IMPLICATIONS OF THE RELATIONSHIPS BETWEEN INTELLIGENCE AND PHYSICAL FITNESS

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TABLE OF CONTENTS

INTRODUCTION

The primary purpose of this paper is to survey the literature with regard to tests concerned with the relationships between intelligence and physical fitness. The writer felt that a general background relative to the scope of the problem would be beneficial to her understanding. For this reason, the paper includes a brief historical background on the concept of mens sana in corpore sano and a general discussion of psychological and physical fitness testing. The paper is expanded to delve superficially into the physiological basis of intelligence, mental and physical growth correlations, and superior and inferior intellectual deviates. These three areas seem to have strong implications for education.

CHAPTER I

A BRIEF HISTORICAL BACKGROUND OF MENS SANA IN CORPORE SANO

Greek civilization was among the first to consider educational problems and philosophy; therefore it is natural to look to the Greeks in consideration of the problem of the relationship of physical education to intellectual education. (96)

According to Van Dalen (96:43), "Individual excellence was the goal of all Greek education." During the Homeric age there were no formal educational institutions; educational aims were in an embryonic stage of development. Even then, mind and muscle were regarded as the perfect component elements of education in preparing the individual for service to the state.

The city state of Sparta deviated from the twofold purpose of education in Athens which developed the "man of wisdom" and the "man of action." The single objective of Sparta was the development of the "man of action," and the body was trained and conditioned for a glorious military end. (96)

Physical education may have achieved its zenith in Athens; it was an accepted, integral part of education. Qualities to form the harmoniously blended Greek personality were developed through physical means. Van Dalen (96:55) states, "The early Athenian ideal was to encourage the individual to develop all capacities of his mind and body into a well-proportioned and harmonious personality capable of serving the state effectively in both war and peace."

In contrast to the Greek ideals, the monastic education during the Dark Ages required that the body be completely subjugated to the development of the spirit. Monks competed with each other in thinking of ways to mortify the flesh. Their point of view was expressed by St. Bernard, "Always in a robust and active body the mind lies more soft and more lukewarm; and, on the other hand, the spirit flourishes more strongly and more actively in an infirm and weakly body." (96:102)

From the eleventh to the fifteenth centuries there was a gradual intellectual awakening in the Christian world; many schools and universities were established, but physical education was not sanctioned as a part of the curriculum. Scholasticism was a narrow and exacting discipline.

"Many of the seeds of progress sown in the Middle Ages came to bloom in versatile and creative efforts between the fourteenth and seventeenth centuries." (96:133) The unfolding of creative spirit released mental activity from the limited areas of theology and encouraged the free development of the individual's aptitudes.

The men of the Renaissance became intrigued with the ideas from the East and were stimulated by the rediscovery of Aristotle's writings and by the establishment of universities. Italy was the nursery of this movement which was called Humanism. According to Van Dalen (96:135), "The humanists desired a physically sound youth with an alert and fertile intellect; a cultured gentleman who was socially adept, skilled in arms, learned in letters, sensitive to beauty, and the apogee of proper and natural manners."

Alberti, a scholar of the Renaissance period, believed that the body nourished the mind and that one defect in the corporeal being would in turn damage the corresponding mental power. (96)

Another man of the Renaissance, Vittorino da Feltre, who has been called "the first modern Schoolmaster," established the first great school of the Renaissance in the service of the Gonzaga family at Mantau, Italy. As a Humanist, Vittorino's aim was to graft ancient learning upon the stock of Christian training. He regarded regular exercise in all conditions of weather as the foundation of health, and health as the first necessity of mental progress. Modern Italian critics ascribe to Vittorino an anticipation of the more important doctrines of educational theory: dependence of mental upon physical conditions, logical order of lessons, choosing logical stimulus, careful observation of the child's mental powers. (101:64)

In the scholastic and later humanistic schools, physical development of students had been given very little consideration. In the sixteenth and seventeenth centuries, Verbal Realists - Juan Luis Vives, Francois Rabelais, and John Milton - awakened pedagogical interest in physical education. All their writing was done on a philosophical level; the ideas were not incorporated by the schools of the day, but their suggestions became a part of the heritage that was to influence pedagogical thinking for some generations. (96)

A Social Realist, Montaigne, advocated a system of education that was a revolt against the bookish instruction during the Renaissance. (71) He suggested that education must be liberal and must prepare the pupil

for life as a gentleman. Physical education was formally acknowledged by Montaigne as a prerequisite for the development of man, for through the physical, man's essential mental and moral powers were to be activated. (96) Montaigne (66:36) wrote, "It is not enough to fortify his soul; you must also make his muscles strong. The mind will be oppressed if not assisted by the body; it is too much for her alone to discharge two offices. I know very well how mine groans under a tender and delicate body that eternally leans and presses upon it."

Sense Realism, or the theory that ideas are acquired through the senses, naturally insisted that education be concerned with the body. The thesis of Sense Realism was that to learn most effectively, man needs sound physical equipment. An interest in the physiology of the mind and body opened the door to improvement of physical education. According to Van Dalen, Roger Bacon stated (96:184), "There seemeth to be a relation or conformity between the good of the mind and the good of the body." Richard Mulcaster (96:185), a strong advocate of physical education, taught that it was necessary to "consider the strength of his bodie, no lesse than we do the quicknesse of his witte." John Amos Comenius (96) saw play as a natural educational phenomenon and cautioned that restraining it would cause deficiencies in the harmonious development of the mind and body.

In the seventeenth century John Locke took the course of the "middle of the road disciplinarian." (96) Locke allowed nothing to be knowledge that was not acquired by the perception of the intellect. Since in children the intellectual power is not yet developed, Locke believed

that knowledge was not within their reach. He contended that the educator could prepare children for the age of reason by caring for their physical health and by teaching formation of good habits. His road to health and welfare was through a hardening and disciplining process. He has much to say about hygiene but little about the value of play. (71) After dealing with the health, the educator should concern himself with virtue, wisdom, and good breeding in that order. To Locke, learning was secondary in childhood. (1) Locke (58:6) states, "A sound mind in a sound body, is a short, but full description of a happy state in this world; he that has these two, has little more to wish for; and he that wants either of them, will be but little the better for anything else." Furthermore, according to Aaron, Locke (1:290) believed that "Dejected minds, timorous and tame and low spirits are hardly ever to be raised and very seldom attain to anything."

Comenius and Locke had proclaimed an education according to nature, but both had submitted the child to authority: Comenius to the will of the Bible and Locke to the will of society.

Jean Jacques Rousseau desired that the child be free from every bondage. Rousseau held such enlightened concepts of physical education that embraced ideals as investing the child with adequate motor skills; developing his physical environment; providing him worthy recreation; hardening his body to meet emergencies of every sort; and teaching him to work and play with his fellow. He believed in a general, democratic and universal education.(96) In discussing the dependence of the intellectual on the physical, Rousseau (85:121) states, "In proportion

as a sensitive being becomes active, he acquires a discernment proportionate to his strength; it is only when he possesses more strength than is necessary for his preservation that he develops those speculative faculties which are adapted to the employment of his capacity to other purposes." Rousseau found difficulty in determining when an activity ceased to be of physical value and became intellectual. No educational theorist had conceived of mind and body as being so nearly the same thing as had Rousseau. (75)

Among the founders of the Science of Education was Pestalozzi who tried to "psychologize" education. His study of the child was through actual contact and this became the basis for education procedures. Pestalozzi noted that after playing in open air for a time, a boy could concentrate on his studies for an unusually long period. He felt that the competitive instinct was a means of accomplishing the harmonious development of mind, heart, and body. Pestalozzi believed that Nature uses physical and mental faculties alternately for the development of each other. (75) One of his underlying principles of education was that "The practice of purely mechanical exercises which are not the result of an intellectual stimulus has no part in human education; such exercises tend to blunt intellectual and moral power." In other words, the child must associate himself with what he is doing. (37:117) Among Pestalozzi's many contributions to education was the stimulus that his theories gave to the professional preparation of teachers, who were required to have special training. (96)

In the United States the prime figure in the initiation of develop-

mentalism movement, the shift from curriculum to emphasis on the child himself, was G. Stanley Hall. His unique contribution was the creation of the science of adolescence. He firmly believed in play as one of the best forms of education in modern civilization. (96) Hall stated that the muscles come before mind, will comes before intelligence, and that sound ideas rest on a motor basis. (40)

The educational philosopher, John Dewey, was the spokesman for social education and generally he was considered to have had wider influence on education in this country than any other one person. His philosophy was to "learn by doing." He felt that education should be life; he was therefore concerned with living in a society. Social education was firmly established in the early 1930's when acceptance of the educational value of recreation in the schools was realized. (96) Dewey felt that it was impossible to state adequately the evil results from dualism of mind and body. He listed three reasons. First, the body becomes an intruder in a school to train the mind only, an evil with which to be contended. The chief cause for remarkable achievements of Greek education was that it was never misled by false notions into an attempted separation of mind and body. Secondly, even with respect to lessons which have to be learned by the application of the "mind," some bodily activities have to be used. Senses and muscles are used as external inlets and outlets of the mind. Third, direct occupation with things throws emphasis on <u>things</u> at the expense of <u>relations</u>. Observations and ideas would be much keener and more expansive if we formed them under conditions of experience which required us to use judgment. (22)

The philosophy of Dewey had great influence on physical education in other countries. (96)

Hetherington (47) cited sociological reasons for the snail's pace at which physical education had been accepted in good standing in American schools. He expressed belief that public opinion was an inhibiting influence because of powerful prejudices having root in asceticism, scholasticism, and puritanism. Hetherington also believed that the common American concept of play was synonymous with "fooling." The traditional educational thought, research, and professional training had been directed to the intellectual side of education and its psychological foundations.

The advent of physical education in the American school curriculum came in the form of drills and gymnastics from Germany and Sweden which were uninviting to students in the United States.

Hetherington designated five movements as Reconstructing Movements for physical education in the United States. The first one was the athletic movement which took root in the colleges as it swept across the continent in the 1880's and 1890's. The second, the playground movement, began formal organization in 1906. This movement was a counterpart to industrialization. Next was the educational recreation movement, such as the Boy Scouts of America. This type activity delved into many areas - group membership, group leadership, self-protective skills - that are essential elements in physical education procedures. "Health through exercise" became the slogan for the fourth movement and was taken up by the physical culturalists. The fifth movement and the deciding factor

for physical education came with World War I induction examinations and the subsequent physical efficiency campaigns. Conditions of poor physical fitness were made known to the public and aroused public conscience.

These movements have developed a public opinion of a body of ideas, sentiments, convictions, and faiths concerning the big essential elements in a program of physical education which are characteristic of the spirit and life of America.

The identification of physical education with education exists today because physical education made two important decisions. In one decision it changed its purposes and modified its programs of mass calisthenics and formal drill; in the other decision it accepted the responsibility given by wise educational leadership to be interested in and concerned with the whole program of the school or college.

It was understood that physical education contributed to the education of the individual and the citizen. This contribution comes from many areas which may be organized as follows: 1) the development of organic systems, 2) development of neuro-muscular skills, 3) development of interest in play and recreation, and 4) development of standards of behavior. (99)

As with other phases of education, the importance of physical education has fluctuated through the centuries, varying with the changing times. From the Athenian Greeks to the despairs of the Dark Ages, through the Renaissance and its subsequent movements, to the World Wars and education for life adjustment, physical education has evolved with well-defined goals and purposes. The mind-body controversy has raged in

varying degrees in educational circles from the outset of organized education. Some philosophers of education have even maintained that physical activities are important not only for the well-balanced life but also for their relation to mental activities. For the most part, these philosophies were formulated before the age of tests and measurements, but the philosophers were no less sure in their beliefs for their lack of scientific evidence.

CHAPTER II

TESTING IN PHYSICAL AND PSYCHOLOGICAL AREAS

PSYCHOLOGICAL AREAS

Because of the long philosophical history of the relation of physical and mental traits, it is not surprising that in the early investigations of "intelligence," bodily characteristics and signs were designated as important in determining an individual's intellectual status.

Boynton (8:149) has said that "the testing of intelligence is probably as old as human intelligence itself." Even in the essay, Physiognomonia, written in the fourth century B. C. under the influence of Aristotle, there are many references to the opinions of previous authorities. The idea that the key to personality diagnosis might be found through a careful study of bodily conformation and facial characteristics was not new even with Aristotle and his followers. (36)

Belief in physiognomy was general throughout the Middle Ages. Little of scientific importance was added to the Aristotelian outline until the close of the eighteenth century when Franz Joseph Gall hypothesized that personality traits of all kinds may be inferred by careful examination of the skull. The theory seemed reasonable since by that date there was the belief that the predominant role of the brain was to control and direct behavior. The logic, accorded to physiognomy, indicated that since the skull contains the brain, the characteristics of the organ might be judged by its outside covering. (36)

Goodenough (36:39) states, "Although the early search for physical signs of mental characteristics was largely unproductive of direct results, it nevertheless played an important part in the early history of mental testing. The fact that its premises were wrong, its methods unsound, and the conclusions reached often absurd is of small importance in comparison with the faith that it aroused in the possibility of securing objective measures of individual potentialities in advance of actual trial. The phrenologists and their kind performed a service of great importance for the psychologists who were to come after them. They prepared the minds of the general public to accept the idea that mental abilities can be measured."

Early attempts at mental testing concerned themselves chiefly with what may be designated as sensory and motor phases of mentality and gave scant notice to the more elaborate phases of intelligence. (17)

Sir Francis Galton has been called "the father of mental testing." As early as 1882 he established a laboratory in London where, for a small fee, individuals might come for a series of physical measurements including tests of sensory acuity and reaction time. (36) It was plausible to Galton that acuities in vision or hearing or weight discrimination should indicate differences in mentality. (91) He conducted famous investigations of mental inheritance, of sex differences in mental traits, and of characteristics of famous men. (36)

Galton also pioneered in the application of rating scale and questionnaire methods; he developed statistical methods for the analysis of data on individual differences by selecting and adapting a number of

techniques previously derived by mathematicians. (5)

In 1860 an American psychologist, James McKeen Cattell, used the term "mental test" for the first time in psychological literature. The article described a series of tests which were being administered to determine the intellectual level of college students. The tests included measures of muscular strength, speed of movement, sensitivity to pain, keenness of vision and of hearing, reaction time and memory. Cattell shared Galton's view that a measure of intellectual functions could be obtained through tests of sensory discrimination and reaction time. Cattell felt that simple functions could be measured with precision and accuracy, whereas the development of objective measures for the more complex functions appeared at that time a nearly hopeless task. (5)

According to Goodenough (36:41) both Galton and Cattell, as well as many of their contemporaries, regarded sensory and motor manifestations of the simpler kind as coextensive with the highest manifestations of which the intellect of man is capable. They regarded them as lower and higher rungs of the same ladder and believed that a dependable estimate of the latter could be had by measuring the former.

Alfred Binet, a French psychologist, and his colleagues were in favor of approaching the whole question of mental measurement by means of a sampling technique. Their goal was to find suitable tasks which could be fairly regarded as samples of the kind of abstract judgment and reasoning demanded in those situations which observation had shown could be handled by "intelligent" persons but not by the "unintelligent." (36)

According to Anastasi (5), Binet and his co-workers devoted many

years to active and ingenious research on ways of measuring intelligence. Many approached were tried, including the measurement of physical traits, handwriting analysis, and palmistry.

In 1896 Binet and Henri proposed to try out tests with school children which were designed to"measure" each of eleven named "faculties" or mental processes. Among them were attention, force of will as indicated by sustained effort in muscular tasks, motor skills, and judgment of visual space. One of the purposes of the testing was to determine whether or not there were any consistent differences in the performance of children whom their teachers regarded as bright or dull.

Binet's findings led him in 1898 to emphasize the fundamental differences between the application of measures of material objects as used in the physical sciences and the application of such units to psychological processes. He called attention to the findings of Weber and Fechner as evidence that changes in the physical magnitude of a stimulus-object are not accompanied by changes of equal magnitude in the sensations aroused. Therefore, mental measurement must be expressed in psychological rather than in physical units. (36)

Interest in the "higher" or "more complex" mental processes was shared by others. Ebbinghaus's classical study of memory had appeared in 1885. In referring to the period before the turn of the century, Goodenough (36:46) states, "Most of the tests in common use had shown only low correlation with such indications of ability as school success or teachers' judgments of intelligence. As a result, many of those who had at first been most enthusiastic about the possibilities of mental

testing as a practical device for the guidance of children and college students lost interest in the subject. In America, particularly, the interest that had flamed so high in the nineties was reduced to a feeble and intermittent glow during the next decade. Binet, on the contrary, never lost faith."

According to Freeman (26:20) Binet's efforts from 1890-1900 were of little more practical value than those of other experimenters. During the first decade of the 1900's, Binet overcame the shortcomings of earlier tests.

In 1904 the French Minister of Public Instruction appointed a commission to study procedures for the education of subnormal children attending the Paris schools. This resulted in the Binet-Simon Scale of 1905 which consisted of thirty problems or tests arranged in ascending order of difficulty. The tests were designed to cover a wide variety of functions, with special emphasis upon judgment, comprehension, and reasoning. Although sensory and perceptual tests were included, a much greater proportion of verbal content is found in this scale than in most test series of the time.

In the 1908 Scale the number of tests was increased, some unsatisfactory tests from the earlier scale were eliminated, and all tests were grouped into age levels. Thus a child's score on the test could be expressed as a "mental age." The use of mental norms achieved considerable popularity in the subsequent stages of psychological testing.

A third revision appeared in 1911; in this scale, no fundamental

changes were introduced. Minor revisions and relocations of specific tests were instituted. (5)

After Binet's death in 1911 there were several attempts to revise the Scale. The earlier forms were essentially translations with few new features. In 1916 L. M. Terman of Stanford University published the famous Stanford Revision of the Binet-Simon tests. The Stanford Revision introduced many new items and changed the location or method of administering or scoring of so many others that it became essentially a new scale, bearing only surface resemblance to those that had preceded it.

Goodenough states, (36:65), "For twenty-one years the Stanford 1916 Revision maintained the leading position among the intelligence tests used both in the United States and abroad."

Nevertheless the 1916 Scale was by no means perfect; the new scales which appeared in 1937, had largely, though not completely taken the place of the 1916 Revision. (36)

The Binet tests, as well as their revision, are individual scales suited to the intensive study of individual cases and are not adapted to group administration. Group testing, like the first Binet scale, was developed to meet a pressing practical need. (5)

When the United States entered the First World War in 1917, a committee was appointed by the American Psychological Association to consider ways in which psychology might aid in the conduct of the war.

The committee recognized the need for classifying a million and a half recruits with respect to general intellectual level to determine placement and assignment to different types of service. The tests

developed by the Army psychologist have come to be known as the Army Alpha and Army Beta. The former was designed for general routine testing; the latter was a non-language scale employed with illiterates and with foreign-born recruits who were unable to take a test in English.

The tests were released for civilian use shortly after the termination of World War I, and the testing movement underwent a tremendous growth spurt. The application of such group intelligence tests far exceeded their technical improvement. The fact that the tests were still generally crude was often forgotten. (5)

Goodenough (36:68) states, "'Mental ages' and 'IQ's' obtained from half a dozen different group tests were joyfully computed and entered on children's permanent records by teachers and school principals with as much assurance as their grandfathers had placed in the skull maps drawn up by their favorite phrenologist. The decade of the 1929's was the heyday of the testing movement, the age of innocence when an IQ was an IQ and few ventured to doubt its omnipotence."

The development of nonverbal tests came with the need for better screening of immigrants at Ellis Island to determine whether they were physically or mentally incapable of self-support. Knox devised a series of tests which required no use of spoken language. A number of the tests used by Knox were subsequently incorporated into other scales which were more adequately standardized. In 1917 Pintner and Paterson brought out the first well-standardized scale of "performance" tests. Other scales of the same general sort followed. Of those in use today, the Arthur Point Scale (1930) and the Cornell-Coxe series (1934) are among the best known.

In spite of disagreements as to the nature and organization of intelligence, a system of useful devices for the appraisal of its level of development in the individual has been constructed. Arnold Gesell of Yale University has made the chief contribution to testing mental development during infancy although his tests lack statistical refinement. According to Goodenough (36), Bradway (1944) has conducted the most important study of IQ constancy dating from the pre-school age. The fact that about one child in four showed an IQ change as large as 15 points led Bradway to advise that "an individual IQ obtained before the age of six must be interpreted with discretion." It has not been found possible to develop group tests for children under the age of five. The Stanford 1937 Revision remains the most dependable of the available measures for elementary school children. Of group tests Kullmann-Anderson is probably most popular. For use beyond the junior high school, the Wechsler-Bellevue, revised 1944, is steadily gaining in popularity. It is administered individually and results are expressed in terms of IQ. The Wechsler-Bellevue is used to test adults and takes definite account of the qualitative as well as the quantitative aspects of mental decline in later ages. (36)

Tests of educational aptitude and achievement.

When an analysis is to be made of the pattern of abilities of an individual, a graphic representation of the abilities measured is plotted in a psychological profile or psychogram. By the use of a psychogram it is possible to determine the individual's relative standing on each of the various measurements and also how he stands in the group. Tests have

been developed to identify musical talent and to measure progress in musical education. Goodenough states (36:346), "Although a fairly large number of attempts have been made to measure artistic talent, and even more effort has been expended upon the measurement of artistic appreciation and on achievement tests designed to measure progress in artistic production, none of these can be said to have met with a high degree of success." The available tests for detecting talent in writing English prose or poetry include product scales for judging quality of written compositions, tests designed to measure knowledge of the rules of literary construction, and tests of literary appreciation. A good many attempts have been made to develop diagnostic tests to detect inabilities especially in reading the arithmetic. The educational philosophy behind most of these tests is the realization that the soundest educational therapy is that which helps the child help himself. (36)

Measurements of interests and attitudes.

Methods of determining interests are given systematic form by means of check lists, questionnaires, and rating scales. Most devices for measuring attitudes are local to the situation and are limited to the development of quantitative scales for indicating the direction and intensity of the attitude at the time of the testing. The public opinion poll is a sampling device conducted by trained, employed workers who interview persons to obtain their opinions with respect to questions included in the survey. (36)

Measurement of personal-social characteristics.

A phase of psychological testing which is still in its infancy

is sometimes termed "personality" testing. Anastasi gives three types of current personality tests - the self-report inventory, situation test, and projective techniques. She summarizes (5:18), "Each of the available types of personality tests presents serious difficulties, both practical and theoretical. Personality testing lags far behind aptitude testing in its positive accomplishments."

Tests for vocational guidance.

Goodenough (36) cites four general classifications of tests used by the vocational counselor: (1) tests of general mental and physical ability, (2) tests of vocational interests, (3) tests of special aptitudes and abilities, and (4) measures of personality characteristics by means of paper-and-pencil tests or by projection technique. Vocational guidance includes giving information based upon a knowledge of job requirements and a careful investigation of the individual's qualifications for meeting those requirements.

Summary.

In summary, Goodenough has stated (36:532), "Much has happened during the four decades that have passed since the publication of Binet's first completely organized scale of mental tests. The little band of psychologists who continued along the path upon which Binet had entered has become a multitude. The path has broadened into a highway from which many trails diverge. Some of these roads were well laid out and are much traveled. Others are still little more than footpaths where the weeds of ignorance grow thickly and the traveler's view is often obscured by the dust arising from his own incautious footsteps. The road is long and the end is not in sight."

PHYSICAL AREAS

As measurement of mental traits has a long and continuing history and background, likewise can the development of measurement of physical traits be traced back many centuries.

Clarke (16) designates anthropometric measures as the oldest type of body measurement used in education or life. Krakower (55) refers to the ancient civilizations of India and Egypt as the beginning of anthropmetry. The mathematicians and artists of India and Egypt seem to have agreed that there must be some one part of the body whose length should be the modulus for all other parts. (55) The body was divided into nineteen equal segments, each of which was the length of the High Priest's middle finger. (7)

Baron Quetelet is credited with coining the word anthropometry, and with making the first scientific study of physical growth. In 1835 Quetelet published his admirable work, Man and the Development of his Faculties.

The first important investigation of physical measurements of adolescent boys was made in 1854 by Zeissinly in a study of Belgian children. (55)

Edward Hitchcock at Amherst did important work in the field beginning in 1861. He made extremely careful measurements of the fifty measurements recommended by the American Association for the Advancement of Physical Education.

In 1880 Dr. Dudley A. Sargent of Harvard University began a systematic measurement of students; the compilation of data that he

gathered was published in 1893 in the form of percentile tables for the various years of college life for both men and women. (7)

In the early 1900's there were many anthropometric charts being constructed and a number of special instruments being used to demonstrate anatomical and physiological facts. (7)

From 1932 to the present time, the science of anthropometry has undergone little change. The most outstanding work is a study of somatotyping by Sheldon, which considers the whole individual when measuring body build and thus yields information which is correlated with the modern objectives of anthropometry. (57)

Bovard and Cozens (7:20), "As far as physical education is concerned, the greater part of the early anthropometric work placed emphasis on symmetry and size."

The shift of emphasis in the 1880's from bodily symmetry and size to the measurement of actual work done by an individual was no doubt hastened by the invention of the spirometer and dynamometer. Sargent worked out strength tests in which capacity was given value in judging power and efficiency. He thought that, after all, tape measurements really did not tell much. (7)

The most complete test of strength of the late 1880's and early 1890's was devised by Dr. J. H. Kellogg. He utilized an ingenious dynamometer which could be adjusted to test almost any group of muscles. The test was not practical, since the equipment cost $300 and it took one-half hour to test one person. (59)

In the earlier strength tests the investigations were related to

the size or mass of the various parts of the body. It was supposed that exercise could be prescribed on the basis of muscle size. It was soon demonstrated that the large man is not always the strong man, and the strong man is not always the man of high endurance. This concept led to a decline in emphasis placed on strength tests.

With the invention of the ergograph in 1884 by Mosso, the Italian physiologist, the measurement of muscular strength took on a different aspect. Mosso pointed out the essential relationship that the ability of a muscle to perform was related to the efficiency of the circulatory system. It was then recognized that physical condition and muscular activity are related.

Furthermore the muscular strength test was criticized on the ground that it was not a good test of endurance, heart, and lung development. The cry went up for speed and endurance tests, and Sargent and Meylan complied in 1901 and 1904. Testing was begun in public and private schools and colleges and universities. (7)

The popularity of strength tests declined, and this decline led to the use of cardiovascular tests. Not until the 1920's was interest revived in strength testing. (57) Frederick Rand Rogers at that time scientifically demonstrated that strength tests are valid as measures of general athletic ability. (7)

After 1900, a search was begun for tests of functional fitness more descriptive and predictive of physical performances. As a result, research in the physiology of circulation and respiration developed rapidly.

Much of the early work on cardiovascular-respiratory measurement was done by C. Ward Crampton. One of his first tests compared the pulse rate and systolic blood pressure in the horizontal and standing positions. About this time McCurdy at Harvard Medical School and Springfield College was conducting research on blood pressure and pulse rate related to change of positions of the body. The findings of both men were in agreement.

After about 1930 the development of cardiovascular-respiratory tests was characterized by the introduction of modern techniques of test construction with particular emphasis placed upon the statistical determination of test item selection and validation. (57)

This phase of testing made a definite contribution in establishing the relationship existing between physiological systems and the fact that the body reacts as a whole. Mosso's proposition of 1884, that ability to perform may be considerably modified by physical condition, had been given practical application. (7)

Bovard and Cozens state (7:27), "From 1913 onward a great wave of testing in physical education gradually swept the country." Physical ability or efficiency tests were administered to school children and university students.

The demand arose for a battery of motor tests which were scientifically evolved and could be administered to large groups. In 1927 David K. Brace brought forward a scale of motor ability tests which has proved exceedingly valuable.

Prior to 1920 little was done to set up tests for girls and women.

A committee appointed in 1923 by the College Women Directors of Physical Education constructed a test of motor ability while also stressing physical fitness. Further work in this area was done both at Barnard College and at Wellesley. (7)

In 1931 David K. Brace (9) evaluated the development of measures of pupil achievement in physical education. He said that physical education had not reached the point common to other subjects in the curriculum in measurement of pupil achievement. No educational survey had measured pupil achievement in ways at all comparable to those applied to other school subjects.

Brace cited specific reasons for the failure to measure adequately: imperfect measuring rods were used, workers in the field did not generally have the type of training to enable them to carry on necessary statistical research. The older viewpoint regarding physical education as a remedial health program rather than as an educational procedure had delayed progress. However, according to Brace, the greatest obstacle was the real difficulty of the task, for the measurement of pupil achievement in physical education would involve measuring activities extremely different from each other.

Bovard and Cozens state (7:31), "Much of the work done in physical education measurement prior to 1925 was unscientific, but since that time and increasingly so today investigators in this field have been trained in the scientific approach to test construction. Use of approved research and statistical techniques in the development of measurement tools has improved the validity and reliability of available measures."

McCloy (59) cites the period 1929-1939 as a period when large numbers of tests were developed. He compares their poor construction and inaccurate validation with the situation found earlier in the mental field.

During the last ninety-two years research workers in physical education have developed methodology to fit their own setting and the unique nature of their problems. (4)

Strength tests.

Cureton and Larson (57) have classified muscular strength variables as static strength and dynamic strength. Static strength is the ability to register strength on instruments through squeezing, pushing, pulling. Dynamic strength is the ability of the individual to lift or propel body weight.

McCloy (59) states that recent studies have shown that strength is the one most important item in almost all motor performances, but that strength tests do not measure motor performance except in so far as motor performance depends upon strength.

Much of the recent research in strength testing has been directed toward standardizing strength test items, exploring relationships between accepted strength tests and other factors, and developing predictive indices rather than toward building new strength tests. (7)

Motor ability tests.

Mathews (62) defines general motor ability as "the immediate capacity of an individual to perform in many varied stunts or athletic events." He states that a single test which adequately reflects all

aspects of motor ability would be difficult to develop.

Bovard and Cozens (7) also reflect this viewpoint. They concur with McCloy's definition of motor educability as "the ease with which an individual learns new skills" and motor capacity as "one's innate potentialities" or "the limit to which an individual may be developed." Bovard and Cozens define motor ability as "the level to which one has developed his innate capacity to learn motor skills." They point out the inherent difficulties, in separating native from acquired skill, facing those who work with motor intelligence measurement tools, as well as those dealing with mental intelligence measures.

McCloy (59) states that one or more accurate measures of motor educability and athletic ability are needed in the field of physical education and athletics.

Physical fitness tests.

The modern concept of assessing physical fitness is a functional one which recognizes the fact that there are certain factors which aid or hinder this functional performance. Some of these factors are age, weight, height, and body build. (57) Motor or physical fitness may be referred to as efficient performance in basic requirements as running, jumping, dodging, falling, climbing, swimming, lifting weight, carrying loads, and enduring under sustained effort in a variety of situations. The test results may be used to show fitness status of the pupil, to measure improvement, and as a basis for general ability classification in the physical education program. (62)

A great deal of the difficulty in measuring physical fitness has

been due to the lack of a concise and generally accepted definition of the term physical fitness. (7)

Sports skill tests.

Since sports skills vary with each sport, measurement becomes specifically related to each sport. There are sports skill tests in archery, badminton, baseball, basketball, dance, fencing, field hockey, football, gymnastics, ice hockey, soccer, speedball, swimming, tennis, and volleyball. (57)

Clarke (16) states that sports skill testing is important for classifying pupils according to ability and for determining their achievement and progress.

Cardiovascular tests.

Larson and Yocum state (57:42) "The measurements which are used to estimate the nature and efficiency of circulation and respiration are blood pressures (systolic, diastolic, pulse, and venous), pulse rate, vital capacity, breath-holding, oxygen consumption, basal metabolic rate, respiratory quotient, cardiac output, and blood analysis for hemoglobin, red cells, pH, glucose, and lactate. The criterion test of the efficiency of circulatory-respiratory function is the degree of external stress which can be applied with a minimum loss of physiologic energy."

Experimenters generally agree that many factors influence the elements included in the cardiovascular-type test. The objectivity of cardiovascular tests is definitely uncertain while reliability can be secured only under the most favorable circumstances. (16)

Nutritional measurements and somatotyping.

Today there are two general methods for appraising nutritional status. The subjective method is used in daily observations of characteristics of the poorly nourished child. Several valid objective tests have been developed; most of them include height-weight tables. (62)

Somatotyping may be defined as the concept that an individual's body type is related to his health, immunity from disease, physical performance, and personality characteristics. Kretschmer and Sheldon are among those men who have attempted to develop a process that would adequately define body types. (16)

As to somatotyping, Mathews states (62:221), "The understanding of physical capabilities as related to certain somatotypes should be of interest to the physical educator in order to better understand the pupils with whom he deals. Recognizing limitations as well as potentialities of his youngsters will enable the physical educationist to plan a more scientific program to better serve the needs of his pupils."

Evaluation of body mechanics.

According to Larson and Yocum (57:44), "Posture and body mechanics measurement includes all of the positions which the human body can assume - standing, sitting, walking, sleeping, running, jumping, and throwing.

"Measurement is designed according to objectives. The objectives of posture and body mechanics are physiologic efficiency, mechanical accuracy, and aesthetic or desirable body proportions of symmetry."

The instruments used to evaluate these positions are rating scales, silhouettograph, photograph, motion pictures, x-ray, pedograph, and the flexometer. (57)

Up to the present time practically all objective tests and standards have related only to standing posture. Sitting and walking postures as yet have no clearly defined tests or scientifically defined standards.

Individual differences in skeletal structure would seem to make it imperative that standards for evaluating posture be devised to fit the individual. Most of the present standards have apparently assumed that there is one best posture for everyone. (59)

Summary.

Present-day testing in the physical area is based on the scientific method and sound statistical procedures. The area has well-defined objectives and includes a wide scope of structure and function. Although physical testing has advanced in comparison with the status seen in the 1900's, constant improvements in construction, content, and application are being made.

CHAPTER III

REVIEW OF LITERATURE: PHYSICAL AND MENTAL CORRELATIONS

Around 1910 many scientifically-minded people asserted and attempted to prove that mental development is dependent on physical development. In addition to time-honored height and weight measurements, proposals for measuring physical maturity in terms of anatomical age (stage of ossification of wrist bones made possible by the introduction of Roentgen-ray photography), physiological age (stage of sexual maturity), and dental age (eruption of permanent teeth) were put forth with the definite claim that each of these "physical ages" would be found to be closely correlated with mental age. Also, rather pointed suggestions regarding the interpretation of the significance of mental age were made. They were tantamount to a declaration that relative mental status was to be determined by the ratio of mental age to physical age rather than by the customary ratio of mental to chronological age. The literature of this period (1910 to 1920 roughly) may be characterized as extremely optimistic as to the possibility of ushering in a new era of scientific educational guidance upon a foundation of physical measurements. (68) Pechstein and McGregor (69:41) stated: "Mental growth correlates strikingly with physical and physiological growth; superiority and correspondingly physiological development."

Early studies.

Sir Francis Galton's assertion made in the nineteenth century that men of genius tend to be above average in height and weight exerted great influence upon research seeking to settle the question of correlation

between stature and weight on the one hand and intellect on the other. According to Paterson (68:25), he stated, "A collection of living magnates in various branches of intellectual achievement is always a feast to my eyes; being as they are, such massive, vigorous, capable-looking animals."

In 1892 W. T. Porter (68), a physiologist, supervised the physical measurement of 33,500 boys and girls in St. Louis. He hoped that the data he accumulated could be used to determine the laws of normal growth and that upon "this firm ground may be established a system of grading which shall take into account the physical capacity of the pupil in the apportionment of school tasks."

Age-grade location was used as a measure of intelligence. Porter justified this criterion by the statement "success in school life, like success in after life, is on the average a fair test of intelligence." According to Paterson (68), age-grade location has yielded in current psychological practice the best available single criterion against which standard intelligence tests can be validated.

Porter concluded that precocious children are heavier, and dull children lighter than the average child of the same age; therefore, he said that the data established a physical basis of precocity and dullness.

Lacking knowledge of the modern method of correlation, workers at that time were compelled to present averages only, and merely to observe trends. Porter's statistical method of analysis was crude in that it prevented any statement of the <u>degree</u> of agreement between weight and precocity or dullness. (68)

In 1896, according to Stalnaker, Porter stated (90:183), "The time in which we live will always be memorable as the beginning of a great educational reform. It has seen the complete demonstration of the law that, on the average, the physical strength of the child and his power to do school work go hand in hand."

J. A. Gilbert, a psychologist, in his work in 1894 used one teacher's estimate of general mental ability to determine the relationship between height and weight, lung capacity, and strength of grip. He concluded that the correlation between mental and physical traits was zero. (28) Using a single teacher's judgment, instead of the consensus of a number of teachers' opinions, left no place for compensatory averaging, and errors of judgment remained unchecked. Therefore Gilbert's negative results do not establish the absence of relationship. (68)

In 1896, according to Paterson, G. M. West (68), using Gilbert's method of children being rated by teachers as "good," "mediocre," and "poor" in mental ability, found zero or almost zero relationship between physical traits and mental ability. The errors inherent in Gilbert's technique are equally at work in that of West.

According to Gates, Boas (28) in 1897 also found a slightly negative or zero correlation in the relationship of physical and mental traits in using teachers' estimates of mental ability and measurements of height and weight in school children.

In that same year Arthur MacDonald made an anthropological and sociological study of 16,473 white children and 5,457 colored children in the public schools of Washington, D. C. Physical measurements of height and weight were taken by the teachers, and each child was rated

regarding general mental ability by his teachers. Extremely slight physical differences between the bright and dull were disclosed, but MacDonald concluded definitely that, "Bright boys are in general taller and heavier than dull boys. This confirms the results of Porter." Actually MacDonald's data are more nearly in harmony with Gilbert's and do not support his own conclusion. Since MacDonald employed Gilbert and West's methodology, it is not surprising to find that his results correspond to theirs rather than to Porter's.

However from the studies of Gilbert, West, Boas, and MacDonald, no conclusion can be drawn to establish the relationship between intelligence and height or weight as being zero since faulty technique was employed. (68)

In 1897, according to Stalnaker, Binet and Vaschide (90) attempted to determine physical and mental correlations by the use of tests of reaction time, rate of tapping, dynamometer records, memory, and speed in running. The correlations were so low that they concluded that the abilities are independent although there was correlation between class standing and physical development.

In 1900, according to Paterson, Dr. W. S. Christopher (68) conducted an investigation to determine the relation between the physical status and grade location of 503 twelve-year-olds; it was dominated by Porter methods and Porter conclusions. Inadequate statistical methods were employed. Averages only were presented, with no indices of variability.

According to Gates, F. W. Smedley (28) used height, weight, sitting height, lung capacity, and strength as the physical traits to be

compared with school grade reached in relation to age. His conclusion was that a positive correlation existed. According to Stalnaker, Smedley stated (90:186), "In general there is a distinct relationship in children between physical condition and intellectual capacity, the latter varying directly as the former." Actually he had no more basis for arriving at this conclusion than did Porter.

Wissler in 1901 obtained negative results for the correlation of tests of physical development - among them being height, weight, strength, speed of tapping, steadiness, and tests of mental ability such as memory, perception, association. (90) (28) Stalnaker (90) thinks the outcome of the research may be due to the fact that the subjects were college students who had reached physical maturity.

William Bagley used strength, rapidity and accuracy of voluntary movement, amount and character of involuntary movement as motor data to be correlated with mental excellence by alertness of mind and class standing. The results, published in 1901, stated that there was a general inverse relation between motor and mental ability, but that individual exceptions were numerous. (6)

In the first decade of the twentieth century, Jones (53) did an interesting study of the influence of bodily posture on mental activities. He observed that mental activities seem so dependent on proper blood supply to the brain that it became evident that the problem must be considered physiologically. Jones determined that the vertical position, as opposed to horizontal, was more favorable to pitch discrimination, auditory and visual memory, adding, ability to tap, and strength of grip.

Crampton conducted a study in 1908 with school children as the subjects of height, weight, strength, and pubescent development testing. He concluded that greater height, weight, and strength are related to better scholarship because they are effects of the same cause: earlier pubescence. (28) (90)

Chamberlain in 1901, Crampton in 1908, Cornell in 1908, Rotch in 1909, and Foster in 1910 conducted studies of the relation of physical and mental traits in school children. They all found small positive correlations existing, but their techniques were no improvement over those of their predecessors. (28)

Stalnaker cites the following as an example of the inaccurate conclusions being reached during this period (90:201): Professor Leo Burgenstein of Vienna stated, "We come to the conclusion that inferior physical gifts and development as well as the existence of physical defects, will as a rule, be followed by a lower physical condition and therefore by small success in school career, where so much depends on brain work, even if we are not far enough advanced to say with certainty how largely psychic inferiority is accounted for by physical inferiority and how far ill success in education is everywhere due to this cause."

In 1913, according to Gates, B. W. DeBusk (28) used a height-weight index and the Binet intelligence test and concluded that there was a small positive correlation in mental and physical traits so measured. There was no evident realization of the unreliable and erroneous impression created by slight differences in averages. (68)

According to Paterson, Bird T. Baldwin in 1914 concluded (68:45),

"If pedagogical age be accepted as a fair equivalent to mental development, tall, heavy boys and girls with good lung capacity are older physiologically and further along in their stages toward mental maturity, as evidenced by school progress, than short, light boys and girls." He based this conclusion on term grades and physical measurements of 125 boys and girls.

According to Cozens, Arnold and Stewart (18) who in 1916 used the Porter method of comparing physical and mental traits of school children were satisfied that a positive and close correlation existed. Arnold massed his evidence from data obtained from a study of 30,000 students, and Stewart from 207 boys.

According to Stalnaker and Gates, in 1917 Bickersteth (90) (28) conducted a study of the correlation of mental and physical age of 2,500 pupils in elementary and secondary school. He used the tapping, plunger and steadiness tests and tests of memory, perception and association; Bickersteth found a very low positive correlation between the two groups of tests.

Murdock and Sullivan (67) conducted a very interesting investigation in Honolulu; the physical data and mental data were obtained in entire independence of each other and for purposes other than that of correlation of the two. The Otis Primary test, the National Intelligence test, the Terman Group test of Mental Ability were administered by Katharine Murdock, and Louis Sullivan made the physical measurement on the 600 school children. The study resulted in a small but positive correlation between general intelligence and weight, stature, and head

dimension. The correlations between general intelligence and head diameter exceeded correlation found for weight and stature. The investigators deemed the correlations of little practical value.

Abernethy's study of 487 girls agreed with similar investigation in the finding of very low positive correlation between mental age and commonly accepted indices of physiological and anatomical development. (2)

According to Paterson (68), such slight correlation as seems to exist between intellect and height or 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.

Paterson (68:79), in summarizing the period, stated: "It is apparent that the pedagogical and educational significance of physical size is far less than early students and even some of our contemporary writers have assumed. Indeed, there is reason to affirm that physical measurements of school children should concern the school administrator and teacher in connection with the program of physical education and participation in extra-curricular physical activities but should concern him academically only in so far as physical size is a factor to be reckoned with in determining the size of desks and seats to be installed in the school room."

Such were the early investigations of physical and mental traits. Most of them dealt with height and weight and intelligence with school children as subjects. None proved that physical and mental traits are

positively or negatively correlated. The optimism of ushering in a new scientific era was lost in the errors in techniques employed by the investigators.

The Physical Quotient.

In 1923 James H. McCurdy (61) stated the need for a Physical Quotient to compare in importance with the Intelligence Quotient. In a report based on three reports of the National Committee on Standard Physical Efficiency Tests of the American Physical Education Association from (1) the city and rural elementary schools, (2) the secondary schools, (3) the YMCA, YWCA, and the Industrial Association, he recommended that one group of standards in athletics be established. From those standards a Physical Quotient should be devised and correlated with the Intelligence Quotient.

The next year McCurdy (60) stated that the Physical Quotient should measure skill, alertness, speed, strength, and moderate endurance. Physical education during school ages should train pupils in fundamental skills related to neural and physical health. McCurdy believed that exercise beginning in elementary school should be devised to measure physical intelligence; the PI should compare favorably with the Terman Otis Army test and others. A test devised to measure physical intelligence through college would stimulate improvement and form habits for leisure through skill attained.

Testing in the 1920's and 1930's.

Arthur Gates' (29) study published in 1924 was designed to afford an analysis of interrelations not only of physical and mental abilities

but also of physical, mental, educational, social, and emotional maturity. Fifty-eight pupils of the junior primary level and fifty-seven pupils of grade four were selected. The anatomical age was measured by bone ossification, height, weight, and chest girth; physiological age was measured by lung capacity, forearm strength, index of nutrition, rate of heart beat, estimates of physical vigor, health, and efficiency. Mental ability and maturity were measured by the Stanford-Binet test. Scholastic achievement was judged by the Stanford Achievement Test and Horace Mann Tests.

No physical trait alone correlated in any practically significant degree with mental age, with mental, social, scholastic or emotional maturity. Although small, the coefficients were invariably positive. Gates suggested that the study provided new evidence for the fact, frequently observed for the previous twenty-five years, that desirable traits of all types tend to go together, that possession of some good trait implies slightly the possession of other good traits rather than the opposite. However, the combination of seven physical traits into a multiple correlation of 0.21 with mental age was by no means high.

Gates concluded that correlations among physical measurements while always positive and often high are also often low. To secure a measure of general physical status, it would be necessary to combine several physical measurements. From the study, no single physical measurement yields a high correlation with the estimates of physical vigor, stamina, maturity, and fitness. He emphasized that physical measurements are highly desirable for their own sake, but not for

classifying children intellectually, emotionally, and socially.

In 1925 Arthur Gates (28) presented three theories as to the educational significance of physical status and of physiological, mental, emotional, and social maturity. In effect he thought that the correlation between achievement and capacity would be perfect except for errors in taking tests or mistakes in grading. Gates reasoned that native aptitude established a limit to accomplishment, but also that the degree of accomplishment reached is influenced by other traits, such as physical condition and the stability of nervous system. The third theory dealt with predictions of achievement; such predictions should be based on maturity by using various age concepts: mental age, anatomical age, physiological age, social age, emotional age, and educational age.

Hoefer and Hardy (48) conducted a study on the effect of improvement in physical condition upon the intelligence and educational achievement of 343 elementary school children from eight to eleven years old. They used anthropometric measurements, physical exams, Stanford Revision of Binet-Simon Intelligence Test scores with criteria for physical improvement being: general physical condition based on judgment of a physician, condition of tonsils, three physical traits and habit of coffee drinking.

In order to obviate discrepancies in the size of groups, 27 children from each of four groups were paired in respect to age, sex, an initial IQ. This confirmed the rank relationship previously found among larger groups.

In summary, the study concluded that on the basis of general physical condition and rate of growth in three physical traits, there was no initial difference between the groups in mental status as measured by Stanford. There was, however, a consistent tendency for the children in better physical condition to have higher ratings in intelligence and educational achievement. In comparing the average amount of gain of final IQ over initial IQ, the differences between the groups when classified according to general physical condition were small; none met statistical standards for reliability. However, larger gains were consistently found with better physical condition. When compared on the basis of normal expectancy in mental growth, based on initial IQ, with all factors fairly constant except that of physical condition, the initial superiority of those in good general physical condition over those in fair as shown by differences in mental rate increased five times. There was evidence that children whose physical condition was good throughout the study had a more rapid mental growth than those whose condition was only fair.

According to Burks, David Heron (10) conducted a study of the relationship of defective physique and IQ; he used 4,286 boys and 4,474 girls and rated their mental capacity, age, grade in school, height, weight, and condition of teeth, tonsils, adenoids, and power of hearing. Heron concluded that home environment could not be the chief determining cause of the difference of intelligence, nor was defective physique its source.

A number of other studies were made in an attempt to determine

relationship between physical ability and intelligence. According to Cozens, Garfiel (18) with Barnard college women as subjects, found that the judgment of physical education instructors correlated .77 with results in motor ability. The second rating correlated .92 with the first. She ventured to conclude that mental ability as measured by the Army Alpha and motor ability are different groups of abilities which tend to have the low correlation .10 to .12 in adults. Motor ability represents a group of abilities mainly independent of, or at least different from mental ability.

According to Burley, Meserve (12) compared the Brace Motor Ability Test scores of normal boys with Stanford Binet and Otis Group Test Scores and found a correlation of .318.

Westendarp (98) concluded that a negative correlation exists between physical efficiency and mental capacity. Cozens (18) in criticizing the study said the conclusions were far-fetched in view of the small number of cases considered and high probable errors of correlation, the lowest being 0.12.

Rudisill (86) in his study to determine the relationship of physical and mental capacities among 40 college students, concluded that the results were obtained from too few subjects to permit any definite conclusions. He discerned a tendency toward a relationship between physical capacity and academic performance in women but not in men. Neither sex appeared to have any tendency toward a relationship between fineness of motor control and measure of intellectual status. He thought that the trends were clearly enough marked to make further investigation with a larger number of subjects.

Burtt, Landis, and Nichols (56) found that there was no correlation between intelligence and big muscle group activity as seen in the 100 yard dash, broad jump, baseball throw, and fence climb. Cattell (14) found a positive relation between mental and physical ability in a study conducted at Sargent School over a twelve year period with 1,000 women as subjects.

Fisher used 2,430 school children in his investigation and correlated school grades and promotion with tests of big muscle activity. He concluded that (18) "high classes physically are high classes mentally or scholastically and vice versa." Goll (34) in 1923 concluded that there is a correlation between physical activity and school success, but that there is no correlation between a mental test and a physical test.

At Boston University, Heaton (43) compared physical ability and development of children of low intelligence with that of children of high intelligence. According to his study, the average general level of physical development of children who rate high on intelligence tests is distinctly superior to that of children who rate low on intelligence. According to Cozens, Bovard (18), by using the Physical Ability Test and the Otis-Self-Administering Test, concluded that there is no correlation between group intelligence tests and "big muscle" ability. This was based on 953 cases.

According to Cozens (18), who used college students as subjects, there is no correlation between physical ability as measured by big muscle tests and ability to perform mentally in group or individual intelligence tests. Cozens determined that with boys and girls of elementary age the better developed the boy or girl is for his age, the more able he is in

school. The general level of physical ability of children who rate high on intelligence tests is distinctly superior to that of children who rate low on intelligence tests.

Flemming (24) found positive correlation between physical traits of junior and senior high school students with school achievement and with non-academic leadership. Gittings (33) stated that neither positive nor negative correlation of mental and physical traits can be proved. This is not the same as the relation of physical and mental abilities being established.

Hertzberg (46) found that motor development alone does not correlate to any particularly significant degree with mental age when the subjects are kindergarten age. The coefficients are low, but positive. Hertzberg suggested that a battery of motor tests involving motor tasks might be constructed which would adequately measure the intelligence of children at kindergarten age.

The Oseretsky tests of motor maturation for measuring genetic levels of motor proficiency were first published in Russia in 1923, and the scale has been critically evaluated at various European laboratories. Although the scale does not measure intelligence, it is comparable in structure to the Binet-Simon scale for measuring intelligence and the Vineland Social Maturity Scale for measuring social competence. The tests are for ages 4,6, 10, and 15-16. (19)

To determine the correlation between changes in physical fitness and scholastic marks and between physical strength and the intelligence of high school boys, Giague studied 60 boys over a four-year period.

The resulting correlation coefficient between the Physical Fitness Index and IQ was -.25. Since the PFI has a reliability coefficient of .97 and scientifically standardized norms validated by scores of experiments, Giague attributed the negative correlation to his use of highly subjective teacher's marks and Regents Exam ratings for the mental trait basis of comparison. (32)

According to Halsey, Reeder (42) found that neither an initial posture grade nor posture improvement were significantly related with mental ability as measured by scholastic aptitude tests and academic grades, or to general motor ability as measured by the Lensch test or Harris test.

Studies published after 1935 were more accurate in their conclusions than early ones and at the same time drew less definite conclusions than the ones done in the 1920's.

In 1937 Di Giovanna observed in his study involving 295 subjects that "controlled" experiments involve too many variables. He wrote (23), "Intelligence is exercised in analysis of a skilled movement. The more complex, the more interpretive the movement, the greater intelligence necessary to comprehend it. Educability is dependent on practice. Given a series of athletic tests, administered under the same conditions and with all other factors influencing athletic achievement the same to two individuals identical in physique but differing in intellect, it is reasonable to believe the more intelligent will prove superior. The assumption is that intelligence does play a part in athletic achievement. At best a correlation between intelligence and athletic achievement would necessarily be small in nature. Proof awaits more refined investigation."

Halsey's study at Wellesley involving over 1,000 students concluded that there was practically no correlation between measure of mental ability and physical traits and abilities. She attributes the lack of relationship between physical and mental ability among college women to imperfect validity and discriminating power of the available measures. Halsey refers to correlation between mental and physical measurements in children to underline the fact that the different abilities are associated as essential phases of general development. (42)

Athletic ability and Intelligence Quotient.

Goll and Miller in 1922 conducted a study to correlate IQ and athletic ability scores. The subjects were boys and girls in the fifth through eighth grades, and the tests were the Illinois Examination for IQ, broad jump, basketball throw, and 50 yard dash. The correlation was .115 or practically no correlation. Stated weaknesses of the study were that height and weight were not considered; the group was not homogenous as to year or grade; the mental and physical tests were administered three months apart. (34)

In 1925 Martin Remp (74) concluded from a study of 327 men that in intellectual capacity as indicated by scores in the Army Alpha test athletes rank higher than non-athletes. The difference between athletes and non-athletes was greatest at lower levels of scholarship.

Robert Hall (41) attempted to eliminate factors that would affect the results of his study comparing the mental ability of athletes and non-athletes. The sexes were considered separately, and extra-curricular activities and chronological age were thought of as factors bearing upon

achievement. He concluded that athletics slightly decreased the scholastic efficiency of students.

In 1934 E. C. Davis (21) said that the issue was still not clean-cut; there was lack of agreement of the term "athlete." A resume of studies done in over 200 institutions from 1903-32 reported conflicting results and lack of similarity of testing procedures. In most cases the non-athlete performed slightly better school work than the athlete, but there were no statistically significant differences.

Jones (54) concluded from a study published in 1935 that high school athletes are more intelligent than non-athletes.

Seegers and Postpichal (89) reported that the correlations between IQ and scores in athletic events were positive but too low to be of much forecasting usefulness. The IQ score correlations were higher for the more complicated events. Brighter boys tended to achieve better scores. The individual variation was so great, and the forecasting utility so small that the tendencies should not be given an individual application.

In a study of the relation of intramural participation to academic grades of freshmen and to academic standing of sophomores, juniors, and seniors, Hackensmith and Miller found that freshman participation in intramural athletics does not have a marked influence on academic grades. Sophomore participation showed slightly higher mean academic grade and that junior and senior intramural participation demonstrate a definite higher mean academic grade than do non-participants of the same classes. (39)

Schwegler and Engelhardt in 1924 stated that physical efficiency

tests used at that time were based upon bodily dimensions or standard athletic performance. The former were not satisfactory tests because such measures were not directly related to functional efficiency. Moreover, an athletic event was a test of an acquired skill that required training.

The two men used the Sargent Jump test, executed as rapidly as possible, to measure height of jump, speed, endurance, motor coordination, strength and agility. The test proved to have a high correlation with composite judgment of physical instructors, high self correlation,and was applicable to adolescent and post-adolescent boys. The findings offer no evidence of a marked correlation between mental and physical efficiency. (88)

The Physical Fitness Index.

In the introduction to his dissertation printed in 1925 Frederick Rand Rogers stated (77:3), "It is not inconceivable that scholastic programs of individuals may be determined in part by their physical fitness. Certainly with a given intelligence, more should be required scholastically of the more fit, while vocational advisers must take into consideration the pupil's physical as well as mental qualifications for any future occupation. Even today classification of pupils for physical education is attempted in only the crudest way - by chronological age and grade in school. The writer hopes that in the Physical Fitness Index physical educators may be provided with a more valid and useful method of determining the general needs of pupils, and that they may be encouraged thereby to organize programs and activities better adjusted to meet

individual needs."

Rogers improved upon Sargent's intercollegiate test through construction of norms and statistical validation studies. As a result of these studies the Physical Fitness Index (PFI) and Strength Index (SI) were developed. The coefficient of reliability of the Strength Index is between .94 and .98. Physical education classes could be divided into equal teams for competition by use of the Strength Indices (77). The PFI utilized basic strength as a means for evaluating physical fitness. (62)

As to the relation between the modifiability of muscular and central nervous tissues, Rogers summed up the situation in 1925 by stating (77:84), "Those who have anticipated high correlation have thus far failed to bring convincing evidence to support their case." He thought that the establishment of high correlation between the IQ and strength would involve including large absolute differences in strength; and since neither high correlations nor large average differences had been established, there was no justification for correlations being made.

Rogers accords his thesis with having demonstrated some positive correlation: the average IQ of the boys tested was 112.48, and the average athletic ability of the same boys was higher than that of all high school boys of New Jersey.

Chamberlain and Smiley wrote in 1931 (15) that the PFI was sufficiently objective to be of excellent advantage to physical educators as a rough measure of physical fitness for big muscle activities, but

that it should not be a substitute for medical examination. The two together should provide the physical educator with sufficient data for the classification of pupils. In their study the two ratings agreed exactly in 52 out of 65 cases, which is 80% agreement.

According to Rogers' statement in 1934 (83), nearly every change in the condition or functioning of the vital organs has a corresponding change in the condition of voluntary muscle. He stated that the correlation coefficient between medical ratings and the PFI was twice as high as between teachers' judgments of intelligence and IQ's.

Van Dalen (95) criticized the Rogers' tests after his study of the contribution of breathing capacity to PFI. He concluded that the addition of lung capacity made no notable increase in the validity of the strength test; therefore it was superfluous.

According to Powell and Howe, Kling (70) described the test as a semi-athletic test including factors of coordination, intelligence, and vital capacity.

As Dr. Rogers pointed out (81), the tests had many supporters and had been used extensively by 1939. Modified PFI programs and tests had been verified and adapted to practical uses by over thirty physicians and educators in almost as many institutions. Over a million tests had been given. Rogers considered the test as practically the only standard test of physical fitness to supplement medical examination.

Dr. Rogers (81) compared the test to the IQ tests by pointing out similarities and differences. According to him, both are quotients devised to assist educators in adapting activities to the individual

powers of the pupils; the PFI is to medicine what IQ is to psychiatry.

He had stated previously (82) that even concentrated mental work requires a high level of muscular power to endure.

In 1940 Dr. Rogers (81:528) cites the importance of the tests as lying in "the truly great idea they embody; that strength is closely related to general health, and strength tests, therefore, are of consummate value in the assessment of physical fitness."

Recent years.

There have been a few studies concerned with mental and physical relationship since 1940.

A study made by Harold C. Ray showed a tendency for physical achievement, leadership, and citizenship service to correspond with general intelligence level. IQ and physical achievement were consistently positive for all groups. Throughout, in all respects the records of the athletes were better than records of non-athletes. (73)

Tuttle and Beeber (93) made a study of the school attainments of athletic letter winners in a university; they used placement percentile rank, the grade point average by semester of each man and team athletic success measured by conference standing as their basis of comparison. The subjects included 577 athletes over a five year period. Their results included the statement that school attainments and athletic success are directly related; for the most part the school attainments of letter winners during championship years were well above average for the group of the period studied.

Burley and Anderson (12) conducted a study concerned with jump and

reach measures of power and their relation to athletic performance and to intelligence in high school boys. The relation between power by the Jump and Reach test and intelligence by Henmon-Nelson Tests of Mental Ability was too low to be predictive.

Eleanor Metheny (64) in a study published in 1941 said, "There is little reason to expect to find any very high degree of relation between grip strength and measurement of mental ability of children."

Rarich and McKee (72) completed a study of twenty normal third grade children; ten had a high level of motor achievement and ten a low level. In summary, the superior performers had a more satisfactory scholastic adjustment and tended to be older, taller, heavier, and stronger.

Van Dalen (94) set out to determine the relationship of frequency and duration of time devoted to play and eleven measures including the Strength Index, Physical Fitness Index, mental age, IQ, chronological age, weight, and height. The subjects numbered 348 boys and 348 girls. There was a correlation of .30 and .29 for boys and girls respectively in comparing the IQ, as measured by Terman's Group Test-Form A, and frequency of activities. The relation between intelligence and allocation of time in play was .19 for boys and .11 for girls.

To study the relationship of physical fitness to success in college, Weber used the Minnesota Multiphasic Personality Inventory and the grade average achieved freshman year. He found significant relationship between physical fitness scores and grade point average for a year; the coefficient of correlation was .41. (97)

Frederick Rand Rogers, who had revived strength testing in 1925 with the publication of his dissertation which developed the Physical Fitness Index and the Strength Index, in 1957 struck a most controversial note for physical and mental correlation with the statement of a law: General Learning potential is about twice as dependent upon physical fitness as upon intelligence. (78)

Perhaps in 1944 and 1945 Dr. Rogers was preparing the public for his statement. At that time he was crusading for physical education programs to be included in all schools and for administrators to be concerned with physical fitness. He felt that some physical fitness testing program should be in every curriculum and that PFI scores should be interpreted in relation to medical records, IQ's, and if possible, somatotypes. The end result would be to raise American senior high schools in physical and mental stamina by 20% or more in a single year, for the average of the entire school. (84)

In 1958, Dr. Rogers is working with the Projected American Foundation for Physical Fitness and is a proponent of Contrology, a theory so recent that it defies definition.

In corresponding with Dr. Rogers about the statement of his law, the writer learned that "the proper use of the law 'as a guide' can readily double all education's overall good effects." (79)

Rogers (79) further stated, "I haven't the slightest intention to provide any schoolman anywhere with any fragmentary notes or references on Rogers' Law or its 'proofs' in scientific experiments; though rest assured there are a superabundance."

A second letter from Dr. Rogers (80) states that the key to Rogers' Law is to be found in Rogers' concept of the "synapse." There was no accompanying explanation.

From Galton through Abernethy and Paterson, only general inconclusiveness can be drawn from the studies on physical and mental correlations. The conclusions are conflicting; the purposes of the studies ranged from the correlation of subjective teachers' estimates of physical and mental traits to the influence of bodily posture on powers of sensory discrimination and feats of muscular strength and control. Inaccuracy in drawing conclusions was heightened by the use of inadequate, crude statistical measures.

The McCurdy Physical Quotient, for all its good intents and purposes, never got beyond the stage of speculation.

The period 1920-1930 was the most prolific period with studies of mental and physical correlations. Gates drew sound conclusions from his 1924 study; physical measurements, though highly desirable for their own sake, should not be used to classify children intellectually, emotionally, or socially. In his educational theories of the next year, Gates emphasized maturation in one instance and failed to account for maturation in the achievement-capacity theory. This discrepancy casts a shadow on the 1924 study; an experiment can be only as sound as the experimenter.

Analogies can be drawn from Gates' work to apply to other studies of the 1920-1930 period. That is, the conclusions were either refuted by another study, or the results were insignificant. The quantity of

1920-1930 had not wrought quality.

No positive conclusions are to be drawn from the studies concerned with athletic ability or participation in athletics as correlated with intelligence or scholastic standing.

Rogers' Physical Fitness Index and Strength Index benefited physical fitness testing, but contributed little to the problem of correlating mental and physical traits.

Tests since 1940 have been inconclusive as a group and too varied to make any valid contribution to the controversy. Rogers will not unveil evidence to support his law which "can readily double all education's overall good effects;" therefore educational circles cannot treat this law seriously. Although Rogers takes a determined stand in the statement of Rogers' law, he resolves the mind-body controversy no more nearly than did Porter in the early 1900's.

CHAPTER IV

A SCIENTIFIC BASIS

The physiological basis of intelligence.

Among other definitions, intelligence has been cited as an organic concept, as the potentiality of a given type of behavior inherent in the bodily constitution of an individual. This concept is compatible with the view that behavior is determined jointly by the constitution and environment. (25)

Relative to the physiological basis of intelligence, Stoddard (91) believed that the physical totality includes specialized sense organs and nervous structures that set limits to functions and abilities. He (91:53) stated further, "The underlying structure of intelligent behavior is the body taken as a whole, with contributions from its various parts and functions that run the gamut from the almost inconsequential to the immediate and crucial."

Stoddard also said (91:71), "The brain cannot 'think' without supporting neutral and muscular mechanisms, without life in the organism, without nutrients in the world, without energy from the sun, and so on into the usual infinity of progression."

Carmichael (13:95) has observed that since the blood stream and its components, including oxygen, food materials, hormones, and other agents form the internal environment of the nervous system, "this internal environment in definite ways conditions the growth and functional level of the brain and other organ systems, which themselves function in the

determination of intelligent acts."

Stoddard and Carmichael had supporting viewpoints: that intelligence has a physiological basis. They would not necessarily agree with G. Stanley Hall who has taken the extremist position. Hall (40) was of the opinion that the cortical centers for the voluntary muscles extend over most of the lateral psychic zones of the brain, "so that their culture is brain-building. He further states (40:165), "The education of the small muscles and fine adjustments of larger ones is as near mental training as physical culture can get, for these are thought-muscles and movements, and their perfected function is to reflect and express slight modifications of tension and tone of every psychic charge."

Taking one aspect of the problem, Donaldson (91), according to Stoddard, believed that the vascular tree, represented by the vessels in the pia, is better developed in intellectuals. If this is the case, such individuals would have a better blood supply to the cortex which would contribute to a better performance.

Likewise, according to Carmichael, Hill (13) listed many men like Descartes who "buried his head in a sofa" in an effort to improve his "thinking." Casual observations are said to suggest a correlation between excellence of mental function and a full supply of blood in optimal condition to the brain. Interference with blood supply to the brain always produces dizziness.

These brief statements concerning the physiological basis of intelligence and the one more specific postulate of the importance of

optimum blood supply to the brain suggest a scientific solution to the mind-body controversy. For the writer's satisfaction, the question of neurological function being susceptible to improvement would have to be proved or disproved. If function was susceptible to improvement, the difficulty of devising methods for improvement and their bearing on heightening mental activity would be the task.

Correlates of mental and physical growth.

Johnson (52:10) took a questionable stand in his statement, "That the mental growth of the child is conditioned by the anatomical and physiological characteristics of the organism is widely accepted."

He further emphasized his point (52:145), "Since bodily growth and growth in mental ability proceed simultaneously, there is an obvious relationship between the two in that growth of body is accompanied by growth of mind; but a recognition of this relationship does not explain the influence of one upon the other."

Johnson failed to substantiate his claim.

According to one author (13) brain characteristics, and hence the characteristics of intelligent behavior, will change during growth. These growth changes come as a result of nerve-cell alterations, circulatory modifications, and the like, that are determined by factors intrinsic to the individual organism.

Carmichael (13:125) assumed a more conservative stand: "It would be far going beyond the facts to allege that the growth of intelligent behavior that is measured during the first, second, third, fourth, and subsequent years can be thought of as a mere correlate of the changes

resulting from the inner growth of the nervous system during this period. That much behavior change during this period is dependent upon sheer growth rather than upon specific environmental change, however, is suggested by analogy with the functional changes that accompany the growth of the lower brain centers during fetal life."

According to Davenport and Minogue's reference to Whipple (20), the best mental condition and the most rapid mental development will be found among those whose physical condition is good and whose growth is unimpaired by ill health and faulty nutrition.

Henzik and Jones (45) found that desirable physical characteristics are positively correlated with desirable mental characteristics; the correlation is too low for prediction.

Davenport and Minogue (20) attempted to find correlation between the development of cerebral cortex and the development of physical traits - weight, stature, body proportions, teeth, and body hair. They accepted the idea that mental development depends on the development of the cerebral cortex. Their test on 78 feeble minded white boys gave correlations varying from .24 to .48 for the relation of physical age to mental age.

Schneider (87) experimented with albino rats and showed that long-continued exercise produced many alterations in organs; among these changes brain weight increased 4%.

Stoddard (91) maintained that the principal sources of relationship between intelligence and physical factors would be found through coordinated studies of the development of the nervous system and of the abilities

involved in the concept of intelligence.

Abernethy (3) concluded from her study that there is low positive correlation between the mental and physical status of children. She found no relation in the changes in rate of mental and physical development. There was no correlation between the mental test scores of adults and measures of standing height and weight.

According to Burks, Rogers (10) found in his study that diseased adenoids and tonsil conditions have no unfavorable effect upon intelligence as measured by the Stanford Binet test.

As to the question of the relation between general intelligence and nutrition, Stoddard (91) gave only one possible line of direct relationship and that is in terms of actual changes in the organism. Otherwise there were too many variables with which to contend.

Gesell (31) in discussing precocious puberty and mental maturation, remarked that the nervous system, among all the organs of the body, manifests a high degree of autonomy; it is remarkably resistent to malnutrition.

According to Stalnaker, Blanton (90:199) conducted a study with 6,500 children in Germany and concluded, "The nervous system of the child of good nervous stock can resist malnutrition to an extreme degree extending over three years. But the feebleminded, the borderline defectives and those classed as dull are affected and often prematurely so by malnutrition of even moderate severity."

Striking a note from another angle, Carmichael (13:142) has stated, "Intelligent behavior and mental processes with which education is con-

cerned have never been demonstrated to take place in absence of active bodily structures."

Also Carmichael (13) pointed out that anatomical study of brains of men and women of distinguished intellectual attainments has not demonstrated why they were intellectually superior.

More positively, he (13:126) cited, "There is good evidence that alterations in the character of intelligent behavior during early years are related to the gradual maturation (that is, growth in all its details) of the brain."

The evidence concerning mental and physical status, mental and physical growth correlations, and the cause and effect question of their supposed relation is, for the most part, inadequate and contradictory. There is a general dearth of sound information available.

Superior and inferior intellectual deviates.

According to Davenport and Minogue (20) a relation between mental and physical traits is most observable in a series including the feeble-minded and/or the gifted, when it may not be found in so highly selected and uniform a group as college students. Failures to find any correlation have mostly occurred in reporting on a too-homogeneous or a non-developing group.

A study conducted in 1923 in which thirty-seven anthropometric measurements were taken of 594 boys and girls, ages 7 to 14, concludes that the gifted children were in all respects slightly superior physically to various groups used for comparison. (92)

Terman's study of the gifted, as designated by an IQ of 140 or

better, demonstrated that intellectually gifted children, either because of better endowment or better physical care, or both, are as a group slightly superior to the generality of children in health and physique and tend to remain so (51).

Goodenough (35) corroborated this viewpoint with her statement that gifted children show superiority over those of control groups in respect to general health and health habits. She views this in reference to the fact that a majority of the intellectually brilliant come from homes of relatively high educational status. Whether or not their superior physical care can account for their better physical condition is unknown.

Hollingworth, Terman, and Oden (51) believed that sex, race, economic status, and physical stamina all count heavily in achieving eminence through genius.

Monahan and Hollingworth (50) found that children, selected for high IQ are distinctly superior to children unselected for IQ in regard to effective speed of movement in arm and hand tapping. They were also found superior in school achievement, in body size, and hand strength. However, great discrepancy existed between the amount of deviation in intellect and in scholastic achievement, on the one hand, and in size and motor capacity, on the other.

In a later study Hollingworth and Monahan (65) concluded that in performance involving raising the body weight, such as the standing broad jump, the gifted do not surpass their ordinary school mates.

Witty and Lehman (100) in an intensive study involving fifty

children, concluded that a gifted group and a control group demonstrated the same versatility of interest in play and engaged in the same number of activities, even though the gifted spent more time in reading.

In 1924 Hollingworth and Taylor (49) had observed that intellect cannot be readily inferred from physical size, nor physical size from intellect. There was nothing to suggest that superior children are bright because they are tall and heavy as a group in general; nor that they are tall and heavy because they are bright.

The supposition that intellectual giants necessarily are physical weaklings has practically been dispelled. However there has been no explanation for the reason why the gifted of 140+ IQ may also be superior in body build and some types of physical performance.

Conversely, inferior intellectual deviates tend to be undersized, lacking in vitality, and exhibit an unusual number of physical defects. (51)

According to Hollingworth, Oden, and Terman, Brander (51) found that among prematurely born babies, the lower the median birth weight, the lower the IQ was at seven to fifteen years. Inferior deviates are characterized by a lower birth weight.

Wheeler (51) observed that dull children are inferior as a group to norms established for height, weight, and several other variables of physique.

Dayton (51) grouped 14,176 mentally inferior children with reference to incidence of physical defects. The number of the latter increases as intelligence decreases.

According to Stoddard, Doll (91:285) stated, "Recent evidence reaffirms that motor retardation accompanies mental retardation among the feebleminded. They are subnormal in general alertness (not synonymous with MA), initiative, creative aptitude, sentiments and ideals. They excel in monotonous perseveration and fall short in adaptive concentration."

It was Stoddard's opinion (91) that the inferior physique of mentally deficient children may be, except at the lowest grade, a reflection on the educational and economic status of the home. Remediable organic conditions may go from bad to worse.

The view that environment is a causative factor in superior and inferior mental and physical deviation is supported: "Superior environments, like superior diets, are those environments that produce superior results." (25:25) Theoretically, if the child's IQ is as high as the particular environment is capable of producing in him, there will be no increase; if lower, there will be an increase. Conversely if the environment is a depressing one, the amount of drop will be greater when his initial status is higher. (25)

Freeman, Holzinger, and Mitchell, (27) in a study on the effect of environment upon the intelligence of foster children, concluded that the children in the better foster homes gained considerably more than did those in poorer homes.

Burks (11) studied the factors conditioning the intelligence of a group of white American school children living in ordinary variable circumstances. She concluded that home environment contributes about

17% of the variance in IQ, and that nearly 70% of school children have an actual IQ within six to nine points of that represented by their "innate intelligence."

However, the research giving strength to the environment theory does not claim that environment is the answer to this inferior-superior deviation pattern. The writer observes that the matter is open to another cause-and-effect proof; that is, mental superiority causing physical superiority or vice versa.

Implications for education.

Carmichael (13:144) has stated, "Since also many environmental factors, such as nourishment, especially including the appropriate provision or exclusion of the vitamins, oxygen, toxic substances, disease products in the blood stream, and the like, are known to influence the development of the brain, whatever its hereditary 'potentiality' may be, such factors should be controlled to the fullest degree possible by a society that wishes to maintain the maximal intelligence in the behavior of its population. Thus, every effort may well be made by society and by educators to provide the most adequate human nourishment in its completest sense in an environment as free as possible from toxic agents in order to influence the optimal growth of each brain and thus allow the optimal education for each human brain within the boundary set by the inherited anatomical limits of each brain."

Gates (30:460) concisely confirms Carmichael's belief, "Education must become an intricate art, which must be grounded in a complex science."

The science needs more facts gleaned through research about the

physiological basis of intelligence and mental and physical correlates of growth. One very interesting problem to be investigated is the possibility of mental development affecting physical development and/or physical development affecting mental development.

CONCLUSIONS

After a review of literature, the question of mental-physical correlation remains as complex and inconclusive as ever.

Certain observations regarding this research come to mind: the content of many of the studies was superficial; too few subjects participated; the studies were too short-range; the tests did not measure what they purported to measure. Perhaps concentrated work in physiological psychology and with mental and physical growth correlations would result in more conclusive evidence. The writer does not have the answer.

Perhaps John Locke's observation that, "A sound mind in a sound body, is a short, but full description of a happy state in this world," is philosophically still applicable today.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Aaron, Richard I., John Locke. London: Oxford University Press, 1937. 328 pp.

2. Abernethy, Ethel M., "Correlations in Physical and Mental Growth," Journal of Educational Psychology. 16:458-466 (October, 1925).

3. _____, "Relationships Between Mental and Physical Growth," Monographs of the Society for Research in Child Development. Washington: Society for Research in Child Development. Vol. I, No. 7, 1936. 70 pp.

4. American Association for Health, Physical Education, and Recreation. Research Methods Applied to Health, Physical Education and Recreation. Washington, D. C., 1952. 517 pp.

5. Anastasi, Anne, Psychological Testing. New York: The MacMillan Company, 1954. 582 pp.

6. Bagley, William Chandler, "On the Correlation of Mental and Motor Ability in School Children," American Journal of Psychology. 12:193-205 (January, 1901).

7. Bovard, John F., Frederick W. Cozens, and E. Patricia Hagman, Tests and Measurements in Physical Education. Philadelphia: W. B. Saunders Company, 1949. 410 pp.

8. Boynton, Paul L., Intelligence. Its Manifestations and Measurement. New York: D. Appleton and Company, 1933. 466 pp.

9. Brace, Donald K., "The Development of Measures of Pupil Achievement in Physical Education," The Research Quarterly. 2:32-37 (October, 1931).

10. Burks, Barbara Stoddard, "A Summary of Literature on the Determiners of the Intelligence Quotient and the Educational Quotient." The Twenty-Seventh Yearbook of the National Society for the Study of Education. Nature and Nurture. Part II: Their Influence Upon Achievement. Bloomington, Illinois: Public School Publishing Company, 1928. 248-350 pp.

11. _____, "The Relative Influence of Nature and Nurture Upon Mental Development: A Comparative Study of Foster Parent-Foster Child Resemblance and True Parent-True Child Resemblance." The Twenty-Seventh Yearbook of the National Society for the Study of Education. Nature and Nurture. Part I: Their Influence Upon Intelligence. Bloomington, Illinois: Public School Publishing Company, 1928. pp. 219-316.

12. Burley, Lloyd R. and Ray L. Anderson, "Relation of Jump and Reach Measures of Power to Intelligence Scores and Athletic Performance." The Research Quarterly. 26:25-34. (March, 1955).

13. Carmichael, Leonard, "The Physiology of Intelligence." The Thirty-Ninth Yearbook of the National Society for theStudy of Education. Intelligence: Its Nature and Nurture. Part I: Comparative and Critical Exposition. Bloomington, Illinois: Public School Publishing Company, 1940. pp. 93-145.

14. Cattell, Psyche, "School Standing and Physical Efficiency." School and Society. 20:60-64. (July, 1924).

15. Chamberlain, Carl G. and Dean F. Smiley, "Functional Health and the PFI," The Research Quarterly. 2:193-198 (March, 1931).

16. Clarke, H. Harrison, The Application of Measurement to Health and Physical Education. New York: Prentice-Hall, Inc., 1945. 343 pp.

17. Colvin, Stephen S., "Principles Underlying the Construction and Use of Intelligence Tests." The Twenty-First Yearbook of the National Society for the Study of Education. Intelligence Tests and Their Use. Part I: The Nature, History, and General Principles of Intelligence Testing, 1923. pp. 11-44.

18. Cozens, Frederick W., "Status of the Problem of the Relation of Physical to Mental Ability," American Physical Education Review. 32:147-155. (March, 1927)

19. Da Costa, Marie I. L., (Translated by E. J. Fosa) "The Oseretsky Tests; Method, Value, and Results." Training School Bulletin. 43:1-13, 27-38, 50-58, 62-74. 1946.

20. Davenport, Charles B. and Blanche M. Minogue, "The Intelligence Quotient and the Physical Quotient: Their Fluctuation and Intercorrelation," Human Biology. 2:473-507. 1930.

21. Davis, E. C., "Athletic Ability and Scholarship - A Resume of Studies Comparing Scholastic Ability of Athletes and Non-Athletes," The Research Quarterly. 5:68-78 (December, 1934).

22. Dewey, John, Democracy and Education. New York: The MacMillan Company, 1916. 434 pp.

23. Di Giovanna, V. G. A., "Comparison of Intelligence and Athletic Ability of College Men," The Research Quarterly. 8:96-106 (October, 1937).

24. Flemming, Cecile Woodard, Analysis of Achievement in High School. Teachers College, Columbia University: Bureau of Publications, 1925.

25. Freeman, Frank N., "Definition of Concepts." The Thirty-Ninth Yearbook of the National Society for the Study of Education. Intelligence: Its Nature and Nurture. Part I: Comparative and Critical Exposition. Bloomington, Illinois: Public School Publishing Company, 1940. pp. 11-38.

26. _____, Mental Tests. Their History, Principles, and Applications. New York: The Houghton Mifflin Company, 1939. 460 pp.

27. _____, Karl J. Holzinger, and Blythe C. Mitchell, "The Influence of Environment on the Intelligence, School Achievement, and Conduct of Foster Children." The Twenty-Seventh Yearbook of the National Society for the Study of Education. Nature and Nurture. Part I: Their Influence Upon Intelligence. Bloomington, Illinois: Public School Publishing Company, 1928. pp. 103-217.

28. Gates, Arthur I., "Educational Significance of Physical Status and of Physiological, Mental, Emotional and Social Maturity," American Physical Education Review. 30:299-300 (May, 1925).

29. _____, "The Nature and Educational Significance of Physical Status and of Mental, Physiological, Social, and Emotional Maturity," Journal of Educational Psychology. 15:329-358 (September, 1924).

30. _____, "The Nature and Limit of Improvement Due to Training." The Twenty-Seventh Yearbook of the National Society for the Study of Education. Nature and Nurture. Part I: Their Influence Upon Intelligence. Bloomington, Illinois: Public School Publishing Company, 1928. pp. 441-460.

31. Gesell, Arnold, "Precocious Puberty and Mental Maturation." The Twenty-Seventh Yearbook of the National Society for the Study of Education. Nature and Nurture. Part I: Their Influence Upon Intelligence. Bloomington, Illinois: Public School Publishing Company, 1928. pp. 399-409.

32. Giague, Charles D., "An Inquiry into the Correlation Between Physical Fitness and Scholastic Standing." Supplement to The Research Quarterly. 6:269-275 (March, 1935).

33. Gittings, Ina E., "Correlation of Mental and Physical Traits in University of Arizona Freshman Women," American Physical Education Review. 32:569-583 (September, 1927).

34. Goll, Reinhold W. and Robert S. Miller, "A Study in Correlation Between IQ and Athletic Ability Scores," Mind and Body. 29:211-218 (September-October, 1922).

35. Goodenough, Florence L., Exceptional Children. New York: Appleton-Century-Crofts, Inc., 1956. 412 pp.

36. _____, Mental Testing. Its History, Principles, and Applications. New York: Rinehart and Company, Inc., 1949. 541 pp.

37. Green, John A., The Educational Ideas of Pestalozzi. Baltimore: Warwick and York, Inc. 222 pp.

38. Griffitts, C. H., "The Inadequacy of Strength Norms," The Research Quarterly. 6:117-124. (December, 1935).

39. Hackensmith, C. W. and L. Miller, "A Comparison of Academic Grades and Intelligence Scores of Participants and Non-Participants in Intramural Athletics at the University of Kentucky." The Research Quarterly. 9:94-99 (March, 1938).

40. Hall, G. Stanley, The Psychology of Adolescence. New York: D. Appleton and Company, 1931. 589 pp.

41. Hall, Robert T., "How Athletes and Non-Athletes Compare in Mental Ability and in Educational Achievement." American Physical Education Review. 33:388-389 (June, 1928).

42. Halsey, Elizabeth, "The Relation Between Various Measurements of Mental and Physical Traits." Supplement to The Research Quarterly, Wellesley College Studies in Hygiene and Physical Education. 9:57-58 (March, 1938).

43. Heaton, Kenneth L., "Physical Development of Children of High and Low Mental Ability Groups," American Physical Education Review. 30:127-130. (March, 1925).

44. Heidbreder, Edna, "Intelligence and Height Weight Ratio," Journal of Applied Psychology. 10:52-62 (March, 1926).

45. Henzik, Marjorie P. and Harold E. Jones, "Mental-Physical Relationships during the Preschool Period." Journal of Experimental Education. 2:139-146 (December, 1937).

46. Hertzberg, C. E., "The Relationship of Motor Ability to the Intelligence of Kindergarten Children." Journal of Educational Psychology. 20:507-519 (October, 1929).

47. Hetherington, Clark W., School Program in Physical Education. New York: World Book Company, 1926. 132 pp.

48. Hoefer, Carolyn and Mattie Crumpton Hardy, "The Influence of Improvement and Physical Condition on Intelligence and Educational Achievement." The Twenty-Seventh Yearbook of the National Society for the Study of Education. Nature and Nurture. Part I: Their Influence Upon Intelligence. Bloomington, Illinois: Public School Publishing Company, 1928. pp. 371-387.

49. Hollingworth, Leta S. and Grace A. Taylor, "B Studies of Physical Condition and Growth: B2. Size and Strength of Children Who Test above 135 IQ." The Twenty-Third Yearbook of the National Society for the Study of Education. Part I: The Education of Gifted Children. Bloomington, Illinois: Public School Publishing Company, 1924. pp. 221-237.

50. _____, and J. E. Monahan, "Tapping Rate of Children Who Test above 135 IQ," Journal of Educational Psychology. 17:505-518 (November, 1926).

51. _____, Lewis M. Terman, and Melita Oden, "The Significance of Deviates." The Thirty-Ninth Yearbook of the National Society for the Study of Education. Intelligence: Its Nature and Nurture. Part I: Comparative and Critical Exposition. Bloomington, Illinois: Public School Publishing Company, 1940. pp. 43-84.

52. Johnson, Buford J., Mental Growth of Children in Relation to the Rate of Growth in Bodily Development. New York: E. P. Dutton and Company, 1925. 149 pp.

53. Jones, Elmer E., "The Influence of Bodily Postures on Mental Activities," Archives of Psychology. No. 6. 60 pp. (October, 1907).

54. Jones, Rowland H., "Comparison of the Intelligence of High School Athletes with Non-Athletes," School and Society. 42:415-416 (September, 1935).

55. Krakower, Hyman, "Anthropometry," The Research Quarterly. 8:85-95 (October, 1937).

56. Landis, M. H., H. E. Burtt, and J. H. Nichols, "The Relation Between Physical Efficiency and Intelligence," American Physical Education Review. 28:220-221 (May, 1923).

57. Larson, Leonard A. and Rachel D. Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education. St. Louis: The C. V. Mosby Company, 1951. 496 pp.

58. Locke, John, "Some Thoughts Concerning Education," Locke's Works. London, 1794. 472 pp.

59. McCloy, Charles Harold, Tests and Measurements in Health and Physical Education. New York: F. S. Crofts and Company, 1939. 329 pp.

60. McCurdy, James Huff, "A Physical Intelligence Quotient," American Physical Education Review. 29:213-215 (May, 1924).

61. _____, "Physical Efficiency Standard," American Physical Education Review. 28:109-110 (February, 1923).

62. Mathews, Donald K., Measurement in Physical Education. Philadelphia: W. B. Saunders Company, 1958. 349 pp.

63. Meserve, Cecille A., "Status of Relationship of Motor and Mental Ability." Unpublished Master's Thesis. University of New Hampshire, 1933. 59 pp.

64. Metheny, Eleanor, "The Present Status of Strength Testing for Children of Elementary School and Preschool Age," The Research Quarterly. 12:115-130. (March, 1941).

65. Monahan, Jane E. and Leta S. Hollingworth, "Nueromuscular Capacity of Children Who Test above 135 IQ," Journal of Educational Psychology. 18:88-96. (February, 1927).

66. Montaigne, Michel E., Education of Children. New York: D. Appleton and Company, 1899. 170 pp.

67. Murdock, Katherine and Louis R. Sullivan, "A Contribution to the Study of Mental and Physical Measurement in Normal Children." American Physical Education Review. 28:209-215, 276, 280, 328-330. (May, 1923).

68. Paterson, Donald G., Physique and Intellect. New York: The Century Company, 1930. 290 pp.

69. Pechstein, L. A. and A. L. McGregor, Psychology of Junior High School. Houghton Mifflin Company. Boston, 1924.

70. Powell, Elizabeth and Eugene C. Howe, "Problems Related to Motor Ability." Supplement to The Research Quarterly. 9:57-66. (March, 1938).

71. Quick, Robert Herbert, Essays on Educational Reformers. New York: D. Appleton and Company, 1924. 526 pp.

72. Rarick, G. Lawrence and Robert McKee, "A Study of Twenty Third Grade Children Exhibiting Extreme Levels of Achievement on Tests of Motor Proficiency." The Research Quarterly. 20:142-151 (May, 1949).

73. Ray, Harold C., "Inter-relationships of Physical and Mental Abilities and Achievements of High School Boys," The Research Quarterly. 11:129-141 (March, 1940).

74. Remp, Martin, "A Comparison of the Scholastic Records of Athletes and Non-Athletes," American Physical Education Review. 30:187-192 (April, 1925).

75. Rice, Emmett A., A Brief History of Physical Education. New York: A. S. Barnes and Company, 1926. 276 pp.

76. Rifenberick, Robert H., "A Comparison of Physical Fitness Ratings as Determined by the Pulse-Ratio Test and Rogers' Test of Physical Fitness," The Research Quarterly. 13:95-107 (March, 1942).

77. Rogers, Frederick Rand, Physical Capacity Tests. New York: Teachers College, Columbia University, 1926. 86 pp.

78. _____, Unpublished Material. September 9, 1957.

79. _____, Unpublished Letter. November 4, 1957.

80. _____, Unpublished Letter. November 6, 1957.

81. _____, "The Evolution of PFI Tests and Programs," Education. 60:527-540 (April, 1940).

82. _____, "The PFI, Analogue and Complement of the IQ," School and Society. 50:546-557 (October, 1939).

83. _____, "The Significance of Strength Tests in Revealing Physical Condition," The Research Quarterly. 5:43-46 (October, 1934).

84. _____, Three Articles. American School Board Journal. 109:17-19; 110:21-22, 24-25 (December, 1944, February and April, 1945).

85. Rousseau, Jean Jacques, Rousseau on Education. New York: Longmans, Green and Company, 1912. 262 pp.

86. Rudisill, E. S., "Correlations Between Physical and Motor Capacity and Intelligence," School and Society. 18:178-179 (August, 1923).

87. Schneider, Edward C., "Physical Efficiency and the Limitations of Efficiency Tests," American Physical Education Review. 28:401-408 (November, 1923).

88. Schwelger, R. A. and J. L. Engelhardt, "A Test of Physical Efficiency: The Correlation Between Results Therefrom and Results from Tests of Mental Efficiency," American Physical Education Review. 29:501-505 (November, 1924).

89. Seegers, J. C. and O. Postpichal, "Relation Between Intelligence and Certain Aspects of Physical Ability," Journal of Educational Research. 30:104-109 (October, 1936).

90. Stalnaker, E. M., "A Comparison of Certain Mental and Physical Measurements of School Children and College Students," Journal of Comparative Psychology. 3:181-239 (June, 1923).

91. Stoddard, George D., The Meaning of Intelligence. New York: The MacMillan Company, 1943. 481 pp.

92. Terman, Louis M., Editor, The Gifted Child Grows Up. Stanford, California: Stanford University Press, 1947. 438 pp.

93. Tuttle, W. W. and F. S. Beebee, "A Study of the School Attainment of Letter Winners at the State University of Iowa," The Research Quarterly. 12:174-180 (May, 1941).

94. Van Dalen, D. B., "A Study of Certain Factors in Their Relationship to the Play of Children," The Research Quarterly. 18:279-290 (December, 1947).

95. _____, "The Contribution of Breathing Capacity to PFI," The Research Quarterly. 7:93-95. (December, 1936).

96. _____, Elmer D. Mitchell, and Bruce L. Bennett, A World History of Physical Education. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1953. 599 pp.

97. Weber, Robert John, "Relationship of Physical Fitness to Success in College and to Personality," The Research Quarterly. 24:471-474 (December, 1953).

98. Westendarp, Dorothy Emma, "Mental Capacity and its Relation to Physical Efficiency," American Physical Education Review. 28:216 (May, 1923).

99. Williams, Jesse Feiring, The Principles of Physical Education. Philadelphia: W. B. Saunders Company, 1956. 351 pp.

100. Witty, Paul and Harvey Lehmen, "The Play Behavior of Fifty Gifted Children," Journal of Educational Psychology. 18:259-265 (April, 1927).

101. Woodward, William Harrison, Vittorino da Feltre and Other Humanist Educators. Cambridge: University Press, 1905. 260 pp.