1] believe that more fruitful results may be yielded through the use of composite measures of physical growth. They instance the manner in which more effective scales for measuring intelligence were built up by combining a variety of measures, and believe that if the fluctuations in rate of growth of the different parts of the body could be equalized by averaging a large number of measurements, then a more reliable measure of physical development might be obtained, and, in turn, the studies between physical and mental growth would become more reliable.

The same writers[2] put forward a very interesting suggestion of a "nervous age". Possibly the derivation of a "nervous age" would be of more value than such measures as height and weight, when compared with intellectual growth. It would be reasonable to suppose that the nervous system, which maintains such an intimate relation with changes in

(1) op. cit. p.280.

(2) op. cit. p.281.

the body as a whole, may itself grow at some rate which is a composite of the rates of growth of the separate segments and organs of the body.

Dr. Karlin of the Jewish Hospital, Brooklyn, New York believes that the defective or retarded development of the myelin of the cortical speech areas is the primary cause of stuttering. The myelin sheath is considered to have an insulating function. A nerve fibre which has not been completely myelinated may transmit impulses, but the resulting action will lack precision and fine co-ordination.

He says,

"Myelinization is regarded as correlated with function. For instance, an infant begins to maintain equilibrium and perform co-ordinate movements such as crawling and standing only when certain tracts begin to myelinate. In the brain, the various cortical areas do not myelinate at a uniform rate. The myelinization of the speech areas in the brain is a comparatively late process in cortical development."(1)

The secondary cause of stuttering Karlin believes is due to emotional stress, which acts as a catalytic agent in producing stuttering. The combination of these organic and psychological factors prompts Karlin to call his theory of the cause of stuttering a psychosomatic one.

(1) Karlin, I.W. "Stuttering," The American Jour. of Nursing, Jan. 1948. p.43.

Enough of Karlin's work in this field has been given to show that as neurological studies advance, a more intimate relationship between physical and mental growth may be revealed through the connecting link of the nervous system.

Glandular therapy has been demonstrated to have some beneficial effect on mal-functioning of particular glands in children. More recently, mental efficiency has shown some improvement when diet and nutrition have been modified. Of particular note in this field is the work that has been carried out with glutamic acid.

Protein is an important element in diet. It is the most important source of nitrogen, and the body relies mainly on it for energy. In the human organism, animal and vegetable proteins are taken into the body, broken down through the action of enzymes into amino acids, and then reassembled from these into new types of proteins. Among the aminos one of the most important is glutamic acid; it is neither fat nor water-soluble, and is the only one of the aminos known to be metabolized - altered in its character- by brain tissue.(1) A possible cause of low intelligence in infants can be a diet on the part of the mother so gravely deficient in certain essentials as to cause damage, or atrophy, or even destruction of the foetal brain. Import- ant experiments to find out the effect of injections of

(1) Weil-Maeherbe H. "Studies on Brain Metabolism Mechanism of Glutamic Acid in Brain." Biochem. Jour. 30: 1936, p. 665.

glutamic acid on mental activity have been carried out.

The most notable investigators in this field have been Zimmerman, of Columbia University, and his associates, Burgemeister and Putnam of the Neurological Institute in New York City.

The first experiments(1) were with rats which had glutamic acid in specified amounts included in their diet over a period of time. The test of increased brain activity was the ability to learn a complicated maze. In all cases, rats that had been fed glutamic acid solved the problem of the maze in substantially shorter times than was true of rats in a control group which had not been given this acid. Some of them were able to learn the maze in half the time. The ability to make correctly successive choices in the maze went up a maximum of more than 200 per cent.

Since then, similar experiments(2) have been conducted on a group of human beings, including children of various ages, some of whom were mentally deficient, while others could be classified as mongols. Glutamic acid certainly appeared to increase mental efficiency. The dose was gradually increased until a maximum was reached which gave definitely increased mental and physical activity

(1) Zimmerman F.T. and Ross S. "Effect of Glutamic Acid and other Amino Acids on Maze Learning in the White Rat". Archiv. of Neuro. and Psych. 51: 1944, p.446.

(2) Zimmerman F.T., Burgemeister Bessie B., and Putnam T.J. "A Group Study of the Effect of Glutamic Acid upon Mental Functioning in Children and Adolescents". Psychosomatic Med. 9: No. 3. May June 1947.

without passing the border to excessive restlessness and excitability. Then the dose was maintained or reduced.

These experiments were not able to show when the effects were greatest, or how long the increase in mental efficiency would last. Later work has helped to clarify these points and has also shown that mongols not only increased in mental efficiency but showed improved skin and hair qualities. Zimmerman and his associates say,

"It is apparent that in the majority of cases the greatest rise in intelligence quotient occurred during the first six months of treatment, and that a limit, or ceiling, was usually reached in about one year."(1)

Table twenty shows the effect of glutamic acid treatment on 252 mentally deficient children.

(1) Zimmerman F.T., Burgemeister Bessie B. "The Techniques, Dynamics and Permanency of the Glutamic Acid Treatment of Mental Retardation." Education, 70: No. 7, March 1950, p.412.

TABLE TWENTY: (The Effect of Glutamic Acid Treatment on 252 Mentally Deficient Children) after Zimmerman and Burgemeister.

BEFORE GLUTAMIC ACID TREATMENT						AFTER 6 MOS. OF GLUTAMIC ACID TREATMENT				
TEST	AV. AGE	N	M.A.	I.Q.	S.D.	M.A.	I.Q.	S.D.	CHANGE M.A. +	CHANGE I.Q. +
Stanford	11 yrs.	252	7 yrs.	59.6	19.05	7 yrs.	64.69	19.95	10 mos.	5.08
Binet	8 mos.		0 mos.			10 mos.				

As to the permanency of the treatment the investigators say,

"Sufficient time has not elapsed to determine accurately the permanency effect of glutamic acid when glutamic acid is discontinued. To date many cases are holding remarkably well, with the loss in re-test intelligence quotient being negligible, ... from the evidence to date, however, it appears that permanency effect is related to the amount of original gain under treatment and to the duration of therapy itself."(1)

The work of Zimmerman and his associates may eventually provide many indications of new directions in which investigators of physical and mental growth may look. When the chemical functioning of the brain is more fully understood, the relationship between physical and mental growth may be revealed.

Studies of pre-school children are almost completely lacking. It is known that physical and mental growth during this period are particularly rapid, and suitable studies whereby chronological age is effectively controlled, may reveal relationships that are significant for this period and point towards channels of investigation for other age-groups.

Man's knowledge of his physical and mental functioning is by no means complete and as investigations into

(1) op. cit. p.412.

all aspects of development advance, it is possible that the relation between physical and mental development will be revealed.

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LIST OF ABBREVIATIONS USED

A - J: Appendices to the Journal of the House of Representatives.

Archiv. Dis. of Childhood: Archives of Diseases of Childhood.

Archiv. of Neuro. and Psych: Archives of Neurology and Psychiatry.

Archiv. of Psych: Archives of Psychology.

Annals of Eug: Annals of Eugenics.

Biochem. Jour: Biochemical Journal.

Harv. Monog. in Educ: Harvard Monographs in Education.

Jour. of Ab. and Soc. Psych: Journal of Abnormal and Social Psychology.

Jour. of Appl. Psych: Journal of Applied Psychology.

Jour. of Educ. Psych: Journal of Educational Psychology.

Jour. of Expt. Psych: Journal of Experimental Psychology.

Jour. of Pers: Journal of Personality.

Jour. of Pers. Res: Journal of Personnel Research.

Jour. of Psych-Asthenics: Journal of Psycho-Asthenics.

Rev. of Educ. Res: Review of Educational Research.

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